Journal of Student Research (2015) Volume 4, Issue 1: pp. 144-151
Research Article

A Statistical Analysis of Weight Gain during the Freshman Year of College

Elaine Perrin[a], Travis Sellers[b], Lorena Hernandez Maxwell[c], Malachi Morgan[d], Sherod-Malik Davis[d], Cynthia Cook[e], Monica C. Jackson[f], and Kimberly F. Sellers[g]

This study examined freshman weight gain and its contributing factors, with the objective being to determine what environmental and societal changes in the college freshman experience associate with weight gain. We designed a 27-question survey which asked participants about their lifestyles during their freshman year in college. Responses were obtained through social media from 95 student participants across 37 United States colleges and universities. The resulting data distribution of weight gained among surveyed freshmen was right-skewed with a median weight gain of zero and an interquartile range of 6.5 lbs. In particular, 52% of the survey respondents reported no weight gain. Accordingly, we modeled the data via a zero-inflated negative binomial regression analysis to investigate what student characteristics prior to and during his/her freshman year are associated with weight gain and likewise determine an estimated probability of no weight gain in the freshman year. Our study and statistical model found significant associations between freshman weight gain and the choice of major, average amount of nightly sleep, one's relationship with his/her parents, and gender.

Keywords: weight gain; college freshmen; environmental influences; societal influences

Introduction

Several studies [for example, Levitsky et al. (2004)] recognize significant weight gain to be a common problem many college students experience during their freshman year. While the notion of a "freshman fifteen" has been deemed an overstatement (Vella-Zarb and Elgar, 2010), a vast majority of these studies showed that there was modest (approximately three to seven pound) weight gain in college freshmen during their first semester. Many researchers also found that, by the second semester, the freshman's weight had stabilized (Anderson et al., 2003). Holm-Denoma et al. (2008) found that a student's relationship with their parents was a significant factor for weight gain; a good relationship with parents was associated with weight gain in females, while a troublesome relationship with parents led to one in males.

Other variables have also been studied to see their connection with weight gain, including campus setup, a student's amount of physical activity, and their eating habits. The campus layout was found to have an effect on students' eating and exercise habits (Kapinos and Yakusheva, 2010). Research also showed that students who lived on-campus gained more weight than those who lived off-campus (Vella-Zarb and Elgar, 2010). Wengreen and Moncur (2009) found that those who gained weight were less physically active in college than in high school, and more likely to eat breakfast and sleep more than those who did not gain weight. Ironically, Lowe et al. (2006) found that traditional methods such as restraint, disinhibition, and emotional eating were not predictive factors of weight gain, however a history of weight loss, dieting, and weight suppression were associated with it.

We are interested in testing a few of the previously mentioned variables, along with other factors not previously studied to see if there are any additional variables associated with weight gain. The administered survey considered the following variables: current age and freshman age, distance between hometown and college/university (measured in travel time (hours)), major, race/ethnicity, eating habits (e.g. whether or not they ate breakfast), participation in extracurricular activities, gender, alcoholic intake (number of drinks/week), smoking status, study frequency (hours/week), grade point average (GPA), stress level (on a 1-10 scale), amount of exercise (days/week), vegetarian status, previous experience living away from home, freshman year employment status, relationship with their parents (on a five-point Likert scale), the amount of financial support they received from their parents, their parents' marital status, video game frequency (hours/week), familial healthy lifestyle promotion, average amount of sleep (hours/night), and increased caffeine consumption status. Many of these variables are influenced by the change in environment students experience during their freshman year. Our goal is to determine which, if any of these, factors impact weight gain. Statistical analysis was performed via the freeware statistical computational software tool, *R* (available for download at http://cran.us.r-project.org/).

Materials and Methods

Survey Design and Data

A 27-question survey was administered to current college students asking respondents about their lifestyles during their freshman year of college; the list of questions is provided in the Appendix. The survey was created in the Qualtrics survey software provided by Miami University, and conducted with IRB approval from American University (Washington, DC). We obtained a sample of 95 respondents

a. Department of Mathematics and Statistics, Miami University, Oxford, OH, 45056, USA
b. Department of Mathematics, Maryville College, Maryville, TN, 37804, USA
c. Department of Mathematics, Rose-Hulman Institute of Technology, Terre Haute, IN, 47803, USA
d. Department of Mathematics, Morehouse College, Atlanta, Georgia, 30314, USA
e. Department of Statistics, Penn State University, University Park, Pennsylvania 16802, USA
f. Department of Mathematics and Statistics, American University, Washington, DC 20016, USA
g. Department of Mathematics and Statistics, Georgetown University, Washington, DC 20057, USA

from students across 37 United States colleges and universities.

The survey questions addressed freshman weight gain (in pounds), stress level (on a 10-point Likert scale), grade point average (GPA), freshman age, and relationship with parent(s). Current age was also collected to observe the age difference between it and freshman age, but current age was not used in the analysis. Remaining variables were treated as categorical to provide confidence and flexibility to participants' estimated responses. These variables included the distance between hometown and college/university (as measured by travel time in hours), major, race/ethnicity, eating habits, number of extracurricular activities, gender, amount of alcohol consumption (number of drinks per week), smoking status, average number of sleeping hours per day, hours per week watching television or playing video games, study hours per week, exercise days per week, vegetarian status, whether a student lived away from home during high school, regular breakfast eating status, employment status, parents' marital status, parental financial support status, increased caffeine consumption status, and how well health was promoted by family.

We use the ceiling function in *R* to transform the weight gain values into integer form. This transformation is reasonable because weight gain responses provided by the participants are estimates, and most responses provided were integer-valued.

Model

To accommodate the integer-valued weight response values, we consider various count regression models to describe the relationship between the amount of weight gain and the possible explanatory variables. We condense some of the categorical variables in order to avoid model over-parameterization. For example, we group the list of majors, combining Arts and Humanities majors into one category, and Science and Engineering majors into one category. We further condense the race/ethnicity variable from six to five categories by combining the Indian and Asian categories into one group. We feel that such a procedure is legitimate because no Indian students responded to the survey.

Results

Exploratory Data Analysis

The weight gain distribution is right-skewed and over-dispersed with 52% of the survey respondents reporting no weight gain; see Figure 1. We thus use a zero-inflated negative binomial model to describe the relationship between the explanatory variables and the amount of weight gained in the freshman year of college. The zero-inflated negative binomial model is a popular choice for such data because it can easily address data over-dispersion via the negative binomial model component while addressing the excess zeroes in the data via the logistic model. Because we focus our attention on those factors causing weight gain, we fit a constant-only logistic model to account for the probability of no weight gain, and a log-linear negative binomial model to associate freshman weight gain with the various potential factors under consideration.

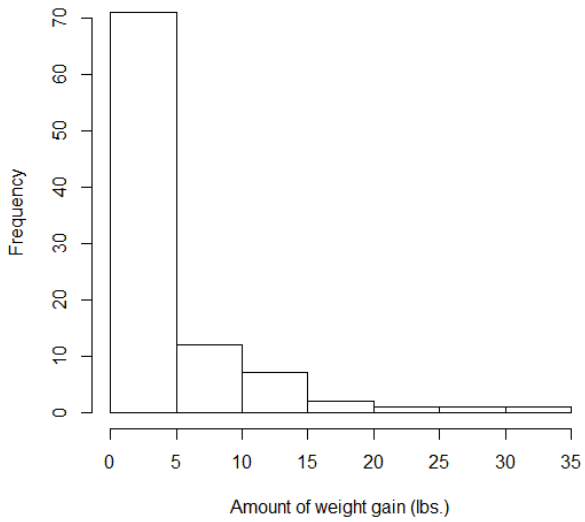

Figure 1: Histogram of weight gain among 95 survey respondents

Tables 1-3 contain summary information associated with the survey responses. Table 1 confirms that at least half of the respondents report not gaining any weight in their freshman year of college, while other students report gaining as much as 35 pounds. These respondents, mostly from Rose-Hulman Institute of Technology, range in age from 19-29, having entered college between 17-20 years of age. The range in stress level and reported familial support covers the full spectrum in scale. For both factors, 75% of the students report having a mid-to-high level of stress during their freshman year, but also having strong family support; see Table 1 and 3.

Table 1: Quantitative variable summary information

	Minimum	1st Quartile	Median	3rd Quartile	Maximum	Mean
Weight Gain (lbs.)	0	0	0.0	6.5	35	4.77
Freshman Age	17	18	18.0	18.0	20	18.06
Current Age	19	20	21.0	21.0	29	20.86
Stress Level	1	5	7.0	8.0	10	6.31
GPA	2	3	3.5	3.8	4	3.34

Table 2 provides additional information about our survey respondents. We see that approximately one-third of the respondents increased their caffeine intake, while most of the students are non-smokers. Most students did not live away from home prior to attending college, and most of them are not vegetarians. While most of the respondents were financially supported by their parents, over half of them were employed while in school. Finally, almost half of the students report that they ate breakfast regularly; see Table 2.

Table 2: Binary categorical variable summary information

	Yes		No		No response	
	n	**%**	**n**	**%**	**n**	**%**
Increased caffeine intake	30	31.58	64	67.37	1	1.05
Smoker	8	8.42	87	91.58		
Ate breakfast regularly	41	43.16	52	54.74	2	2.11
Lived away from home in high school	11	11.58	84	88.42		
Employed	53	55.79	42	44.21		
Vegetarian	2	2.11	93	97.89		
Financially supported by parents	77	81.05	18	18.95		

Table 3 provides general demographic information, along with other summary information collected from the survey. Approximately 72% of the survey participants were female, and a large majority of the respondents were either Science or Engineering majors. The majority of students attend college up to three hours away from home and come from two-parent households. Most respondents report eating in the dining halls, and that they come from families where the parents promoted somewhat healthy lifestyles. Over half of the respondents got 5-6 hours of sleep per night on average, and participated in one to two extracurricular activities. Finally, the distribution of respondents is relatively uniformly distributed across the number of days spent exercising; see Table 3.

Table 3: General Demographics and Other Summary Information

		n	**%**
Gender			
	Male	27	28.42
	Female	68	71.58
Institution			
	Ball State University	2	2.11
	Cincinnati Christian University	1	1.05
	Fisk University	1	1.05
	Florida Institute of Technology	1	1.05
	Georgia State University	1	1.05
	Georgia Institute of Technology	6	6.32
	Indiana University	1	1.05
	Kent State University	1	1.05
	Lehigh University	1	1.05
	Maryville College	5	5.26
	Miami University	5	5.26
	Miami University- Hamilton	1	1.05
	Morehouse College	2	2.11
	Ohio State University	5	5.26
	Ohio Wesleyan University	1	1.05
	Penn State University- Behrend	1	1.05
	Purdue University	1	1.05
	Rose-Hulman Institute of Technology	32	33.68
	Rowan University	1	1.05
	Sinclair Community College	1	1.05
	Smith College	1	1.05
	South Central College	1	1.05
	Southern Illinois University- Edwardsville	1	1.05
	Transylvania University	1	1.05
	University of Cincinnati	3	3.16
	University of Georgia	1	1.05
	University of Illinois at Urbana-Champaign	1	1.05
	University of Louisville	1	1.05
	University of Mary Washington	1	1.05
	University of Missouri	1	1.05

	University of Notre Dame	1	1.05
	Valparaiso University	1	1.05
	Waynesburg University	1	1.05
	Winston Salem State University	8	8.42
	Wittenberg University	1	1.05
	Xavier University	1	1.05
Major			
	Sciences	24	25.26
	Arts	7	7.37
	Business	11	11.58
	Education	4	4.21
	Humanities	6	6.32
	Pre-Medicine	6	6.32
	Engineering	37	38.95
Travel time (hours) between hometown and college/university			
	Within an hour	28	29.47
	Between 1 and 3 hours	36	37.89
	Between 3 and 5 hours	16	16.84
	Between 5 and 7 hours	3	3.16
	More than 7 hours	12	12.63
Race/ethnicity			
	Caucasian	68	71.58
	African American	14	14.74
	Asian	5	5.26
	Hispanic	6	6.32
	Indian	0	0.00
	Other	2	2.11
TV/video game usage			
	0-5 hours	50	52.63
	6-10 hours	28	29.47
	11-15 hours	12	12.63
	16-20 hours	3	3.16
	21 or more hours	2	2.11
Parents' marital status			
	Married	67	70.53
	Divorced	22	23.16
	Other	6	6.32
Level of healthy lifestyle promoted by parents			
	Very healthy	20	21.05
	Somewhat healthy	62	65.26
	Not healthy	13	13.68
Time spent studying			
	0-5 hours	13	13.68
	6-10 hours	25	26.32
	11-15 hours	24	25.26
	16-20 hours	23	24.21
	21 or more hours	10	10.53
Dining habits			
	Cooked own meals	13	13.68
	Ate at dining halls	75	78.95
	Ate out/ restaurant	7	7.37
Alcoholic intake			
	0-5 drinks	76	80.00
	6-10 drinks	11	11.58
	11-15 drinks	4	4.21
	16-20 drinks	0	0.00
	21 or more drinks	4	4.21
Number of extracurricular activities			
	0	12	12.63

1 or 2	51	53.68
3 or 4	25	26.31
5 or more	7	7.37
Number of exercise days		
0 or 1	28	29.47
2 or 3	26	27.37
4 or 5	26	27.37
6 or 7	15	15.79
Family Relationship Rating (0 = not supportive; 5 = very supportive)		
0	1	1.05
1	0	0.00
2	8	8.42
3	5	5.26
4	16	16.84
5	65	68.42
Number of sleep hours		
less than 4 hours	5	5.26
5 or 6 hours	50	52.63
7 or 8 hours	39	41.05
9 or more hours	1	1.05

We exclude freshman age from the analysis because the range for the age distribution is very small; see Table 1. We also exclude smoking and vegetarian status, respectively, because very few participants (less than 10% in each case) claimed either status at the time of the survey; see Table 2.

Zero-inflated Negative Binomial Model

Our resulting model included the respondent's chosen major, familial relationship, average amount of nightly sleep hours, and gender as factors contributing to freshman weight gain. Humanities and Arts majors (p-value = 0.002), and Science and Engineering majors (p-value = 0.038) experienced statistically significantly less freshman weight gain relative to Business majors. Meanwhile, family relation (p-value = 0.008), and respondents receiving either 5-6 hours (p-value = 0.089) or 9 or more hours of sleep (p-value = 0.052) had a statistically significant relationship with the freshman weight gain at the 10% significance level. The model showed a negative association between family relation and weight gain thus, among same-gendered college freshmen with the same major and amount of sleep, every unit level decrease in familial relationship between a college freshman and his/her family was associated with weight gain by a factor of 1.22, on average; see Table 4. Meanwhile, those receiving 5-6 hours of sleep or 9+ sleep hours respectively gained over two and four times the amount of weight relative to those college freshmen getting up to four hours of sleep, on average.

Table 4: Coefficient table associated with zero-inflated negative binomial model associating major, family relation, sleep hours, and gender to freshman weight gain. Variables found to be statistically significant at the 0.1 significance level are marked with an asterisk (*).

Variable	Estimate	Standard Error	Z value	Pr(>|z|)
Intercept	2.833	0.652	4.345	1.39×10^{-5} *
Education major	-17.107	838.445	-0.020	0.984
Humanities/Arts major	-1.163	0.380	-3.058	0.002 *
Pre-med major	-0.902	0.738	-1.222	0.222
Science/Engineering major	-0.830	0.400	-2.077	0.038 *
Family relation	-0.198	0.074	-2.671	0.008 *
5-6 hrs. of sleep	0.842	0.490	1.718	0.086 *
7-8 hrs. of sleep	0.687	0.506	1.359	0.174
9+ hrs. of sleep	1.498	0.770	1.945	0.052 *
Gender	0.420	0.310	1.356	0.175

Table 5 provides the corresponding incidence ratio rates for each variable. The resulting incidence rate of weight gain for a freshman Humanities or Arts major is 0.312 times that of a freshman Business major (among those students of the same gender, family relationship, and amount of sleep), implying that the probability of a freshman Humanities and Arts major gaining weight is 0.312 times the probability of a freshman Business major gaining weight (p-value = 0.002). The Engineering and Science major is also a statistically significant contribution in the model (p-value = 0.038). The incidence rate among freshman Engineering and Science majors is 0.44 times that for freshman Business majors implying that, among those students of the same gender, family relationship, and amount of sleep, the probability that a freshman Engineering or Science major experiences weight gain decreases by a factor of 0.44 in comparison to a freshman Business major.

Table 5: Incidence rates for each of the variables in final model.

Variable	Incidence Rate
Intercept	16.990
Major: Education	3.70×10^{-8}
Major: Humanities/Arts	0.312
Major: Pre-med	0.406
Major: Engineering	0.436
Family Relation	0.820
Sleep (5 or 6 hours)	2.321
Sleep (7 or 8 hours)	1.988
Sleep (more than 9 hours)	4.472
Gender	1.522

Tables 4-5 show a statistically significant association between the amount of sleep and freshman weight gain. The incidence rate for freshmen sleeping 5-6 hours per night is 2.31 times that for freshmen sleeping less than four hours per night (p-value = 0.086). Meanwhile, the incidence rate for freshmen getting at least nine hours of nightly sleep is 4.472 times that for freshman getting up to four hours of nightly sleep (p-value = 0.052); see Tables 4-5.

Finally, we ran a Vuong non-nested hypothesis test to compare a standard negative binomial model using these variables with its zero-inflated counterpart, and found the zero-inflated negative binomial model to be statistically significantly better than the standard negative binomial model (p-value = 4.446×10^{-6}), supporting our use of the zero-inflated model.

Discussion

This study examined freshman weight gain and its contributing factors, with the objective being to determine what environmental and societal changes in the college freshman experience associate with weight gain. We designed a 27-question survey which asked participants about their lifestyles during their freshman year in college, and modeled the resulting data via a zero-inflated negative binomial regression model. Our final model found an association based on the choice of major, the average amount of nightly sleep, one's relationship with his/her parents, and gender. In particular, our study showed that Business majors are statistically significantly more likely than Humanities and Arts majors or Science and Engineering majors to experience freshman weight gain, among students of the same gender, the same family relationships and average amount of sleep. Meanwhile, students who either don't obtain a sufficient average amount of sleep (5-6 hours/night) or sleep too long (9+ hours/night) were statistically significantly more likely to gain weight in their freshman year of college, among students in the same major, with the same familial relationship, and gender.

There were several limitations associated with this work, including those stemming from survey length, distribution, and response. As with any survey, we were limited by what we resolved to be an appropriate number of questions. This, in turn, determined the number of variables for consideration in our analysis. We strived to design the survey to be an optimal length so that it was not perceived to be too long by survey respondents. While there are numerous potential factors that could impact weight gain during one's freshman year, we were only able to ask participants a chosen number of questions about a chosen number of possible explanatory variables.

The survey was distributed through the Facebook social media website and via e-mail. This choice of distribution may have caused under coverage and/or bias due to the lack of responses from schools. Further, a majority of respondents attended college in the eastern United States. It is because of these issues that we opted to consider a more relaxed significance level of 10%, rather than the traditional 5% statistical significance level. The choice of significance level is subjective; our goal is to detect some more elusive contributions associated with freshman weight gain. This way, one can gain ideas about potential factors to measure in a larger, more comprehensive study. Additional factors for future consideration could include the healthiness of the common citizen, the number of fast food restaurants within a given radius, or the number of health food stores within a given radius. It would be interesting to see if these demographics affect the weight gain of a school's freshman class.

This work relies heavily on respondent estimations of their freshman weight gain, as well as other questions that depend on respondent recollection and/or approximation. It is likely that students further removed from their freshman year had greater difficulty in providing accurate responses.

While the use of categorical responses allowed for a greater chance of respondent accuracy, it may have contributed to lack of precision in the regression model. For example, instead of dividing survey responses regarding their sleep duration hours into categories, we could ask respondents for an exact (numeric) amount. Future surveys could also achieve greater response accuracy by limiting survey participation to college sophomores. With these survey improvements and increased response time for potential participants, future studies can continue to gain insights into contributing factors that associate with freshman weight gain, thus helping institutions to establish programs and policies to combat this issue.

Acknowledgements

This work was funded by the Summer Undergraduate Mathematics Research Institute (SUMSRI) program at Miami University of Ohio.

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APPENDIX

Freshman Fifteen Survey Questions:

1. Did you experience weight gain during your first year in college? If so, approximately how much?
2. What school did you attend your freshman year of college?
3. What is your current age?
4. How old were you as a freshman?
5. How far was your school located from your hometown?
    a. within an hour
    b. between 1 and 3 hours
    c. between 3 and 5 hours
    d. between 5 and 7 hours
    e. over 7 hours
6. What category did your major lie under your freshman year?
    a. Sciences
    b. Arts
    c. Business
    d. Education
    e. Humanities
    f. Pre-medicine
    g. Engineering
7. What is your race/ethnicity?
    a. Caucasian
    b. African American
    c. Asian
    d. Hispanic
    e. Indian
    f. Other
8. How did you typically eat?
    a. cook your own meals
    b. eat at a dining hall
    c. eat at a restaurant/carry out
9. How many extracurricular activities were you involved with?
    a. 0
    b. 1 or 2
    c. 3 or 4
    d. 5 or more
10. What is your gender?
    a. Male
    b. Female
11. How much alcohol did you consume a week? (numbers refer to the amount of drinks)
    a. 0-5
    b. 6-10
    c. 11-15
    d. 16-20
    e. 21 or more
12. Did you smoke as a freshman?
    a. Yes
    b. No
13. How many hours a week did you study?
    a. 0-5
    b. 6-10
    c. 11-15
    d. 16-20
    e. 21 or more
14. What was your GPA at the end of your freshman year?
15. Rate your stress level on a scale of 1 to 10, 1 being not stressed, and 10 being extremely stressed.
16. How many days of the week did you exercise?
    a. 0 or 1
    b. 2 or 3
    c. 4 or 5
    d. 6 or 7
17. Were you a vegetarian?
    a. Yes
    b. No
18. Did you live away from home before going to college?
    a. Yes
    b. No
19. Did you eat breakfast on a regular basis?
    a. Yes
    b. No
20. Did you have a job?
    a. Yes
    b. No
21. Rate your relationship with your family on a scale of 0 to 5, with 0 being not supportive and 5 being very supportive.
22. Did your family support you financially?
    a. Yes
    b. No
23. What was your parent's marital status?
    a. Married
    b. Divorced
    c. Other
24. How much time did you spend playing video games or watching TV?
    a. 0-5 hours
    b. 6-10 hours
    c. 11-15 hours
    d. 16-20 hours
    e. 21 or more hours
25. Did your family promote a healthy lifestyle growing up?
    a. Very healthy
    b. Somewhat healthy
    c. Did not necessarily promote
26. On average, how many hours of sleep did you get a night?
    a. Less than 4 hours
    b. 5 or 6 hours
    c. 7 or 8 hours
    d. 9 or more hours
27. Did your intake of caffeine increase significantly when entering your freshman year?
    a. Yes
    b. No