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The Relationship Between Meal Timing and Body Mass Index Readings of College Students

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Abstract

In this study the relation between Body Mass Index (BMI) of college students and the timing of their food consumption was investigated to see if the timing of students' meals affects their metabolism and BMI. For this study a survey was developed and disseminated using email distribution lists, and the survey link was shared using social media. By applying the Ordinary Least Square (OLS) Regression analysis results show that being older, female, and being a freshmen compared to being a senior contribute to higher BMI. In addition, less exercise, less smoking, more napping and more snacking contributed to a higher BMI. Finally, waking up later during school days, waking up earlier when there is no school, having lunch later when there is no school and lower frequency of food consumption per day were also correlated with higher BMI.

Keywords: Obesity; College Students; Meal Timing.

1. Introduction

According to the World Health Organization report of 2013, the rate of obesity among college students is continuously increasing. The Centers for Disease Control and Prevention reports that 5.2 million college students are obese and even more are overweight [1].

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The obesity rate among college students has increased rapidly during the past 30 years due to a number of reasons such as eating late at night, skipping meals and not exercising [2]. If students do not change their eating habits, they will be even more overweight than their parents [2]. Obesity is a condition of excess body fat due to which the number and size of fat cells increase. Obesity affects health status and can cause chronic diseases such as cardiovascular diseases, musculoskeletal disorders and some cancers [3]. The presence of obesity is commonly assessed by calculating the BMI which is a simple index of weight-for-height that is used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m2) [1]. In this study the relation between Body Mass Index (BMI) of college students and the timing of their food consumption was investigated to see if the timing of students' meals affects their metabolism and BMI. For this study a survey was developed and disseminated using an email distribution lists, and the survey link was shared using social media. By applying the Ordinary Least Square (OLS) Regression analysis results show that being older, female, and being a freshmen compared to being a senior contribute to higher BMI. In addition, less exercise, less smoking, more napping, and more snacking also led to a higher BMI. Finally, waking up later during school days, waking up earlier when there is no school, having lunch later when there is no school, and lower frequency of food consumption per day were also correlated with higher BMI.

2. Materials and Methods

The intended population of this research consisted of college students in the United States (US) of America. The population surveyed included only US college students who were 18 years old or older. Most of the students that participated in the survey were from New York State (98.36%). This included both male and female students. The purpose of the survey was to learn more about the relationship between the meal timing and BMI of college students. All students started to evaluate their results in October and finished in December. Data were collected using a survey designed and hosted by Campus Labs, a third party vendor with which LIU has a license. The information obtained was not recorded in a manner that human subjects could be identified. A convenience sample was used, and the survey link was posted on different online sites, such as Facebook and Instagram. Also, the survey was distributed among LIU students by email. The survey was analyzed using STATA (Data Analysis and Statistical Software for Professionals). Data was received with 320 participants originally. However, by cleaning up the data (some questions were skipped, wrong information was entered, or participants left the survey before even evaluating any information) 111 participants left. 24.32% Males (27) and 75.68% Females (84). Because of the difference in male and female participants, it was decided to evaluate the summary statistics two times. In the analysis both Females and Males (the results are shown in Table 2.1) were included. In addition, only Females were included as well (the results are shown in Table 2.2). As shown in Table 2.1, average BMI is 24.2. BMI<25 is considered normal, which means on average a participant in the survey does not have any significant overweight problems. That can be true, because looking at the summary statistics the average amount of times people eat per day is 4, which is considered higher than normal. However, the maximum BMI is 46.9, and the minimum BMI is 16.8. Also, from Table 2.1, we can see that all students eat at least once a day.

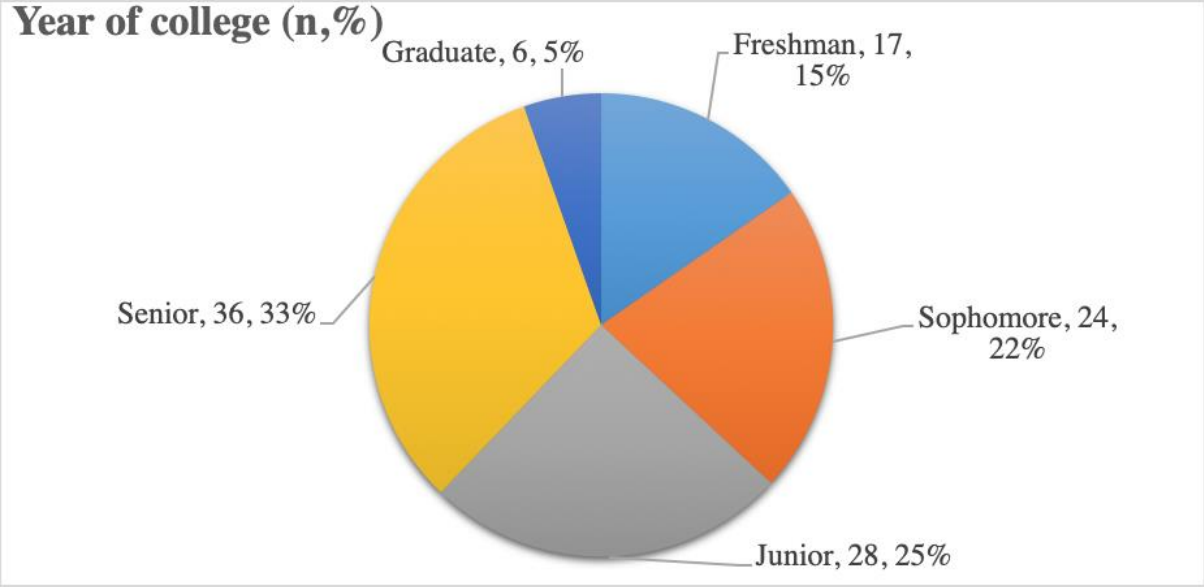

Figure 1: Year of college (n, %)

Table 1: Descriptive Statistics (both Females and Males, n=111) % (n)

Condition	Men (27)	Women (84)
Underweight range (BMI is less than 18.5)	3.7% (1)	4.8% (4)
Normal Weight (BMI is 18.5 to <25)	25.9% (7)	70.2% (59)
Overweight range (BMI is 25.0 to <30)	59.3% (16)	14.3% (12)
Obese range (BMI is 30.0 or higher)	11.1% (3)	10.7% (9)

The maximum amount of alcohol consumed per week is five times. Even though on average the consumption of alcohol is 0.9, which is around once a week. On average, students take around 16 credits (min-3 and max-26) which proves that the data is valuable, since the average student in college takes five classes per semester (15-16 credits). Snack variable shows that the maximum amount students snack a day is 5, however on average students almost do not snack (0.3). The mean for caffeinated drinks is relatively high, it is 3.5, which means that on average students consume them around 3-4 times a week. LIU Post students, who most likely make up the majority of the sample, have classes from Monday through Thursday. Because of late studying and early classes students might need caffeinated drinks to sustain themselves. As shown in Table 2.2, the mean BMI is 23.7. Comparable to Table 2.1, average BMI is lower. By the following comparison of two tables, it is apparent that males consume more alcohol than females. Moreover, it shows the same pattern in consumption of caffeinated drinks ($\mu_{\text{Males \& Females}} = 3.50$; $\mu_{\text{Females}} = 3.45$). Furthermore, females smoke (times a week), exercise (times a week) and work (hours a week) less than males. However, by comparing two tables, changes do not appear significant since there are just 27 males in our data set.

Table 1.1: Summary Statistics (both Females and Males, n = 111)

Variable	Mean	Std. Dev.	Min	Max
BMI	24.24	4.8	16.83	46.92
GPA	3.52	0.4	2.10	4.00
Exercise	3.22	2.1	0.00	7.00
Smoke	0.68	1.8	0.00	7.00
Alcohol	0.91	1.2	0.00	5.00
Coffee	3.50	2.6	0.00	7.00
Nap	2.14	2.2	0.00	7.00
Homework	10.64	8.2	1.00	50.00
Credits	16.38	3.5	3.00	26.00
Work	11.25	11.6	0.00	40.00
Times food	4.04	1.3	1.00	7.00
Breakfast	5.08	2.3	0.00	7.00
Snack	0.30	0.9	0.00	5.00
Eat out	2.56	1.9	0.00	7.00

Table 2.2: Summary Statistics (only Females, n = 84)

Variable	Mean	Std. Dev.	Min	Max
BMI	23.66	5.1	16.83	46.92
GPA	3.56	0.4	2.10	4.00
Exercise	3.14	2.2	0.00	7.00
Smoke	0.50	1.6	0.00	7.00
Alcohol	0.83	1.2	0.00	5.00
Coffee	3.45	2.6	0.00	7.00
Nap	2.11	2.1	0.00	7.00
Homework	11.01	8.5	1.00	50.00
Credits	16.69	3.6	3.00	26.00
Work	10.76	11.4	0.00	40.00
Times food	4.07	1.3	1.00	7.00
Breakfast	5.31	2.1	0.00	7.00
Snack	0.29	0.9	0.00	5.00
Eat out	2.65	1.9	0.00	7.00

3. Results

The purpose of this study is to determine the relation between the BMI of a college student and meal time.

3.1. Hypothesis

H#1: Students who eat lunch at late hours will have higher BMI.

H#2: Higher workload will be correlated with higher BMI.

H#3: More intake of food in a day or snacks per day will cause higher BMI.

H#4: Students who are older have higher BMI.

H#5: Smoking can decrease BMI of students.

3.2. Regression Analysis

Using Ordinary Least Square Regression (OLS), we controlled for Age; what is participants Gender; are they freshmen, sophomore, junior, senior or graduate (Year College), how many days a week he/she exercises (Exercise); how many days a week a participant smokes (Smoke); how many days a week she/he naps (Nap); what time does he/she typically wake up during the school week (Monday, Tuesday, Wednesday, and Thursday) (Up School); what time does a participant typically wake up during the school week on weekends (Friday, Saturday and Sunday) (Upnosch); what time does he/she typically eat lunch during school week on weekends (Friday, Saturday and Sunday) (Lnchnosch); how many times does a participant typically eat per day (This includes soups, juices, coffee, and snacks) (Times Food); on how many days of the week does he/she wake up at night to have a snack (Snack) on BMI. Only the following questions were used from the survey since those were the ones with significant results. Because of the differences in gender ($n_{\text{Males \& Females}}=111$, $n_{\text{Females}} = 84$), it was decided to run the regression two times (Regression 1 = Females & Males; Regression 2 = Females).

Table 3: Regression Results

	Regression 1	**Regression 2**
Age	0.48**	.58**
Gender	-1.70*	
Year College	-1.06**	-1.14**
Exercise	-0.34*	
Smoke	-0.42*	
Nap	0.42 **	
UpSchool	1.28**	1.39**
Upnosch	-1.28 **	-1.75**
Lnchnosch	0.46 **	0.91**
Timesfood	-0.81 **	-1.22**
Snack	1.30**	2.07***

(*) – Significant at the 90% level;(**) – Significant at 95% level;(***) – Significant at 99% level.

Linear regression is identifying the line of best fit using the formula:

Regression 1

$$BMI = a\ (21.77) + b_1\ Age - b_2\ Gender - b_3 YearColleg - b_4\ Exercise - b_5 Smoke + b_6 Nap + b_7 UpSchool - b_8 Upnosch + b_9\ Lnchnosch - b_{10} TimesFood + b_{11} Snack$$

Regression 2

$$BMI = a\ (20.01) + b_1\ Age - b_2 YearColleg + b_3\ UpSchool - b_4\ Upnosch + b_5 Lnchnosch - b_6\ TimesFood + b_7\ Snack$$

3.3. Snack Intake of Female Vs Males

According to the results 23 (85%) out of 27 males do not take snacks per week. There is a possibility they take one snack in two weeks or one snack in one month. Whereas, one male takes one snack per week, two males take two snacks per week, and one male takes four snacks per week. 73 females (87%) out of 84 take no snack per week. Maybe they take one snack in two weeks or in one month. Six females take one snack per week. Two females take two snacks per week. One female takes three snacks per week. And one female takes four snacks per week. One female takes five snacks per week.

Table 4: Snack Intake of Female Vs Males

Snack Intake	Males (27)	Females (84)
No Snack per week	85%	87%
1-3 times per week	11%	11%
4-6 times per week	4%	2%

4. Discussion

4.1. Factors affecting BMI

From the above results, R^2 (Regression 1) explains about 38% of the variation in BMI among 111 participants and R^2 (Regression 2) explains about 40% of the variation in BMI among 84 participants. This concludes that Age, Gender, Year College, Exercise, Smoke, Nap, UpSchool, Upnosch, Lnchnosch, Timesfood and Snack are the factors that attribute to the change in BMI, and hence the hypotheses hold well. Students who eat lunch at late hours will have higher BMI. Higher workload will be correlated with higher BMI. More intake of food in a day or snacks per day will cause higher BMI. Students who are older have higher BMI. Smoking can decrease BMI of students. This is what American Heart Association suggested in its research when it was relating the causes of cancer to obesity. In its results, it also concluded that the BMI of adults is affected by the sleep time, energy intake, physical activities, smoking, and age [4].

4.2. Sleep Time and its Effect on BMI

The coefficient sign for what time do you typically wake up during the school week (Monday, Tuesday, Wednesday, and Thursday) was positive which means that later waking up during the school week is causing

the higher BMI. This is because during the school days, students have less time in the morning. They have to get up, prepare for school, and reach school on time. If a college student wakes up late, then he/she does everything in a hurry and sometimes does not get time to make breakfast [5]. If students skip breakfast, it may lead to a higher consumption of calories later in a day. When a student does not eat anything for breakfast, it leads to lack of energy [18]. During college time if he/she feels hungry then there is no other option but to take snacks or any other food which may contain a high amount of calories. This causes higher energy consumption and higher BMI [6]. The coefficient sign for what time do you typically wake up during the school week on weekends (Friday, Saturday, and Sunday) was negative, and it was statistically significant (.001). It means that the earlier you wake up during weekends, the higher your BMI. The assumption is that people who wake up early on weekends do not have enough sleep, which could cause stress and higher consumption of calories [7]. Stress levels prompted by examinations or emotional reasons make food consumption times inconsistent and not self-controlled [17]. What time you typically eat lunch during school week on weekends (Friday, Saturday, and Sunday) had a positive coefficient sign, which means that later in a day you eat lunch, the higher your BMI. It was statistically significant. If a student gets busy in tasks, then he may skip his lunch. This will increase his hunger later in a day and will lead to high energy food consumption at dinner time which will cause the increase in the BMI. The reason people would eat lunch later in a day can be also because of work. When eating schedule shifts and you consume more calories at night, and this causes the higher BMI [7]. The result for question of how many times a week are you having a nap during a week was significant (.02) and the coefficient sign was positive which indicates that the more you nap the higher the BMI. The research by Leng and his colleagues concluded that daytime napping was associated with 58% higher diabetes risk. Also, it increased risks of type 2 diabetes [16]. Above results are similar as the results of Tim S. Olds. In his research on the "Relationship between Sleep Habits and Weight Status" he concluded that sleep time affects the BMI of the adults. The late-bed/late wake up times are associated with higher weight [8].

4.3. Age and BMI

The results show that the question about the age of a participant had a positive coefficient sign which shows that the older a person, the higher BMI. There are two reasons for that. Firstly, physical activities are affected by the age of the person. When a person gets older, it results in less physical activity. Secondly, older the person, slower metabolism [9]. However, the year of college of a participant was statistically significant and had a negative coefficient sign. This means that if you are a freshman, your BMI will tend to be higher than if you are a senior. That can be the truth in the case that when a student leaves his/her parent's house, they have stress and because of that, they consume more calories than usual. But in a year or two, they get adapted to the new atmosphere, and they lose all the weight that they gained during their freshman years [10].

4.4. Gender and BMI

According to the results, the question about Gender was significant at the 90% level (.079). This result might be biased due to the proportion of males and females in my sample. Rani A. Desai did a research to evaluate the relationship between the gender and BMI and concluded that it is not the gender which affects the BMI rather it is the energy intake which is the primary cause of the increase in BMI [11].

4.5. Energy Consumption and BMI

The question of how many times do you typically eat per day (this includes soups, juices, coffee, and snacks) had the negative coefficient sign, which shows that the fewer times a day you eat, the higher BMI. The result was statistically significant. Fuse and his colleagues using mice, proved that two meals per day rather than one meal `is a preferable eating schedule for protecting against obesity [12]. My last significant independent variable was Snack. The positive coefficient sign indicated that the more we snack per day, the higher BMI. Based on the fact that our weight is directly depending on our caloric consumption, we see that the more you snack, the more calories you consume, and the higher BMI. K.J. Reid proved that when the adults take more snacks, it causes the increase in BMI [13].

4.6. Physical Activities and BMI

Results show that physical activity plays an important role in reducing BMI. The coefficient sign was negative, which means that the less you exercise, the higher your BMI. Parsons proved that less calories you spend, the higher your weight [14].

4.7. Smoking and BMI

In the results, the smoke variable has a negative coefficient sign, and it is significant at the 90% level (p-value = .08). The negative sign in front of the coefficient shows that less you smoke, the higher the BMI. Smoking may suppress appetite, lead to lower calorie consumption and lower BMI. Shadrach Dare did a research to find a factor which decreases the BMI, and he concluded that smoking plays a vital role in reducing the BMI, but it is not good for health [15].

4.8. Limitations and recommendations for the further research

The research paper was based on the survey, conducted among undergraduate and graduate students at Long Island University Post within time constraints posed by the institution. For further research it is recommended to capture more observations with equal quantity of females and males in the sample. Furthermore, it is recommended to critically evaluate the amount of calories consumed per person at breakfast, lunch and dinner times. As well as the relationship between the amount of calories consumed at lunch, and the probability of having dinner the same day. The correlation between food intakes and higher/lower BMI including calories consumed would evaluate the data more efficiently.

5. Conclusion

The purpose of this study was to determine the relationship between the BMI of a college students and timing of their meals. By using the Ordinary Least Square Regression (OLS), it was concluded that Age, Gender, College Year, Exercise, Smoke, Nap, UpSchool, Upnosch, Lnchnosch, Timesfood and Snack are the factors which attribute to the higher or lower BMI. It was concluded that study results can help college students to maintain their BMI during their college years. As results show when students skip breakfast, eat lunch later, or eat dinner

just before going to bed their BMI increases owing to the fact that their body starves which causes higher calorie consumption at dinner time. Hence, students should wake up earlier in the morning before school and eat a proper breakfast. After their classes, they should eat lunch close to noon. In addition, adding physical activity to their schedule will help with maintaining a healthier BMI.

6. Recommendations

Based on the results of the study the following steps will cause lower obesity rates among college students: decreased snack intake; increased physical activity; consumption of 2 to 3 meals a day; early-bed/early-rise times during weekdays; late-rise time during weekends; regular breakfast and lunch consumption; an early or no dinner intake; no napping.

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References

[1]. "CDC Overweight & Obesity", Centers for Disease Control and Prevention, 2020. [Online]. Available: https://www.cdc.gov/obesity/. [Accessed: 15- Jul- 2020].

[2]. J. Janeway, "Preventing the Freshman 5, 10, 15, 40 - Obesity Action Coalition", Obesity Action Coalition, 2009. [Online]. Available: https://www.obesityaction.org/community/article-library/preventing-the-freshman-5-10-15-40/. [Accessed: 15- Jul- 2020].

[3]. "Obesity and overweight", Who.int, 2020. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. [Accessed: 15- Jul- 2020].

[4]. "Guard your health during busy, pressure-filled December", www.heart.org, 2020. [Online]. Available: https://www.heart.org/en/news/2018/12/13/guard-your-health-during-busy-pressure-filled-december. [Accessed: 15- Jul- 2020].

[5]. J. Nathaniel F. Watson, "A Twin Study of Sleep Duration and Body Mass Index", PubMed Central (PMC), 2020. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2823270/. [Accessed: 15- Jul- 2020].

[6]. M. Grandner, E. Schopfer, M. Sands-Lincoln, N. Jackson and A. Malhotra, "Relationship between sleep duration and body mass index depends on age", Obesity, vol. 23, no. 12, pp. 2491-2498, 2015. Available: 10.1002/oby.21247 [Accessed 15 July 2020].

[7]. K. Baron, K. Reid, A. Kern and P. Zee, "Role of Sleep Timing in Caloric Intake and BMI", Obesity, vol. 19, no. 7, pp. 1374-1381, 2011. Available: 10.1038/oby.2011.100 [Accessed 15 July 2020].

[8]. T. Olds, C. Maher and L. Matricciani, "Sleep Duration or Bedtime? Exploring the Relationship between Sleep Habits and Weight Status and Activity Patterns", Sleep, vol. 34, no. 10, pp. 1299-1307, 2011. Available: 10.5665/sleep.1266.

[9]. "Why Your Metabolism Slows Down With Age", Healthline, 2020. [Online]. Available:

https://www.healthline.com/nutrition/metabolism-and-age. [Accessed: 15- Jul- 2020].

[10]. M. Freedman, "Gender, Residence and Ethnicity Affect Freshman BMI and Dietary Habits", American Journal of Health Behavior, vol. 34, no. 5, 2010. Available: 10.5993/ajhb.34.5.1.

[11]. R. Desai, M. Manley, M. Desai and M. Potenza, "Gender Differences in the Association Between Body Mass Index and Psychopathology", CNS Spectrums, vol. 14, no. 7, pp. 372-383, 2009. Available: 10.1017/s1092852900023026.

[12]. Y. Fuse, A. Hirao, H. Kuroda, M. Otsuka, Y. Tahara and S. Shibata, "Differential roles of breakfast only (one meal per day) and a bigger breakfast with a small dinner (two meals per day) in mice fed a high-fat diet with regard to induced obesity and lipid metabolism", Journal of Circadian Rhythms, vol. 10, no. 0, p. 4, 2012. Available: 10.1186/1740-3391-10-4.

[13]. K. Reid, K. Baron and P. Zee, "Meal timing influences daily caloric intake in healthy adults", Nutrition Research, vol. 34, no. 11, pp. 930-935, 2014. Available: 10.1016/j.nutres.2014.09.010.

[14]. T. Parsons, O. Manor and C. Power, "Physical activity and change in body mass index from adolescence to mid-adulthood in the 1958 British cohort", International Journal of Epidemiology, vol. 35, no. 1, pp. 197-204, 2005. Available: 10.1093/ije/dyi291.

[15]. S. Dare, D. Mackay and J. Pell, "Relationship between Smoking and Obesity: A Cross-Sectional Study of 499,504 Middle-Aged Adults in the UK General Population", PLOS ONE, vol. 10, no. 4, p. e0123579, 2015. Available: 10.1371/journal.pone.0123579.

[16]. Y. Leng, F. Cappuccio, P. Surtees, R. Luben, C. Brayne and K. Khaw, "Daytime napping, sleep duration and increased 8-year risk of type 2 diabetes in a British population", Nutrition, Metabolism and Cardiovascular Diseases, vol. 26, no. 11, pp. 996-1003, 2016. Available: 10.1016/j.numecd.2016.06.006.

[17]. A. OFFER, "Body Weight and Self-Control in the United States and Britain since the 1950s", Social History of Medicine, vol. 14, no. 1, pp. 79-106, 2001. Available: 10.1093/shm/14.1.79.

[18]. "Adolescents who skip breakfast may develop obesity", Medicalxpress.com, 2020. [Online]. Available: https://medicalxpress.com/news/2019-07-adolescents-breakfast-obesity.html. [Accessed: 16- Jul- 2020].