

PAPER

The freshman weight gain: a model for the study of the epidemic of obesity

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OBJECTIVE: The objective of this study was to quantify the weight gain of freshmen during their first 12 weeks at Cornell University. In addition, students completed questionnaires that revealed particular behaviors and activities that were associated with weight gain.

DESIGN: Serial, correlational study.

SUBJECTS: A total of 68 freshmen from Cornell University.

MEASUREMENT: A total of 60 students were weighed during the first week of the semester, then again 12 weeks later. They were also given a questionnaire to complete concerning their behavior during the previous 12 weeks.

RESULTS: After adjusting for clothing weights, the mean weight gain of the freshmen was 1.9 ± 2.4 kg, a value significantly different from 0. Two regression models generated from the questionnaire were fitted to the weight gain. The first linear regression model (Model 1) accounted for 58% of the variance and indicated that eating in the 'all-you-can-eat' dining halls accounted for 20% of the variance in weight gain. Snacking and eating high-fat 'junk food' accounted for another 20%. When initial weight was used as a covariate (Model 2), the consumption of junk foods, meal frequency and number of snacks accounted for 47% of the variance.

CONCLUSION: The study clearly demonstrated that significant weight gain during first semester college is a real phenomenon and can be attributed to tangible environmental stimuli. The weight gain is considerably greater than that observed in the population and may be useful as a model to test various techniques that may reduce or reverse the 'epidemic' of obesity observed in the general population.

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Introduction

Weight gain of humans is usually a very slow process, undetectable by ordinary daily self-observation and is caused by such small changes in energy balance that it is practically undetectable by current technology. Yet, this slow insidious imbalance in energy is responsible for the significant rise in the incidence of overweight and obesity in the US population, which is sufficiently alarming, and many prominent researchers and public health officials have labeled the increase as an epidemic.^{1–9}

One possible model of this small, persistent increase in positive energy balance is the increase in the body weight that is believed to occur in freshmen during their first year at college. The public seem to be keenly aware of the problem and have labeled the phenomenon as the 'Freshman Fifteen.' A Google search yielded an astounding 16 000 web sites, most of which were posted on college bulletin boards and newsletters. The scientific literature, on the other hand, is quite sparse and does not fully support the finding that freshmen gain a significant amount of weight. Hovell *et al*¹⁰ reported only transitory weight gain of freshmen, while Hodge *et al*¹¹ did not observe any significant weight gain in freshman women.

The purpose of the following study was to quantify the change in body weight in freshmen during their first semester at Cornell University and to explore some of the factors that may be associated with an increase in body weight.

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Subjects and methods

Participants were recruited from Cornell University's two large introductory courses during Fall semester, 2000: Human Development and Nutrition and Health; and Concepts and Controversies. The study was approved by the Cornell University Human Subjects Committee. Students were informed about the purpose of the study and they signed a written consent form at the beginning of the study.

Of the 68 students who completed the initial questionnaire and were weighed at the beginning of their first semester, 60 (88%) completed the follow-up questionnaire and had a second measurement of weight taken 12 weeks later, at the end of their first semester. The initial weight of the eight subjects who dropped out from the study was within one standard deviation of the mean of initial weight of those who remained in the study. General characteristics and demographics of the participants in the study are presented in Table 1. The participants were similar to the actual demographics at Cornell University in Fall 2000 where 73% of students were Caucasian and 27% minorities.

Questionnaire

While the initial questionnaire obtained information about students' lifestyle during high school years, the second questionnaire (Appendix A1) gathered information about the student's lifestyle factors related to their eating, sleeping and exercising habits during the preceding semester. All qualitative variables and comparisons with the high school lifestyle factors were assessed using a numerical scale ranging from -3 ('much less/often') to +3 ('much more/often'). The results from the second questionnaire were used in all statistical analyses, while the first questionnaire served as an internal validity check.

Body weight measurements

Body weight was measured using a Healthometer scale (Sunbeam® Products) at the beginning (August 28–September 1) and at the end of the study (November 27–December 1). The scale was placed on a bare, level floor and was manually re-calibrated before each weight was taken. Students were weighed in their regular indoor clothing.

Table 1 Subject demographics

	Number	Percentage
Total	60	100
Male	9	15
Female	51	85
Age (y)	18.2	
Dieters	8	13
Ethnicity ^a		
Caucasian	46	77
Minority	16	23

^aActual demographics of Cornell in Fall 2000: 73% Caucasian; 27% minority.

Because the second weight measurement would be taken during the winter season whereas the first measurement would be taken during early fall, it is possible that heavier winter clothing may be worn during the second weight measurement. Along with the weight measurement, the amount and kind of external clothing that the subject was wearing was also recorded. Each piece of clothing was categorized as light, moderate or heavy and given a weight. The sum of weights of all clothing was subtracted from the body weight measurement. To eliminate interobserver error, the same researcher rated the amount of clothing participants wore at each measurement and assigned them to the appropriate clothing class (light, moderate or heavy). All statistical analyses were performed on the adjusted body weights.

Statistical analysis was performed by using SAS statistical software for Windows '98 platform, version 7.1. Associations between weight changes and lifestyle variables were investigated by correlation analysis. Stepwise multiple regression with maximal *R* improvement and standard diagnostic tests were used to develop a statistical model that best explains the observed weight change.

Results

The distribution of the weight changes across the 12 weeks is depicted in Figure 1. The mean weight gain, adjusted for clothing, was 1.9 ± 2.4 kg (range -5.9 to +8.6 kg) and was highly significant ($P < 0.01$). Mean body mass index (BMI), similarly, increased significantly ($P < 0.01$) from 20.8 ± 2.1 to 21.5 ± 2.3 kg/m² over the period of 12 weeks, with most of the students being in the normal range of BMI between 19.8 and 22.7 kg/m².

Two multiple regression models explained the majority of the variation in the weight gain. The results from the first

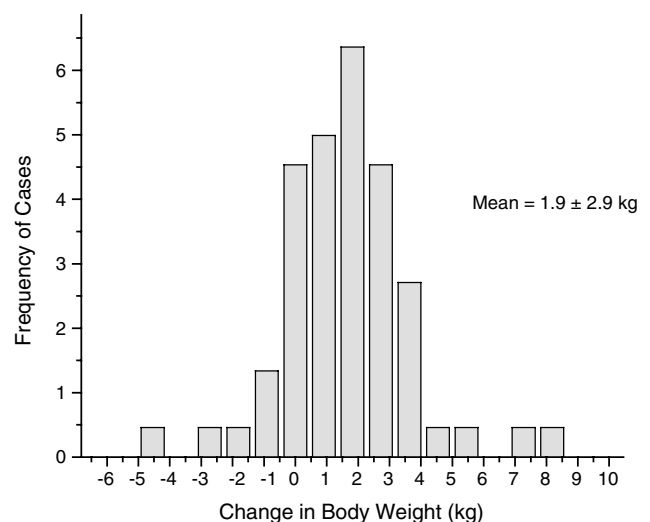


Figure 1 Distribution of weight change of freshmen during their first 12 weeks of semester.

Explained percent of the variance of the weight change-Model 1

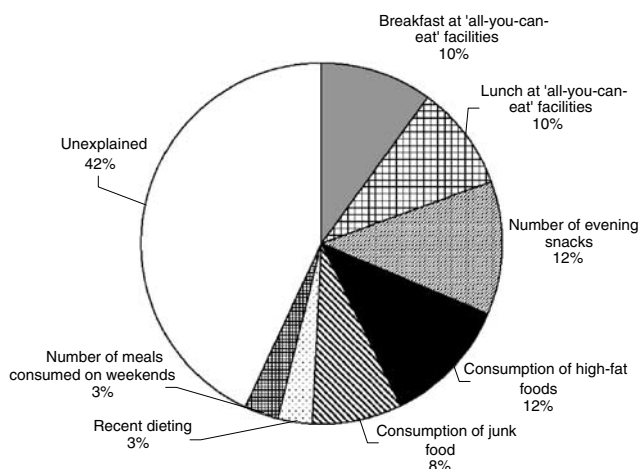


Figure 2 Percentage of total variance of weight gain in Model 1 attributed to specific variables. All variables listed were statistically significant ($P < 0.05$).

model are depicted in Figure 2. The variables identified account for 58% of the total variance and were all statistically significant ($P < 0.05$). The two variables that best predicted the weight gain were an increase in the consumption of evening snacks and the consumption of high-fat foods, each variable accounting for about 12% of the total variance. The next two variables, eating breakfast and lunch in 'all-you-can-eat' dining halls, each explain 10% of the total variance. The consumption of 'junk' foods (high-fat cookies, cakes, chips and ice cream) explained another 8% of the variance. The term 'junk' food was not defined in the questionnaire, but left to the subject to evaluate. Interestingly, recent dieting accounted for another 3% of the variance, as well as the total number of meals consumed on the weekends. In all, 42% of the variance could not be explained.

The second multiple regression model of the variance in weight gain is shown in Figure 3. The second model included initial body weight as a covariate. The inclusion of this variable significantly improved the amount of the total variance that could be explained by the variables measured from 58 to 71%. When initial weight was controlled, the variable that could explain most of the gain in weight was the consumption of junk foods, explaining 24% of the total variance. The next best predictor was recent dieting, explaining 9% of the remaining variance. The amount of evening snacks consumed explained another 6% of the variance, eating lunch at a restaurant explained another 5% and eating at a 'pay for cash' facility accounted for another 4% of the variance, as did the number of hours of sleep. Only 29% of the total variance was left unexplained by this second model.

In both models, meals consumed in 'all-you-can-eat' facilities were associated with eating larger size meals ($r = 0.465$), of longer meal durations ($r = 0.27$) and having

Explained percent variance of the weight change-Model 2

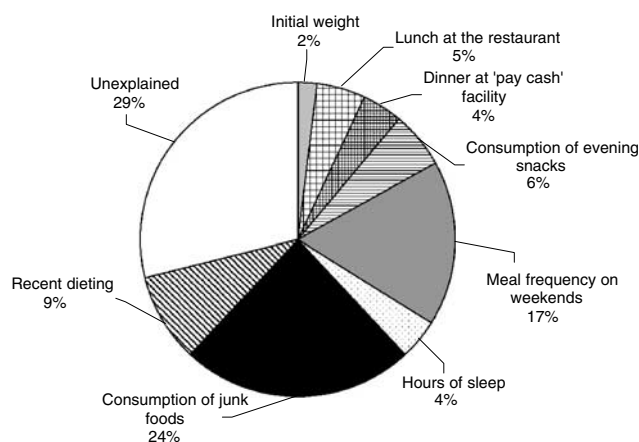


Figure 3 Percentage of total variance of weight gain in Model 2 attributed to specific variables. All variables listed were statistically significant ($P < 0.05$).

increased feelings of 'fullness' ($r = 0.4$). Students did not report increased consumption of junk food or higher fat diets in such facilities. They also did not report eating less healthily when dining at 'all-you-can-eat' facilities.

Discussion

The results from this study verify the 'Freshman Fifteen' by demonstrating that freshmen at Cornell University, who were enrolled in introductory courses in Nutrition and in Human Development, experienced significant weight gain during the first 3 months of college. The gain in weight during the first 12 weeks of the semester was 1.9 kg or 158.3 g/week. This amount of weight is more than double of that observed by Hovel *et al*¹⁰ (76.57 g/week) and more than that recorded by Matvienko *et al*¹² (103.85 g/week in their untreated control group).

The rate of weight gain observed in college freshmen is considerably greater than that observed in the population. Figure 4 shows the distribution of values of the rate of weight gain averaged from studies published in the literature. All the values have been converted to grams weight gain per week to enable comparisons across studies. The central tendency of the distribution hovers around a gain of about 8 g/week in adults, a value considerably lower than that observed in freshmen; yet such a rate of increase is considered an 'epidemic' by many.¹⁻⁹

Part of the discrepancy between the rate of weight gain in the first year of college and that observed in the population may be due to difference in age. Figure 5 shows the average weight gain derived from published studies for different ages and for each gender. As can be seen from this figure, spontaneous weight gain decreases significantly with increasing age. Although the slope of the decrease in the rate of

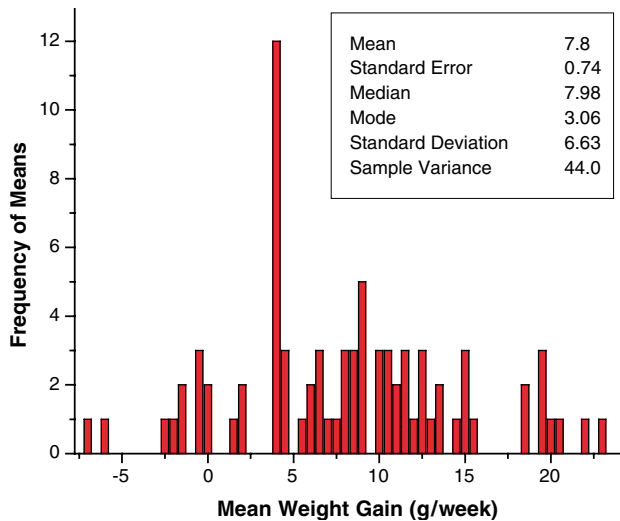


Figure 4 Frequency distribution of weight gain from studies of spontaneous weight gain in adults.^{18–27}

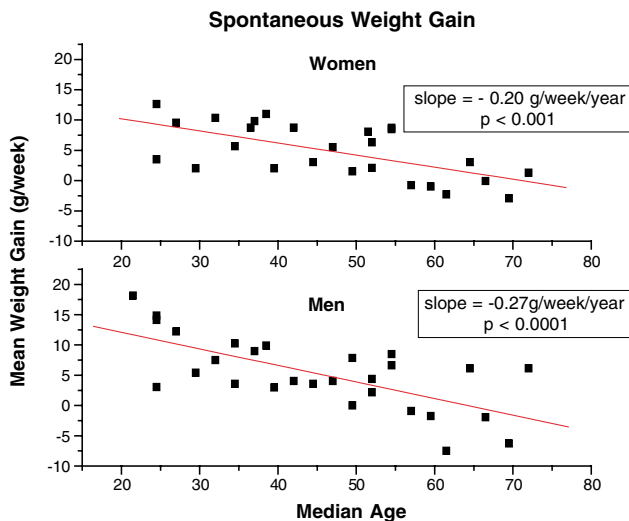


Figure 5 Weight gain as a function of age for adult men and women extracted from literature.^{19,20,23,24,26}

spontaneous weight gain is slightly greater for male than female subjects, the difference was not statistically significant. What is important, however, is that the expected weight gain of people aged 17–18 y, extrapolated from the linear regression equation, is less than 15 g/week. Thus, whatever is responsible for spontaneous weight gain in human populations is exaggerated in the first year of college compared to the population at large.

For most freshmen, the transition from home to college is the most dramatic change of environment in their lives. It is certainly greater than the change in our society during the last 30 y during which time body weights have been increasing. However, identifying the environmental facts most closely related to weight gain may help us understand

which changes in our environment may be responsible for the insidious increment in the weight of the population.

The fact that responses to the questionnaire were subjective does not diminish the strength of the findings. However, the use of self-selected subjects (volunteers), under-representation of male students, imprecise and limited physical activity assessment as well as the short duration of the study are weaknesses of the present study that limit our ability to generalize our results to all college freshmen. Nevertheless, within this sample, self-evaluation of the lifestyle factors and eating habits was a very significant predictor of weight gain.

Although both statistical models of the total variance in weight gain were highly significant, it is informative to distinguish and understand which variables remained statistically significant in both models and which did not. The variables that remained statistically significant when initial weight was used as a covariate were (a) the number of evening snacks, (b) the number of meals consumed on weekends, (c) the consumption of junk foods and (d) recent dieting. The fact that previous dieting was *positively* related to weight gain and remained a significant predictor of weight gain in both models is consistent with the evidence showing that dieting is ineffective at maintaining weight loss.¹³

Eating breakfast and lunch at the ‘all-you-can-eat’ dining halls accounted for 20% of the total variance in Model 1, but lost statistical significance as an explanatory variable for weight gain when initial body weight was used as a covariate. One possible explanation for this observation is that students with larger appetites may tend to eat at establishments that provide more food for the money. Thus, they may choose to eat at such facilities that serve large portion sizes. In addition, students with lower appetites may elect to skip breakfast and lunch more frequently than students with larger appetites.

Despite the fact that the questionnaires used in the study provided a very crude estimate of lifestyle during that first semester on campus, it was sufficiently sensitive to detect dietary factors and eating habits (consumption of junk foods, meal frequency on weekends and consumption of evening snacks) accounting for almost half (47%) of the total variance of weight gain. Although other lifestyle changes such as altered sleeping patterns affected students’ eating habits, these were not significant predictors of weight gain. Decreased physical activity, although significantly and positively correlated with the observed weight gain, did not remain a significant explanatory variable after adding the dietary factors and eating habits to the statistical model for weight change. It is possible that our measures of physical activity were too insensitive to detect a relationship to weight change.

The results of the present study raise serious questions concerning the contribution of cuisine in promoting weight gain in our society. Although the use of ‘all-you-can-eat’ dining halls may be effective as a recruiting technique for

colleges, they may also be responsible for much of the weight gain evident in freshmen as evidenced from this study. The questionnaires indicated that students felt that they ate more in such dining facilities and were left with a greater sense of 'fullness', suggesting that the portions served were considerably larger than in alternative eating establishments. Because both adults^{14,15} and children^{16,17} appear to consume food proportional to the amount they are served, part of the responsibility for the overconsumption must lie with the dining facilities. The greater variety of foods offered in such dining facilities and the ease of obtaining food have been shown to increase human energy intake.¹⁶⁻¹⁸ Outside the dining hall, the easy accessibility of 'junk foods' in dormitories and classrooms may also contribute to the excessive weight gain because humans do not appear to 'calorically compensate' for food that is consumed between meals.^{16,17}

The increase in body weight observed in the present study of freshmen (158 g/week) is equivalent to eating approximately 42 kJ (174 kcal) more each day than corresponding to energy expenditure. This amount represents a relatively small alteration in behavior, yet it has enormous cumulative consequences on weight. On the other hand, if small changes can cause an increase in weight, then small behavioral and/or environmental changes should be able to prevent or possibly reverse the weight gain. The 'epidemic of obesity' that is frequently cited in the lay and scientific press is a result of an even smaller energetic imbalance. From Figure 4, it can be seen that the average weight gain of the American public is about 8 g/week. If we use the conservative, but common, estimate of 32 000 kJ (7700 kcal) of energy necessary to gain 1 kg of body weight, or 32 kJ (7.7 kcal) to gain 1 g of body weight, then an increment of 8 g of body tissue per week would result from eating an excess of about 256 kJ (61.6 kcal) per week or about 37 kJ (8.8 kcal) per day. Such a small change in body weight (1.1 g) or intake is imperceptible in daily practice. However, if the phenomenon of the freshman weight gain is an amplification of the same process that is occurring among the public, then it should be possible to study various methods and techniques that might prevent freshman weight gain in the hope that they might be effective to reduce or even reverse the secular trend toward increasing body weight and obesity in the general population.

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Appendix A1

Name: _____

Student ID No.: _____ Height: _____

Age: _____ Home state: _____

Ethnicity (optional): [] Caucasian [] Asian [] African [] Hispanic [] Other

Please answer the following questions based on your regular activities and lifestyle from the past semester at Cornell University. Once again we greatly appreciate your participation.

1. Average bed time (Sunday-Thursday): 10pm 11pm 12pm 1am 2am other _____
2. Average bed time (Friday - Saturday): 10pm 11pm 12pm 1am 2am other _____
3. Average waking time (Sunday-Thursday): 6am 7am 8am 9am 10am other _____
4. Average waking time (Friday-Saturday): 6am 7am 8am 9am 10am other _____
5. How many meals did you consume in a day? 1 2 3 4 5 other _____

Snacks

6. How many snacks did you consume before dinner in a day? 0 1 2 3 4 other _____
7. How many snacks did you consume after dinner in a day? 0 1 2 3 4 other _____
8. What was the average size of your before dinner snack? light moderate large did not eat
9. What was the average size of your after dinner snack? light moderate large did not eat
10. Average number of people with whom you ate pre-dinner snack? _____
11. Average number of people with whom you ate post-dinner snack? _____
12. What would you usually snack on before dinner?

13. What would you usually snack on after dinner?

14. Did you snack more or less before lunch compared to high school? more less same
15. What would you snack on before lunch?

Breakfast

16. What was the average size of your breakfast? light moderate large skipped or did not eat
17. The average number of people you ate breakfast with? _____
18. Number of times per week you prepared yourself breakfast (in room, kitchen, etc.)? _____
- 19a. Number of times per week you ate your breakfast at an all-you-can-eat dining hall? _____
- 19b. Number of times per week you ate your breakfast at a cash-op? _____
20. Number of times per week you ate your breakfast at a restaurant (off Cornell campus)? _____
21. Number of times per week you ate your breakfast at place other than room, campus, or restaurant?

22. Where? _____
23. The average number of people you ate breakfast with? _____

Lunch

- 24. What was the average size of your lunch? light moderate large skipped or did not eat
- 25. The average number of people you ate lunch with? _____
- 26. Number of times per week you prepared yourself lunch (in room, kitchen, etc.)? _____
- 27a. Number of times per week you ate your lunch at an all-you-can-eat dining hall? _____
- 27b. Number of times per week you ate your lunch at a cash-op dining hall? _____
- 28. Number of times per week you ate your lunch at a restaurant (off campus)? _____
- 29. Number of times per week you ate your lunch at place other than room, campus, or restaurant (e.g., vending machine)? _____
- 30. Where? _____

Dinner

- 31. What was the average size of your dinner? light moderate large skipped or did not eat
- 32. Did the number of people you ate dinner with increase, decrease or stay the same compared to high school?
 increase decrease same
- 33. How many more or less people did you usually eat with? _____
- 34. Number of times per week you prepared yourself dinner (in room, kitchen, etc.)? _____
- 35a. Number of times per week you ate your dinner at an all-you-can-eat dining hall? _____
- 35b. Number of times per week you ate your dinner at a cash-op dining hall? _____
- 36. Number of times per week you ate your dinner at a restaurant? _____
- 37. Number of times per week you ate your dinner at a place other than room, campus, or restaurant?

- 38. Where? _____
- 39. With regards to your meals at college did the duration of your meals:
 increase decrease same amount of time
If the time increased or decreased, by how much? _____
- 40. Did you eat your meals as compared to high school: later earlier same time
- 41. Did the average size of your meal as compared to high school: increase decrease stay the same
- 42. The average number of people you ate a meal with: increased decreased stayed the same
- 43. The number of meals you ate per day: increased decreased stayed the same
- 44. The number of snacks you ate per day: increased decreased stayed the same

Lifestyle

- 45. Number of alcoholic beverages consumed in a given week? _____
- 46. Did you purposely engage in dieting activity or try to lose weight? _____
- 47. Did you smoke on a daily basis? If so how many cigarettes? _____
- 48. How many times did you exercise in a given week? 1 2 3 4 more than 5

Free response

- 49. Do you think your weight changed since entering Cornell? increased decreased same
If you experienced a weight change,
why? _____

50. What was the biggest change that occurred in your dietary habits since at Cornell?

51. What was the biggest change in your daily habits?

Thank you for completing our survey. Once again all information is completely confidential. Enjoy your time at Cornell!