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Body Mass Index of Freshman University Students

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Abstract

Purpose: Obesity has become a major epidemic affecting Americans of all ages including adolescents. The purpose of this study was to determine the Body Mass Index (BMI) of university freshman students during their first month of college, to assess its association with race/ethnicity, blood type, and demographic/lifestyle factors, and to document the change in weight and BMI in this same group of students at the end of their first year of college.

Methods: Two hundred freshman students were enrolled at the beginning of freshman year and followed up at the end of freshman year. Information regarding various lifestyle factors, demographics, and blood type were collected.

Results: Eight percent of students were obese (BMI ≥ 30) and 33.5% were overweight (BMI ≥ 25) or obese, with a significantly higher BMI amongst students from rural towns. On follow-up there was a significant increase in mean BMI, from 24.24 +/- 4.49 to 24.85 +/- 4.75 (p<0.0001). Lifestyle factors, race, and blood type were not associated with increased BMI.

Conclusions: A significant percentage of university freshmen students are overweight or obese. The serious consequences of increasing prevalence of obesity call for earlier interventions to combat progression to obesity in young adults. These data indicate the need for interventions in university settings as a means for combating the United States obesity epidemic.

Keywords

Obesity; University freshmen students; Body Mass Index; Blood type; Rural; Lifestyle factors

Introduction

Obesity has become a major national health challenge in the United States, and has been recognized by the World Health Organization as a global non-communicable disease target [1]. The National Health and Nutrition Examination Survey (NHANES) 2015-2016 dataset estimated that 39.6% of US adults and 18.5% of youth (age 2 to 19 years) were obese, and in 2015, the overall prevalence of obesity worldwide was 12.0% among adults and 5% among children [2,3]. Over the span of 40 years, the prevalence of obesity increased from half the prevalence of underweight to significantly more than the prevalence of underweight, both nationally and worldwide [4]. The mean weight gain between 1960 and 2016 for adult males and women in the Unites States has been 32 and 30 lb, respectively [5,6].

Increased morbidity and mortality are positively associated with increased body mass index (BMI); obesity is a risk factor for major chronic diseases including cardiovascular disease, diabetes, chronic kidney disease, nonalcoholic fatty liver disease, metabolic syndrome, and numerous malignancies [1]. In addition to the health implications of rising obesity rates, the McKinsey Global Institute's 2014 report, "Overcoming obesity: an initial economic analysis," estimates that the global economic impact of obesity is about $2 trillion (2.8 % of global GDP) [7].

The clear economic and global health consequences of obesity, combined with the increasing incidence of obesity in our nation's young population, calls for early intervention in the lifestyle choices of our nation's youth. Freshman university students provide a unique cohort for the study of these issues in that the abundance of potentially unhealthy dietary options in university dining halls makes the possibility for weight gain more likely, while the potential for control of on-campus dining options provides an opportunity for early intervention of obesity and prevention of comorbidities. Additionally, the diverse pool of university students provides a wide range of demographic and lifestyle factors such as gender, race, geographic hometown, exercise, diet, caffeine and nicotine exposure that may

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Please fill in the blanks or place an X or check mark next to the word or phrase that best matches your response.

Today's Date:
_____

Full Name: _____ **University ID:**
_____

Birth Date (if less than 18 years old or > 19 years old not eligible):
_____

Email: _____ **Cell phone:**
_____

Dormitory: _____ **Hometown in last year (city/state):**
_____

What is your gender?

☐ Male

☐ Female

How would you describe your race or ethnicity?

☐ Caucasian/White

☐ African American/Black

☐ Asian

☐ Hispanic/Latino

☐ Native American

☐ Other:

Do you average one or more cups of coffee/day? average?

☐ Yes

☐ No

Do you smoke cigarettes more than one/day on

☐ Yes

☐ No

Do you chew nicotine gum more than one time per week on average?

☐ Yes

☐ No

Do you vape more than one time/week on average?

☐ Yes

☐ No

Are you vegetarian?

☐Yes

☐No

Do you regularly perform aerobic exercise 2 hours or more per week?

☐ Yes

☐ No

Have you run:

☐ No miles in the last week

☐ 1 to 3 miles in the last week

☐ 3 to 10 miles in the last week

☐ 10 to 30 miles in the last week

☐ 30 to 50 miles in the last week

☐ More than 50 miles in the last week

Figure 1: Student demographics questionnaire

or may not impact obesity risk. Even blood type may be a risk factor, as in one particular study, individuals with the Lewis blood group (Le A-, B-) have been reported to have a nearly two-fold prevalence of obesity when compared with other Lewis blood types [8].

The primary objective of this study was to determine the Body Mass Index (BMI) of university freshman students entering their first month of college, and secondarily, the association of BMI with race/ethnicity, blood type, and demographic/lifestyle factors, and the change in weight and BMI in this same group of students at the end of their first year of college.

Methods

This clinical study was approved by the Institutional Review Board of the University of Iowa. Over two consecutive days in the first week of September 2018, two hundred university freshman students (18 or 19 years old) were enrolled in a co-educational dormitory at the University of Iowa from whom we were able to obtain blood from 198 students. Recruitment efforts consisted of study posters posted in common areas of residence halls, campus broadcast email to first year undergraduate students, and a table set-up in the residence hall with study brochures and a study member to answer questions about the study from 10:00AM to 2:00PM.

Students in the lobby of the dormitory were screened for eligibility by confirming freshman status, age of 18 or 19 years old, and current status of good general health with no history of bleeding disorders. Students were excluded if they did not meet all of the above eligibility criteria. Once students were determined eligible for the study and had given informed consent, they each completed a brief questionnaire (Figure 1) and provided 12 mL of blood drawn

via antecubital venipuncture in EDTA anticoagulant, performed by a University of Iowa Hospitals and Clinics (UIHC) -trained phlebotomist. After each student removed their shoes and jackets and emptied their pockets, height and weight were measured in meters and kilograms, respectively, using a UIHC-provided Scale-Tronix scale (Welch Allyn, Inc, Skaneateles Falls, NY). In exchange for their participation, each student was given a $20 gift card at the end of their visit. This procedure was repeated in the last week of April and the first week of May 2019, at the end of these students' freshman year.

Laboratory procedures

Blood type testing (ABO, RH, and Lewis) was performed at the DeGowin Blood Center at the University of Iowa Hospitals and Clinics.

Statistics

Data collected from the questionnaires were entered and stored using REDCap Cloud software. BMI was calculated using weight (kg)/height (M^2). Comparisons between categorical and continuous variables were made using Pearson's chi-square and Wilcoxon rank sum tests, respectively. Type I error rate was set at $\alpha = 0.05$. Statistical analysis was performed using SAS version 9.4.

Results

Demographics

The mean BMI of the 200 students was 24.2 (range 16.2-47.5) of whom 8.0% were obese (BMI ≥ 30) and 33.5% were overweight (BMI ≥ 25) or obese. Of the 73 male students, 8.2% were obese and 35.6% were overweight or obese. Of the 127 female students, 7.9% were obese and 32.2% were overweight or obese. Females had a significantly lower BMI than males (p = 0.0441), with a mean female BMI of 23.8 (range 16.2 – 43.9) compared with a mean male BMI of 24.98 (range 18.3 – 47.5).

Of the 200 students, 79.1% were white (155), 7.1% were "other" (14), 6.1% were Asian (12), 6.1% were Hispanic (12), and 1.5% were black (3 subjects). There was no significant relationship between BMI and any of these racial groups (p = 0.1307), nor between BMI and dichotomized categorization of white versus other (p = 0.3157).

Forty-one (20.7%) of 200 students were from a hometown in a rural area as defined as a town with over 2,500 people, but less than 1,000 persons per square mile, or less than 2,500 people. Mean BMI for students who came from rural hometowns was 25.6, compared with a mean BMI of 23.8 of the students who came from urban hometowns, a difference which was statistically significant (p=0.049).

Lifestyle factors

Thirty-four percent of students drank coffee daily. The mean BMI for those subjects that regularly consumed coffee/caffeine was 24.34 (16.25 – 47.46) while a mean BMI for those who did not was 24.14 (17.93 – 43.02) (p = 0.7481). No student smoked more than one cigarette a day on average, and 24% vaped weekly. The mean BMI of those who vaped weekly was 23.8 versus 24.3 of those who did not (p= 0.8818).

Nine (4.5%) of 200 students reported having a vegetarian diet. The mean BMI for those students who reported a vegetarian diet was 22.82 (17.75 – 26.62) while a mean BMI for non-vegetarians was 24.28 (16.25 – 47.46) (p = 0.2836), but the number of vegetarians was small (n=9).

Seventy-four percent of students reported engagement in aerobic exercise more than twice a week. The mean BMI for students who participated in regular vigorous aerobic exercise was 24.11 (16.25 – 47.46) versus 24.42 (18.31 – 43.89), (p = 0.6446) for those who did not.

Laboratory results

Peripheral blood was obtained from 198 students (125 women,

73 men). Blood samples from each subject were typed for ABO, RH, and Lewis blood antigens. The distribution of blood types of the students was as follows: Type O 44%, A 34%, B 17%, AB 5%, Rh positive 80%, and Lewis A -, B- 6.6%. Mean BMI was 23.65 for type A (16.25 – 43.89), 24.44 for type B (17.10 – 36.20), 24.98 for type AB (18.81 – 34.79), and 24.31 for type O (18.18 – 47.79). Blood type did not have a significant relationship with BMI for ABO blood type (p = 0.676). The mean BMI for Rh positive students was 24.5 versus 24.05 for Rh negative students (p=0.349). The BMI and percent obese for Lewis A-, B- students was 23.7 and 7.7%, respectively, versus 24.2 and 7.6%, respectively, in Lewis positive students (p=0.73 and p=1.0, respectively), but the number of Lewis A-, B- students was small (n=13).

Follow-up results

134 (67%) of the 200 subjects returned for a follow-up visit eight months after the initial visit, of whom 49 (37%) were men and 85 (63%) were women. Repeat measurement of height and weight and calculation of BMI of those with a follow-up visit revealed a significant increase in mean BMI, from 24.24 +/- 4.49 to 24.85 +/- 4.75 (p<0.0001) compared to the BMI of the same 134 students at baseline in the fall. Of the 134 students who followed-up, 9.0% were obese and 40.3% were overweight or obese, compared with 9.0% obese (p = 1.0) and 32.1% overweight or obese (p = 0.1615) at the beginning of the year. Of the 49 male students on follow-up, 14.3% were obese and 46.9% were overweight or obese, compared with 8.2% obese (p = 0.5093) and 34.7% overweight or obese (p = 0.2187) at the beginning of the year. Of the 85 female students on follow-up, 5.9% were obese and 36.5% were overweight or obese, compared with 9.4% obese (p = 0.3843) and 30.6% overweight or obese (p = 0.4179) at the beginning of the year.

There was a significant increase in weight, with a mean gain of 3.44 lb (p<0.0001). Males showed an increase in BMI from 24.98 to 26.24 (p= 0.0003) with a mean gain of 5.15 lb (range: -12.76 – 24.42) (p=0.0002) and females showed an increase in BMI from 23.77 to 24.48 (p=0.0023) with a mean gain of 2.46 lb (range: -24.86 – 20.02) (p=0.0012). Those who exercised regularly gained an average of 3.32 pounds while those who didn't gain an average of 3.93 pounds (p = 0.5911).

Discussion

In this study of 200 students entering their freshman year at the University of Iowa, 33.5% were overweight or obese. According to the most recent National Health and Nutrition Examination Survey, in 2015-2016, 18.5% of youth (age 2-19 years old) and 39.8% of adults were reported to be obese, with a significant increase since 1999-2000[2].While currently, the rate of obesity in the group of individuals enrolled in this study is less than the national average for adults, the percentage of overweight students (24.3% of females and 27.4% of males) and obese students (7.9% of females and 8.2% of males) is consistent with other studies of university students [9,10].

The finding that students from rural hometowns have significantly higher BMI than students from urban areas is consistent with national data in adults [11]. Notably, our study did not show any significant relationship between any racial groups and BMI whereas nationally BMI is significantly higher among Blacks and Hispanics [2]. However, our number of non-white students was relatively small. There was no significant association with ABO, Rh, or Lewis blood type and BMI. This finding of no association with ABO or Rh blood type is not unexpected as none has been reported to our knowledge. However, Lewis A neg B neg blood type has been reported as a marker of obesity in a large population of blood donors in Denmark [8], but we did not find such an association possibly due to the low number of Lewis A neg B neg students (n=13).

Nicotine inhalation among smokers has been associated with a lower BMI [12], but no student reported smoking more than one cigarette per day. We found there was no significant difference in BMI among the 24% of the students who vaped and those who did not.

However, data regarding the amount of nicotine in various vaping products and length of use were not obtained in this study. Higher coffee consumption has been associated with lower BMI [13], but we did not find such an association in students who drank coffee daily versus those who did not. This non-difference could perhaps be due to the fact we did not ask how many cups of coffee were drunk per day in each group which may not have been that much different.

Cardiorespiratory fitness has been associated with lower BMI [14], and nearly three quarters of students reported engagement in aerobic exercise more than twice per week. However, again we saw no significant difference between the two groups which may reflect a necessary exercise threshold not being reached in the exercise group.

Vegetarian diet has also been associated with lower BMI [15]. The 9 students who reported having a vegetarian diet had a lower BMI than non-vegetarians (22.82 versus 24.28), but not significantly different probably explained by the small number of vegetarians in the study.

Our study found an average weight gain of 5.15 lb for men and 2.46 lb for women students after 8 months follow-up. These findings are consistent with a 2008 study performed at Dartmouth college on a total of 607 freshman students which found that the average weight gain during the first six months of college for both men and women was approximately double that of the average American adult during a one year period, with men and women gaining an average of 5.6 lb and 3.8 lb, respectively, between spring of their senior year of high school and November of their freshman year of college [16]. Interestingly, the percentage of obese men in our study increased while the percentage of obese women decreased despite an average weight gain for the group of women as a whole.

Finding that nearly one third of these freshman students were overweight or obese starting college is a major concern. A BMI of 25 or more is predictive for progression to obesity later in life, especially given the small but significant increase in both weight and BMI that was seen in these students over an eight-month period. A literature review performed by Whitlock et al on the implications of overweight in children and adolescents revealed that not only do BMI measures in childhood and adolescence track to adulthood, but the probability of adult obesity in overweight adolescents age 16-18 is 77-80% in white males and 66-68% in white females [17].

Elevated BMI is associated with numerous comorbidities that have significant and potentially life-long impact on health, healthcare costs, and quality of life. Elevated blood pressure, or hypertension, is itself associated with increased risk for atherosclerosis, coronary artery disease, stroke, kidney disease, and hypertensive retinopathy [18]. Both obesity and hypertension are major risk factors for developing type 2 diabetes, which is accompanied by its own myriad of complications and a lifetime of healthcare expenses [19]. In addition to high systolic and diastolic blood pressures, greater severity of obesity is associated with higher risks for developing low high density lipoprotein cholesterol levels, high triglycerides, and high glycated hemoglobin levels (an indication of prediabetes and diabetes mellitus), all of which have been defined in the New England Journal of Medicine as "cardiometabolic risk factors". These factors have been historically low among children and young adults but are increasing due to the increasing prevalence of severe obesity among these populations [20].

It is clear that there is need for developing better strategies to prevent and combat weight gain and obesity in university students. Our study, while small, documents the need for effective preventative interventions in university students.

Limitations

While this study does provide preliminary insight into some of the demographic and lifestyle factors related to changes in BMI and weight during University of Iowa students' first year of undergraduate education, there are several limitations as to the generalizability of the data obtained. The subject total of 200 freshman students resulted in small sample sizes in some categories (such as that of vegetarian diet of which there were only nine students), resulting in a lack of statistical significance in determining association with BMI. In addition, the timeframes during which lifestyle activities occurred were not asked, but meant to be current which could be variably interpreted. Additionally, the chosen method of recruitment may have resulted in a greater number of female than male subjects, though it should be noted that the total entering undergraduate freshman population consists of 62% females similar to the 63.5% in our study. The chosen time and location of recruitment (the hours before, during, and after lunch, in the entrance to a freshman dining hall) may also have resulted in a selective bias, as we may not have recruited a representative sample of students who regularly skip lunch. While only 67% of students presented to the follow-up visit, the average baseline BMI of this subset was nearly identical to that of the original population (24.2) at baseline. The follow-up data for average baseline BMI and/or weight gain may have been an underestimation, as overweight students or those who gained weight may not be as willing to participate in such a study or to follow up. Finally, true weight may not have been accurate, as students were asked only to remove their shoes, jackets, and pocket contents, and thus clothing may have positively skewed the data for weight and BMI.

The strengths of this study included a relatively broad selection of the freshman students who were available at the recruitment location during study hours. The study was conducted during different days of the week, in order to eliminate bias against students for whom class schedules that might have restricted their participation on any particular day of the week. Additionally, height and weight were measured using a standardized and objective process, and BMI was calculated using a widely-accepted formula.

Conclusions

Of 200 freshman students at the University of Iowa, approximately a third were overweight or obese when starting their first semester of college and gained an average 3.44 lb over 8 months. Students who came from rural hometowns had a significantly higher mean body mass index (BMI) than those who came from urban hometowns. The serious consequences of increasing prevalence of obesity call for earlier interventions to combat progression to obesity in young adults before obesity can progress to chronic disease.

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Acknowledgements

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