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Peer effects and the Freshman 15: Evidence from a natural experiment

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Abstract

This study investigates the importance of peer effects in explaining weight gain among freshman college students. We exploit a natural experiment that takes place on most college campuses in the US – randomized roommate assignments. While previous studies suggest that having an obese spouse, friend, or sibling increases one's likelihood of becoming obese, these social interactions are clearly non-random. We collect data from female students living on campus at a private Midwestern university at the beginning and end of their first year of college. Our findings suggest that the amount of weight gained during the freshman year is strongly and negatively correlated to the roommate's initial weight. Further, our analysis of behaviors suggests that female students adopt some of their roommates' weight-loss behaviors which cause them to gain less weight than they otherwise would have. In particular, we find evidence that this effect may be through influences in eating, exercise, and use of weight loss supplements.

Research highlights

- Selection and shared environment often confound studies of peer effects in obesity.
- Randomized roommate assignment can be used as natural experiment.
- We find significant peer effects in weight and underlying peer effects in behaviors.
- Social environment strongly impacts weight gain and related behaviors of adolescents.

Keywords: Weight gain; Peer effects; Natural experiment

JEL classification codes: I1

1. Introduction

The increase in the prevalence of obesity in the United States in recent decades has attracted considerable attention by public health and policy officials, the media, medical practitioners, and researchers alike. Numerous studies have investigated both the antecedents and consequences of being overweight or obese. The finding that body weight depends not only on biological factors, but also on behavioral and environmental factors (Cutler et al., 2003, Philipson and Posner, 2003, Christakis and Fowler, 2007 and Lakdawalla and Philipson, 2009) implies that interventions that mitigate behavioral and environmental influences are important in policies aimed at addressing this growing problem.

Although previous studies suggest that being overweight or obese is, in some sense, socially contagious (Christakis and Fowler, 2007 and Trogdon et al., 2008), these studies predominately evaluate the social influences of friends or family members. This is problematic because individuals clearly do not randomly choose such relationships. In this study, we examine peer effects in weight gain and weight related behaviors within randomly assigned pairs of roommates.

2. Weight gain and obesity in young adults

From 1988 to 2006, obesity prevalence in young adults, aged 18–29, increased 96% – the largest percent increase for all age groups.[2] While the obesity epidemic has generated initiatives to help curb this growing trend in general, there has been a growing spotlight on childhood and adolescent obesity. In fact, the Healthy People 2010 program urges that policymakers seize the "window of opportunity" to encourage children and adolescents to establish healthy lifestyles now so that they might carry over into adulthood (2000).

While the so-called "Freshman 15" is more likely to be the "Freshman 5" (Megel et al., 1994, Matvienko et al., 2001, Anderson et al., 2003, Butler et al., 2004, Levitsky et al., 2004, Levitsky et al., 2006, Hajhosseini et al., 2006, Hoffman et al., 2006, Morrow et al., 2006, Holm-Denoma et al., 2008 and Lloyd-Richardson et al., 2009), college freshmen gain weight at a greater rate than do others in the general population (Levitsky et al., 2004). Furthermore, larger prospective studies show that weight gain as a young adult tends to set the pace for weight gain well into adulthood (Truesdale et al., 2006 and Lloyd-Richardson et al., 2009). Lifestyle behaviors aimed at weight management in young adulthood are likely to influence both long-term behaviors and related health and disease outcomes (Kuh and Ben-Shlomo, 2004). In fact, researchers have identified college campuses as an important target for weight-related policy interventions (Nelson et al., 2008).

The reasons for weight gain among young adults are similar to those in other age groups, including lack of physical activity and poor diet (Serdula et al., 1999, Li et al., 2000 and Jung et al., 2008). However, although young adults are more likely to be physically active than older cohorts, they tend to be less likely to consume five or more servings of fruits and vegetables per day (Mokdad et al., 2001). In our study, we investigate the importance of these behaviors in explaining weight gain as they pertain to peer influences. More specifically, we expect that peers affect each other's weight through these behaviors.

3. Peer effects and weight

Several recent studies have investigated empirically whether having obese peers increases one's own probability of becoming obese (Christakis and Fowler, 2007, Cohen-Cole and Fletcher, 2008a, Trogdon et al., 2008 and Halliday and Kwak, 2009). However, as the researchers have noted, addressing the several potential biases in estimating peer effects is challenging. We draw upon Manski's (1993) seminal paper on peer effects to delineate these potential biases below.

First, the choice of social interactions with friends and family is clearly non-random. There is considerable evidence in several fields that individuals tend to marry individuals like themselves (assortative mating, Mare, 1991 and Pencavel, 1998) and in general, evidence of homophily – the preference to be around others like oneself (McPherson et al., 2001). Individuals obviously do not choose their siblings, but they do share genetic make-up with them that may explain one's predisposition for weight gain and obesity.[3]

Second, there may be shared environmental and institutional influences that affect weight or weight change of both the individual and his peer(s).[4] For example, spouses both live near the same fast food restaurants, grocery stores, gyms, etc. and share the same physical environment that may influence their weight and related behaviors independently of the social or peer influence. Studies that examine the correlation of the individual and peer's weight measured simultaneously need to account for this potential confounding.

Third, while friends and family may shape an individual's eating and exercise behaviors, the individual may also shape their peers' behaviors. As a result, it is often difficult to determine the extent to which positive correlation between the weight of an individual and that of their peer is a result of the individual being impacted by the peer or vice versa. Manski (1993) refers to this problem as the "reflection bias", showing that this reverse causality will bias the estimated effect of peers on one's obesity status upwards.

Lastly, it is also possible that one's weight is impacted by their peer's characteristics that are unobserved and exogenous to the model.[5] For example, one's weight may be influenced not only by their spouse's weight but also by the spouse's cultural background or family traditions; if the latter factors are unobserved, the estimate will incorporate both endogenous (weight) and exogenous (cultural background, family traditions) peer effects.

In this manuscript, we refer to the endogenous social network effect as "peer effect". We adopt Cohen-Cole and Fletcher's (2008a) nomenclature and refer to the first two sources of bias as "selection" and "environmental effects", respectively. Finally, we refer to biases due to reverse causality and unobserved exogenous group characteristics as "reflection" and "exogenous effects," respectively following Manski (1993) hereafter.

Previous research deals with these problems in different ways, often without addressing all of them. Christakis and Fowler (2007) utilize a lagged measure of the peer's obesity to control for selection and exploit the directionality of friendship to deal with environmental effects, using 32 years of data from the Framingham Heart Study. They also control for age, sex, education, and own lagged obesity status. They find strong evidence of peer effects in weight gain. While their approach deals with the selection issue (assuming that selection is conditional only on the peers' weight) and indirectly with biases due to environmental effects, the inclusion of the peer's obesity status at present and the lack of direct controls for common environmental influences make it subject to biases due to reflection and shared environmental influences. Cohen-Cole and Fletcher (2008a) replicate the work of Christakis and Fowler using a sample of 7th–12th graders from the National Longitudinal Study of Adolescent Health (Add Health). They also extend the analysis by estimating different specifications of the model and by directly controlling for environmental influences with school-specific fixed effects. Cohen-Cole and Fletcher (2008a) find that once they account for contextual effects and selection, the correlation in peers' weights becomes indistinguishable from zero.[6] Note, however, that this study is still subject to the reflection bias.[7] Another recent study utilizing the Add Health data finds a positive effect of peer's Body Mass Index (BMI) overweight status on one's own BMI or overweight status using an instrumental variable model with school fixed effects to deal with the reflective nature of peer influences and common environmental influences (Trogdon et al., 2008). However, this study does not deal with the selection issue. Bias due to exogenous effects has not been dealt with in any of the earlier studies. Thus, while this previous work provides important contributions to the study of peer effects on weight, identifying the peer effect poses a significant empirical challenge.

In another stream of research, studies report evidence of peer effects in explaining other health behaviors, such as smoking, alcohol and drug use (Evans et al., 1992, Norton et al., 1998, Gaviria and Raphael, 2001, Powell et al., 2005, Lundborg, 2006, Clark and Lohéac, 2007 and Fletcher, 2010).

Researchers typically measure peer effects as the influence of the mean peer group behavior with peer-groups defined by living in the same neighborhood or attending the same school (Norton et al., 1998 and Gaviria and Raphael, 2001). Much of this work also controls for environmental effects by including school or neighborhood characteristics or fixed effects (Gaviria and Raphael, 2001, Powell et al., 2005, Lundborg, 2006 and Fletcher, 2010). Some of these studies employ instrumental variables models to deal with reflection – using plausibly exogenous characteristics of the peer that would explain the peer's behavior, such as peer's parental behavior – and still find significant peer effects (Norton et al., 1998, Gaviria and Raphael, 2001, Powell et al., 2005 and Lundborg, 2006), with the exception of Evans et al. (1992).[8]

Our contribution to this literature is unique in that we deal with three sources of bias. Firstly, we deal with the selection bias by drawing on a sample of individuals for whom social ties are essentially randomly assigned. We exploit the natural experiment that takes place on many college campuses in the United States every year: randomized roommate assignment for first year students. College roommates represent an important and interesting peer setting to study because roommates spend a lot of time together in an environment that requires sharing a living space and as such necessarily involves day-to-day exposure to one another's behaviors, including eating and exercise. Several other researchers have utilized this strategy to investigate peer effects on student academic performance (Sacerdote, 2001, Zimmerman, 2003, Foster, 2006, Siegfried and Gleason, 2006 and Stinebrickner and Stinebrickner, 2006), alcohol consumption (, Kremer and Levy, 2003 and Kremer and Levy, 2008), and attitudes (Zimmerman et al., 2004 and Boisjoly et al., 2006).[9] Randomization is a better way of dealing with selection bias than including lagged measures or controlling for observable characteristics used in earlier non-randomized studies of social influences in weight gain.

Secondly, our study eliminates bias from exposure to common environmental influences by using the roommate's pre-college weight to explain the student's weight gain during the freshman year of college. By design, the pre-college weight of the roommate could not have been impacted by common environmental factors shared by the peers during the freshman year because the roommate had not been exposed to this environment prior to the first measurement. Measuring the peer's characteristics prior to exposure to the common environmental influences is arguably a stronger approach than simply controlling for observable environmental variables or fixed effects to deal with shared environmental influences, used in earlier studies. Of note, for reasons discussed below our study also controls for dormitory fixed effects.

Lastly, the use of lagged measures of the peer's weight and behaviors also allows us to eliminate the reflection bias common in earlier studies that utilized model specifications based on contemporaneous measures. Linking a student's end-of-freshman year weight and behavior measures to the peer's weight at the beginning of the freshman year and the peer's behaviors during the year prior to college allows us to rid the estimates of reverse causality.

4. Data

4.1. Setting

We conducted our study at a private Midwestern university during the 2008/2009 academic year. Just fewer than 2000 freshman students entered the university in the fall of 2008. Except for a small number of students with certain special needs or extenuating family circumstances, all freshmen were required to live in on-campus dormitories. Freshman students were not allowed to choose where they lived directly. However, prior to arriving on campus all students were required to fill out a housing application form in which they ranked dormitories according to their preferences, requested a particular room type (number of beds, bathrooms, etc.) and had an option of naming another freshman student if they wanted to share a room with that person. Once all applications were received, all requests were pooled and inputted into housing assignment software that assigned each applicant a priority number via a random number generation process. The priority number did not depend on the time of submission of application or any other criteria. The software first matched applicants with their requested roommate, and then matched applicants by room type and dormitory criteria with available spaces in the order of the randomly assigned priority. As a result of this process, students who did not request a roommate were assigned roommates at random. No attempt was made to pair similar individuals.

4.2. Data collection method

We contacted all incoming freshman students, 1022 females and 938 males, via student email inviting those 18 years of age and older to participate in an online survey in the fall of 2008, and once again in the spring of 2009. We fielded the fall survey in the second week of the fall semester, and the spring survey one week after the end of the spring semester. Incentives were offered in both the spring and the fall waves of the survey and included a cash lottery with 124 cash prizes (1 prize of $100, 3 prizes of $50, 5 prizes of $20, 15 prizes of $10, and 100 prizes of $5). Both surveys contained questions about current height and weight, as well as about weight management behaviors (eating, exercise, use of weight loss supplements, etc.) during the year preceding college entry (in the fall survey) and during the freshman year (in the spring follow-up survey). We also asked about dormitory and room assignment, the number of roommates, and whether individuals were living with a roommate they had requested.

4.3. Sample

A total of 633 females (63% response rate) and 422 males (45% response rate) participated in the baseline survey. Due to the low response rate for males, and because applying our exclusion criteria (as described below) yields too few male observations, we restrict our analysis to female students only. After excluding students who lived off campus and those living in on-campus apartments (6%), we used self-reported dormitory and room numbers to match individuals who said they were living with one other roommate, provided the roommate also responded to the survey.

A total of 372 female students participated in both waves of the survey (41% attrition rate). Of those, 228 observations were excluded from the final sample based on the following exclusion criteria: (1) 117 lived alone or had multiple roommates[10]; (2) 89 could not be matched with the roommate in our sample; (3) 17 lived with a roommate they had requested; and (4) 5 had roommates who did not provide height and weight data. The remaining 144 observations comprise the final sample.[11] The descriptive statistics of the final sample are not significantly different from the sample of females for whom we have baseline and follow up data, but do not have roommate information. We report the descriptive statistics in *Table 1*.

Table 1. Sample descriptive statistics.

	n	**Mean**	**Std. dev.**	**Min**	**Max**
Age	144	18.10	0.31	18	19
Caucasian/White	144	0.89	0.31	0	1
African American/Black	144	0.01	0.01	0	1
Weight at baseline (in lb)	144	139.08	23.16	100	235
Weight at follow-up (in lb)	144	140.74	23.36	100	230
Weight change (in lb)[a]	144	1.65	8.07	−30	25
Height at baseline (in In)	144	65.64	2.88	59	72
Height at follow-up (in In)	144	65.70	2.96	58	72
Tried to lose weight at baseline	143	0.69	0.47	0	1
Tried to lose weight at follow-up	141	0.52	0.50	0	1
Restricted food at baseline	115	0.54	0.50	0	1
Restricted food at follow-up	140	0.47	0.50	0	1
Unlimited meal plan	141	0.31	0.46	0	1
Used gym at baseline	114	2.20	2.02	0	11
Used gym at follow-up	140	2.55	1.93	0	8
Exercised outside at baseline	115	2.55	2.38	0	15
Exercised outside at follow-up	140	1.15	1.56	0	7
Used weight-loss supplement at baseline	115	0.05	0.22	0	1
Used weight-loss supplement at follow up	140	0.07	0.26	0	1
Peer's weight at baseline (in lb)	144	138.45	19.63	100	200
Peer's weight at follow-up (in lb)	96	140.32	21.73	100	210
Peer's height at baseline (in In)	144	65.55	2.79	59	72
Peer's height at follow-up (in In)	95	65.63	10.09	51	72

	n	Mean	Std. dev.	Min	Max
Peer tried to lose weight at baseline	143	0.73	0.45	0	1
Peer tried to lose weight at follow-up	92	0.50	0.50	0	1
Peer restricted food at baseline	124	0.61	0.49	0	1
Peer restricted food at follow-up	92	0.48	0.50	0	1
Peer unlimited meal plan	92	0.32	0.47	0	1
Peer used gym at baseline	122	1.99	1.87	0	8
Peer used gym at follow-up	92	2.48	1.92	0	8
Peer exercised outside at baseline	124	2.61	2.41	0	15
Peer exercised outside at follow-up	89	1.16	1.52	0	5
Peer used weight-loss supplement at baseline	124	0.06	0.23	0	1
Peer used weight-loss supplement at follow-up	92	0.09	0.28	0	1

[a] Weight change is statistically significant, $p = 0.02$.

4.4. Measures

Weight: We use self-reported weight (in pounds) as a measure of weight at baseline and follow-up. We also use the self-reported height (in inches) to construct the Body Mass Index (BMI) variable at baseline and follow up using the standard formula (the ratio of weight in pounds to the square of height in inches times 703).

Weight management behaviors: We use a number of measures in an attempt to capture weight management behaviors. They include the following:

(1) “Tried to lose weight,” a dichotomous variable equal to one if the student answered “yes” to the question asking whether or not the respondent has been trying to lose weight during the previous year (in the baseline survey) and during the freshman year (in the follow-up survey).

(2) “Restricted food,” a dichotomous variable equal to one if the student answered “sometimes” or “often” to the question asking how often the respondent restricted food intake due to concerns about body size or weight during the previous/freshman year. The reference category is “never” or “rarely”.

(3) “Unlimited meal plan,” a dichotomous variable equal to 1 if the student reported having an unlimited meal plan in the spring semester of the freshman year. The reference category is any of the other meal plan options. All freshman students are required to have a meal plan each semester of the freshman year. There are four plan options each semester: a 50 meal plan, a 125 meal plan, a 175 meal plan, and a

“Carte Blanche” plan with unlimited meals. The meal plan is chosen by semester. The choice for the fall semester can be made online before arriving on campus, but it is not uncommon for students to wait until a week or two into the semester to see what the food is like before purchasing a meal plan. Meal plans for the spring semester are purchased in early January. Since the choice of the meal plan for the fall semester may have been influenced by the peer's choice and therefore cannot be utilized as a measure of pre-exposure preferences, we asked this question in the follow-up survey only.

(4) “Used gym,” a continuous variable equal to the numeric answer provided in response to an open-ended question regarding the average number of times per week the respondent exercised at the gym during the previous/freshman year.

(5) “Exercised outside,” a continuous variable equal to the numeric answer provided in response to an open-ended question regarding the average number of times per week the respondent exercised outside of the gym during the previous/freshman year.

(6) “Used weight loss supplements,” a dichotomous variable equal to one if the student answered “rarely”, “sometimes” or “often” to a question about the frequency of using diet pills during the previous/freshman year. The reference category is “never”.

As a check of the roommate randomization process, we test whether weight-related behaviors during the year prior to college entry and weights at the time of college entry correlated significantly between roommates. Due to the random roommate assignment, we expect roommates’ behaviors, as well as weights, to be uncorrelated at baseline. Indeed, correlation coefficients of roommates’ behaviors are, largely, insignificant: “tried to lose weight”, −0.01 ($p = 0.89$); “restricted food”, 0.04 ($p = 0.66$); “used gym”, 0.11 ($p = 0.26$); “exercised outside”, 0.29 ($p < 0.01$); and “used weight loss supplements”, −0.07 ($p = 0.49$) (*Table 2*). The correlation in frequency of exercise outside of the gym could be driven by self-selection of students with similar exercise preferences into dormitories that offer corresponding amenities. Consistent with insignificant correlations in behaviors, the weights of roommates at the time of college entry are also uncorrelated: the coefficient of correlation is −0.01 ($p = 0.87$).

Table 2. Evidence of randomization: zero order correlations in baseline measures between the roommates.

	ρ	***p*-Value**
Age	−0.05	0.63
Caucasian/White	0.04	0.62
African American/Black	−0.01	0.91
Weight at baseline (in lb)	−0.01	0.87
Height at baseline (in In)	−0.10	0.23
Tried to lose weight at baseline	−0.01	0.88

	ρ	*p*-Value
Restricted food at baseline	0.04	0.65
Used gym at baseline	0.12	0.26
Exercised outside at baseline	0.29	0.003
Used weight-loss supplement at baseline	−0.07	0.49
Mother overweight or obese	−0.01	0.89
Father overweight or obese	0.09	0.26

5. Empirical model

To deal with selection bias, environmental influence bias, and reflection bias in measuring peer influences as discussed earlier, we study the effect of a randomly assigned roommate's weight, measured prior to exposure, on the other roommate's weight gain during the course of the freshman year. (Hereafter we will use the term "weight gain" to denote weight change in general. A negative weight gain is a loss of weight.) Empirically, we estimate:

(1)$Y_{i2}=\alpha_0+\beta_0 Y_{j1}+\gamma_0 Y_{i1}+\varepsilon_i$ where Y_{kt} represents the weight of roommate $k = i, j$ at time $t = 1, 2$. We refer to roommate *i*, the one who is being influenced, as the "index student," and roommate *j*, the one who is exerting influence, as the "peer," hereafter. Therefore, conditional on the index student's weight at the beginning of the freshman year, Y_{i1}, coefficient β_0 measures the effect of the peer's baseline weight on the index student's weight gain during the course of the year.[12] Implicit in this model is the assumption that the peer's weight at the beginning of the freshman year and her behaviors during the freshman year are correlated, thus exposing the index student and causing her to gain more or less weight than she otherwise would have.

Due to the fact that roommate matching is random, our analysis is not biased by unobserved peer selection. Furthermore, since the peer's weight is measured prior to exposure to the index student and to the same environmental influences, the analysis is also free of reflection and shared environmental effects biases. Therefore, we identify peer effects in a framework that is nearly fully exogenous.

Since students are often allowed to choose dormitories (conditional on space availability) dormitory selection could, however, have implications for internal validity due to self-selection (if similar peers self-select into dormitories with specific characteristics), or due to common environmental influences (if students select dormitories offering amenities closely replicating their pre-college living environments). As we mention above, the positive correlation in roommates' exercise outside of the gym patterns in *Table 2* would be consistent with dormitory selection. In other work we have done using this dataset, we find significant differences in behaviors and weight gain across dormitories (Kapinos and Yakusheva, 2010). To control for any unobserved heterogeneity that could stem from dormitory selection, Eq. (1) (and all subsequent models) include dormitory fixed effects.[13]

Lastly, since pairs of roommates enter the analysis twice (once for each roommate),standard regression methods that assume independency of observations can produce biased estimates of the standard errors, often increasing the probability of type-I error (i.e. making coefficients appear more significant than they actually are). We adjust standard errors for clustering at the room level using the 'cluster' command in Stata 11.0.[14]

Note that we could conceptualize peer influence as a relationship between the change in the index student's weight and the *change* in the peer's weight during the course of the year. However, this approach would be subject to bias due to exposure of both the index student and the peer to the same environmental influences throughout the year (e.g. dormitory effects), while also suffering from reflection bias because of exposure of the peer to the index student's behaviors. Although instrumenting the peer's weight gain with their weight at baseline could potentially be an appropriate course of action in order to control for reflection and environmental effects issues, sample size limitations do not allow us to utilize this estimation strategy.

The sign of β_0 in (1) is determined by two factors. The first factor is the direction of the effect of the peer's behavior on the index student's behavior during the freshman year. This is the implicit social influence effect, which previous researchers have hypothesized to be positive. The second factor is the sign of the correlation between the peer's baseline weight and her own behaviors. Therefore, the sign of β_0 in (1) will be positive if a heavier peer chose behaviors that reinforced her weight gain and if that in turn caused a change in the index student's behavior, subsequently leading to a greater amount of weight gain for the index student. Alternatively, if a heavier peer chose behaviors associated with weight loss, this could cause the index student to adopt some of the same behaviors and subsequently experience a smaller weight gain, causing β_0 to be negative.

To understand these behavioral mechanisms, we first examine whether heavier students generally chose behaviors aimed at countering weight gain or engaged in behaviors that were likely to reinforce it. Specifically, we estimate the following model:

(2)$B_{j1}=\alpha_1+\beta_1 Y_{j1}+u_j$ where B_{j1} is the peer's behavior prior to college (exercising, restricting food intake, using weight loss supplements) and Y_{j1} is her baseline weight. Note that Eq. (2) is not intended to estimate a causal effect of weight on behavior; rather its intent is to reveal the sign of a reduced form relationship between the peer's own weight and own behavior choices. A significant negative β_1 would suggest that peers choose reinforcing behaviors (e.g., heavier individuals eating without restriction and not exercising), while a positive β_1 would be evidence of counteracting behavior (e.g., heavier individuals trying to lose weight by exercising, and reducing food intake).

Finally, we examine whether the index student adopted the peer's behaviors during the course of the freshman year. Empirically, we estimate a model for behaviors similar to Eq. (1) whereby the index student's behavior during the freshman year is a function of her own behavior, and of her roommate's behavior, prior to college:

(3)$B_{i2}=\alpha_2+\beta_2 B_{j1}+\gamma_2 B_{i1}+v_i$

Again, we rely on the fact that the index student has not influenced the peer's behavior during the year prior to college and that roommates are randomly assigned. Given the non-experimental evidence that family members and friends positively influence weight status and that peers influence other related health behaviors, such as smoking or drinking, we expect β_2 to be positive.

6. Results

The average female weight in the fall was 139.08 pounds which increased by 1.65 pounds ($p < 0.05$) during the freshman year (Table 1). Based on the CDC guidelines that define overweight and obesity status, only 19% and 6% of the young women in the sample were overweight and obese, respectively, in the fall. These percentages changed only slightly (and not significantly) over the course of the year to 21.5% and 4% overweight and obese, respectively. Although the observed average weight gain was small, it was associated with noticeable changes in behaviors, such as a significant reduction in the proportion of females trying to lose weight (from 69% to 52%, $p < 0.001$) and in the frequency of exercising outside (from 2.5 to a little more than 1 times per week, $p < 0.001$). The frequency of exercising at the gym increased, but only slightly (from 2.23 to 2.55 times per week, $p = 0.07$) and not enough to compensate for the drop in exercise outside of the gym. We also observed a lower frequency of females restricting food intake (from 54 to 47%) and a slight increase in the use of weight-loss supplements (from 5 to 7%), but these changes were not significant. These behavioral changes, if they persist into adulthood as suggested by many experts on adolescent health, could significantly impact future health outcomes including adulthood obesity. Thus, while the observed weight change in our sample may seem small, the fact that we observe significant changes in weight-related behaviors underscores the importance of studying not just changes in weight per se, but also in behaviors. Additionally, our findings support the theoretical notion of an underlying behavioral mechanism that explains the obesity contagion.

In *Table 3*, we report the effect of the peer's initial weight (at baseline) on the index student's weight change over the course of the year (Eq. (1)). In columns 1 and 2, we regress the index student's end-of-year weight on the peer's baseline weight controlling for the index student's own baseline weight (column 1) and also for both of the roommates' heights (column 2). In columns 3 and 4, we specify the model slightly differently by using the change in weight as the dependent variable while continuing to control for the heights of both roommates (column 3) and also controlling for the baseline weight of the index student (column 4). Finally, in column 5, we estimate the model using the BMI instead of weight. In all specifications, we cluster at the room level and control for dormitory fixed effects. We find that the peer's initial weight has a negative effect on the index student's weight change in all models, and that the effect becomes slightly smaller in magnitude once we control for height.

Table 3. The relationship between the index student's weight at the end of freshman year and the peer's weight at baseline

	D.V. = own weight at the end of freshman year		**D.V. = own weight change during freshman year**		**D.V. = own BMI at the end of freshman year**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Weight, at baseline	0.93 (25.55)***	0.88 (20.35)***		−0.12 (2.68)***	
Height, at baseline		0.80 (2.60)**	0.37 (1.54)	0.80 (2.60)**	
Peer's weight, at baseline	−0.10 (2.76)***	−0.07 (2.18)**	−0.07 (2.16)**	−0.07 (2.18)**	
Peer's height, at baseline		−0.25 (1.09)	−0.17 (0.73)	−0.25 (1.09)	
BMI, at baseline					0.87 (16.77)***
Peer's BMI, at baseline					−0.04 (1.33)
Constant	29.27 (3.77)***	−4.91 (0.19)	3.11 (0.13)	−4.91 (0.19)	4.02 (3.44)***
Observations	144	144	144	144	144
R-squared	0.89	0.90	0.08	0.16	0.83

Notes: Robust *t*-statistics are in parentheses. All models control for dormitory fixed effects. Errors are adjusted for clustering at the room level.
*<10%; **<5%; *** <1%

The magnitude of the coefficient, −0.07, is robust to alternative specifications of the model, and it suggests that increasing the peer's baseline weight by one standard deviation (19.3 pounds) results in 1.35–1.93 fewer pounds gained over the course of the year for the index student, depending on whether we control for height. This represents a non-trivial reduction in weight gain and is comparable in magnitude to the average weight gain of 1.65 pounds observed in our sample. Estimates in column 4 show that the coefficient on the student's own weight at baseline is considerably larger in magnitude than the coefficient on the peer's baseline weight (−0.12 vs. −0.07, respectively). This is not unexpected – if we are to believe that the peer's weight affects the index student's weight gain, then the index student's own weight should have at least as large an effect.

The peer effect is insignificant in the BMI model. This is because the BMI is inversely related to height, and as the estimates in column 2 show, the peer's height appears to be slightly negatively correlated with the index student's weight gain. Because the BMI model does not allow us to disentangle the effect of weight from the effect of height, and because the BMI can be a particularly noisy measure in children and adolescents (Hannan et al., 1995, Wildhalm et al., 2001 and Burkhauser and Cawley, 2008), the rest of the analysis focuses on the model that uses weight and height as separate variables (column 2).[15]

We test for non-linearities in the relationship between the index student's weight gain and the peer's baseline weight using two spline specifications with knots at the median and the four quartiles of the distribution of the peer's weight. We find the relationship to be monotonic, and there are no significant differences between the slopes of the spline segments. However, due to the small sample size, our study is underpowered for estimating a spline model and none of the spline segments were individually significant. We also investigate whether the magnitude of the negative correlation between own weight gain and roommate's baseline weight varies depending on the index student's own baseline weight. We find a slight negative gradient, suggesting that the negative effect of the peer's starting weight may be stronger for initially heavier females; however, the difference was not statistically significant in any of the specifications that we tried.[16]

The results suggest that the amount of weight gained by female students during the freshman year is negatively related to the starting weight of their peers. As discussed earlier, the negative correlation between the index student's weight gain and the peer's baseline weight could be a result of counteracting weight management behaviors of the peer impacting behaviors of the index student. In particular, if a heavier peer feels that she needs to lose weight and engages in behaviors associated with weight loss, her behaviors could in turn cause the index student to adopt some of the same behaviors and consequently gain less weight.

The relationship between the peer's baseline weight and her behavior choices during the year prior to entering college (Eq. (2)) is shown in *Table 4*. The estimates reveal a pattern that is consistent with counteracting weight-management behavior. For example, we find that peers who weighed more at baseline were significantly more likely to have been trying to lose weight during the year prior to entering college (marginal effect is 0.013, $p < 0.01$). To put this number in perspective, a one standard deviation size increase in baseline weight is associated with an over 25% increase in the likelihood of having been trying to lose weight. Focusing more specifically on weight management behaviors, the estimates show that heavier roommates were more likely to have been restricting food intake (marginal effect is 0.012, $p < 0.01$) and they had a higher weekly frequency use of the gym (coefficient is 0.016, $p = 0.08$). While the coefficients on exercise frequency outside of the gym and on weight supplement use are not significant, their signs are consistent with counteracting weight management behavior.[17] These findings are consistent with earlier studies of female adolescents that find that those who are heavier are more likely to engage in weight-loss behaviors, including unhealthy behaviors, succumbing to the pressure to be thin (see, for example, Favaro et al., 2003, Field et al., 2003, Field et al., 2008, McVey et al., 2004, Vanselow et al., 2009 and Waaddegaard et al., 2009).

Table 4. The relationship between peer's behaviors prior to freshman year and peer's weight at baseline.

	DV = peer's behaviors, prior to freshman year				
	Tried to lose weight	**Restricted food**	**Used Gym, times per week**	**Exercised outside, times per week**	**Used weight-loss supplement**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Peer's weight, baseline	0.08 (4.29)*** *0.013*	0.06 (4.14)*** *0.012*	0.02 (1.76)*	0.01 (0.48)	0.01 (0.42) *0.000*
Peer's height, baseline	−0.30 (3.04)*** *−0.05*	−0.13 (1.53) *0.03*	0.09 (1.42)	0.10 (1.22)	−0.22 (1.45) *−0.01*
Constant	10.52 (1.92)*	0.50 (0.10)	−6.16 (1.59)	−3.32 (0.65)	10.61 (1.10)
Observations	143	124	122	124	124
R^2/pseudo R^2	0.18	0.15	0.06	0.01	0.04

Notes: Robust *t*-statistics in parentheses; marginal effects are in italics for logit models only.
*<10%; **<5%; ***<1%.

Next, we investigate whether the peer's behaviors at baseline predict changes in the index student's behaviors over the course of the freshman year (Eq. (3)). The results, as shown in *Table 5*, are consistent with positive peer effects in weight management behaviors among college students (note that the term "positive" is used to describe the direction of the peer effect, and it does not imply a normative assessment). For example, we find that students whose peers had been restricting food intake prior to college were 22% ($p = 0.02$) less likely to have an unlimited meal plan during the freshman year, and those whose peers had been exercising outside of the gym more frequently prior to college were themselves also exercising 0.13 times ($p = 0.05$) more on a weekly basis during the freshman year. These effects are conditional on the index student's own initial behaviors. We also find that, conditional on their own history of weight loss supplement use, students whose peers were using supplements prior to college were 18% ($p = 0.01$) more likely to be using them during the freshman year. Interestingly, we find an insignificant negative relationship in the "tried to lose weight" model, suggesting that the observed changes in behavior patterns may have been unintentional.

Table 5. The relationship between index student's behaviors during the freshman year and peer's behaviors prior to freshman year.

	D.V. = behaviors during the freshman year				
	Tried to lose weight	**Unlimited meal plan**	**Used gym (per week)**	**Exercised outside (per week)**	**Used weight-loss supplement**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Behavior, prior to freshman year	1.97 (4.35)***	−0.80 (1.63)	0.55 (6.16)***	0.28 (3.89)***	3.76 (2.62)***
	0.40	*−0.16*			*0.19*
Peer's behavior, prior to freshman year	−0.59 (1.27)	−1.13 (2.21)**	−0.05 (0.53)	0.13 (1.97)*	3.50 (2.49)**
	−0.12	*−0.22*			*0.18*
Constant	−1.36 (1.88)	1.21 (1.72)*	5.10 (26.45)***	−1.38 (3.89)***	−4.68 (4.03)***
Observations	139	91	93	96	76[a]
R^2/pseudo R^2	0.15	0.12	0.42	0.28	0.35

Notes: Behaviors as independent variables in these models are the same as the dependent variables denoted in each column heading except that they are measured prior to college entry. However, in column 2, the behavior on the right hand side is whether or not the student and peer had been restricting food intake prior to college, respectively. Robust *t*-statistics are in parentheses; marginal effects are in italics for logit models only. All models control for dormitory fixed effects. Errors are adjusted for clustering at the room level.

[a] 18 observations were excluded because they came from a dormitory with no reported use of weight loss supplements.

*<10%; **<5%; ***<1%.

Thus, we find that students whose peers engaged in weight-loss behaviors were likely to adopt such behaviors and, as a result, gain less weight than students whose peers were not trying to lose weight. We also find that heavier peers were more likely to be actively trying to lose weight, which resulted in a negative peer effect coefficient in the weight model.

Though the design of our study eliminates biases that many previous studies of peer influences on weight status struggled with, we point out the following caveats. Firstly, students self-report all of our measures. This may be particularly problematic for measurement of weight and weight change, as other studies have found that in general, individuals tend to understate their weight (Rowland, 1990, Nawaz and Katz, 2001 and Cawley and Burkhauser, 2006). On a related note, weight and BMI may be noisy measures of obesity in adolescents because they do not allow us to account for developmentally appropriate changes in weight or to distinguish between the source of weight gain (i.e. weight gain due to increase in muscle mass or body fat). Ideally, we would have other relevant measures, such as waist circumference or percent body fat.

A second potential issue with our study is the fact that we collect initial data from students at about 10–15 days into the semester. Administrative rules at the university under study precluded us from surveying students any earlier. We argue that although roommates will have been "exposed" to each other by the time we start to study them, this amount of exposure is minimal. Furthermore, we word the questionnaires to elicit the behavioral patterns over the course of the "previous year" as opposed to at the time of the survey, which should reduce the impact of the potential exposure on baseline variables. Lastly, we find little evidence of weight or behavior correlations between roommates at the time of the initial survey.

A third limitation of our study, and one that is very common in observational studies, including earlier peer effect studies, is that we are not able to distinguish between endogenous and exogenous peer effects. Our study attributes effects only to the peer's weight and behaviors, and not to other characteristics of the peer possibly correlated with weight, such as family background. Future work on this topic will need to incorporate a randomized intervention targeting the peer's weight-management behaviors, along with the randomized peer assignment, to disentangle the effects.

Lastly, using a panel approach, and restricting the sample to matched pairs of roommates who resided in double occupancy rooms and were randomly assigned, reduces our sample size from over 630 to fewer than 150 observations. While sample selection does not pose a threat to internal validity of our estimates (i.e. they are unbiased *for our sample*), it can have implications for external validity and generalizability of our results. We explore this issue further in the next section.

7. External validity

Three types of sample selection issues potentially threaten the external validity of our findings. First, students who did not respond to our fall survey may have been systematically different with respect to their weight or weight-management behaviors from students included in our sample. To test for selection in non-response we used the method of comparing early respondents to late respondents (Armstrong and Overton, 1977), by operationally defining early/late respondents based on successive waves of responses generated by the initial solicitation email and two subsequent reminder emails (Lindner et al., 2001). This approach allows us to get an idea about differences between respondents and non-respondents by examining differences between early respondents (those who filled out the survey during the first week after the initial solicitation email), and late respondents (those who filled out the survey after the 4th or 8th day reminders) (Fig. 1). We find no significant differences between early and late respondents in any of the baseline variables used in the study (*Table 6*).[18,19]

Fig. 1. Frequency distribution of the fall survey response lag

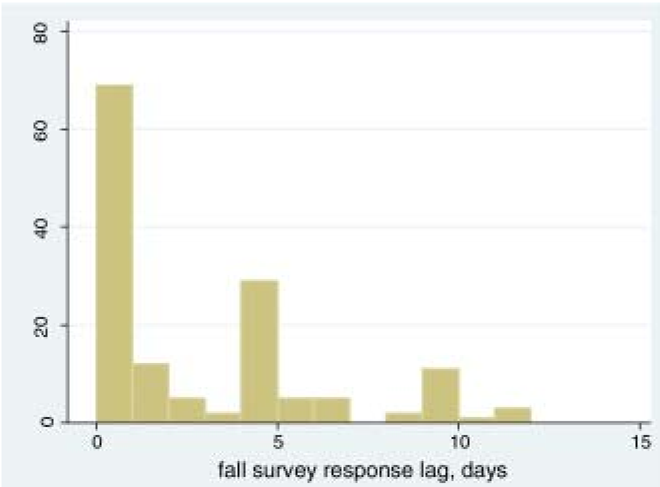


Table 6. Summary statistics by fall survey response lag, N = 144.

	0–3 days (N = 88)	**4+ days (N = 56)**	**Δ**	***p*-Value**
Age	18.08	18.11	0.03	0.61
Caucasian/White	0.89	0.91	0.02	0.64
African American/Black	0.01	0.02	0.01	0.75
Weight at baseline (in lb)	139.1	139.05	−0.05	0.99
Height at baseline (in In)	65.71	65.53	−0.17	0.72
Tried to lose weight at baseline	0.73	0.60	−0.14	0.08*
Restricted food at baseline	0.54	0.55	0.01	0.92
Used gym at baseline	2.13	2.31	0.18	0.64
Exercised outside at baseline	2.73	2.26	−0.47	0.31
Used weight-loss supplement at baseline	0.04	0.07	0.03	0.55

*<0.10.

The second potential sample selection issue is attrition. For example, students who gained more weight or did not exercise may have been less likely to fill out the spring survey. We test whether students that were lost to attrition differ from those in our sample on baseline measures of weight or weight-related behaviors, and find some significant differences (*Table 7*). For example, it appears that students who did not respond to the spring survey were more likely to be black; prior to college, more of them had been trying to lose weight, and fewer exercised outside of the gym. Although we find no differences in the actual weight or any of the other baseline measures, it is possible that some of these behaviors persisted into college thus causing us to observe a smaller amount of weight gain in our sample. We use the above method of comparing early and late respondents to the spring survey, to seek evidence of any differences in freshman year weight gain or behaviors between students with different spring survey response patterns, but find none of them to be significant (*Table 8, Fig. 2*).

Table 7. Summary statistics by spring survey participation status, *N* = 634.

	Participated (*N* = 391)	**Did not participate (*N* = 243)**	***Δ***	***p*-Value**
Age	18.13	18.07	−0.06	0.18
Caucasian/White	0.87	0.81	−0.05	0.08
African American/Black	0.02	0.05	0.03	0.04**
Weight at baseline (in lb)	137.42	136.92	−0.50	0.79
Height at baseline (in In)	65.50	65.41	−0.09	0.69
Tried to lose weight at baseline	0.65	0.76	0.11	0.01***
Restricted food at baseline	0.48	0.56	0.08	0.06*
Used gym at baseline	2.05	2.21	0.15	0.38
Exercised outside at baseline	2.54	2.15	−0.39	0.04**
Used weight-loss supplement at baseline	0.05	0.06	0.01	0.76

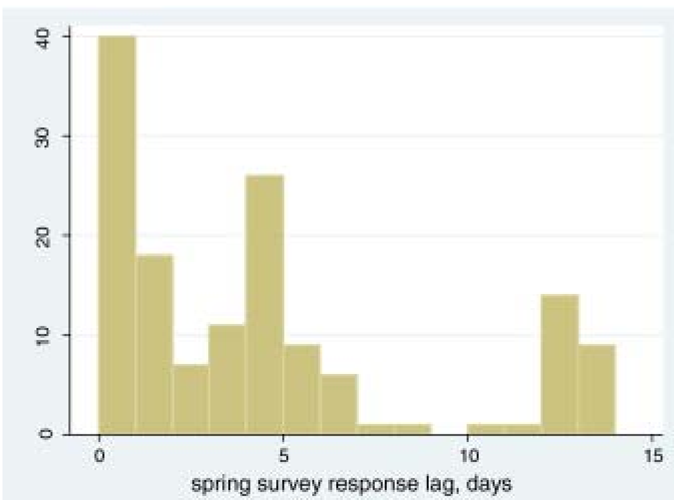
Notes: We included all female students, both with and without a matched roommate.
<0.05; *<0.01.

Table 8. Summary statistics by spring survey response lag, *N* = 144.

	0–3 days (*N* = 76)	**4+ days (*N* = 68)**	***Δ***	***p*-Value**
Age	18.11	18.07	−0.03	0.62
Caucasian/White	0.91	0.89	0.02	0.64
African American/Black	0.03	0	−0.03	0.18
Weight at follow-up (in lb)	139.72	140.73	2.14	0.58
Change in weight (in lb)	1.53	1.79	0.27	0.84
Height at follow-up (in In)	66.05	65.15	−0.90	0.09*

	0–3 days (*N* = 76)	4+ days (*N* = 68)	*Δ*	*p*-Value
Tried to lose weight at follow-up	0.53	0.51	−0.02	0.83
Restricted food at follow-up	0.48	0.47	−0.01	0.90
Purchased unlimited meal plan	0.33	0.28	−0.05	0.52
Used gym at follow-up	2.63	2.46	−0.17	0.60
Exercised outside at follow-up	1.12	1.18	0.06	0.80
Used weight-loss supplement at follow-up	0.07	0.08	0.01	0.81

Fig. 2. Frequency distribution of the spring survey response lag.



Lastly, sample selection with respect to our sample inclusion criteria requiring that both roommates must have completed the fall survey could mean that we are observing pairs where peer influence may be the strongest. In other words, if we think that we are observing a disproportionate number of pairs where the roommate does influence the index student, then the magnitude of the peer effect in the general population could be smaller than that observed in our sample. This might be the case if the index student's likelihood of completing the survey is correlated with whether her roommate completes the survey. To gauge whether students may have influenced one another's survey response behavior we test whether the response lag, survey completion time, and skip patterns are correlated between the roommates and find none of the correlations to be even marginally significant (correlation in the spring survey completion times is actually negative, *Table 9*). As a further check of this potential bias, we compare students in our final matched sample to those who completed both fall and spring surveys but for whom we do not have roommates and find that no differences in baseline or follow-up measures to be statistically significant at the 0.05 level (*Table 10*).

Table 9. Zero-order correlations between roommates' survey response behaviors and skip patterns, *N* = 144.

	ρ	*p*-Value
Survey response lag, baseline	−0.05	0.59
Survey response lag, follow-up	0.16	0.12
Survey completion time, baseline	0.10	0.25
Survey completion time, follow up	−0.18	0.09[*]
Skipped questions:		
Tried to lose weight at baseline	−0.01	0.93
Tried to lose weight at follow-up	−0.01	0.92
Restricted food at baseline	0	0.99
Restricted food at follow-up	0.05	0.56
Purchased unlimited meal plan	−0.01	0.92
Used gym at baseline	−0.03	0.74
Used gym at follow-up	0.05	0.56
Exercised outside at baseline	0	0.99
Exercised outside at follow-up	0.04	0.63
Used weight-loss supplement at baseline	0	0.99
Used weight-loss supplement at follow-up	0.05	0.56

[*] <0.10

Table 10. Summary statistics by matched/unmatched roommate status.

	Matched (*N* = 144)	**Not matched (*N* = 247)**	***Δ***	***p*-Value**
Age	18.10	18.17	0.07	0.39

	Matched (*N* = 144)	Not matched (*N* = 247)	*Δ*	*p*-Value
Caucasian/White	0.90	0.85	−0.05	0.20
African American/Black	0.01	0.02	0.01	0.48
Weight at baseline (in lb)	139.08	136.40	−2.68	0.25
Weight at follow-up (in lb)	140.74	138.03	−2.71	0.26
Height at baseline (in In)	65.64	65.41	−0.23	0.42
Height at follow-up (in In)	65.62	65.46	−0.15	0.61
Tried to lose weight at baseline	0.69	0.63	−0.05	0.26
Tried to lose weight at follow-up	0.52	0.54	0.02	0.68
Restricted food at baseline	0.54	0.43	−0.11	0.08*
Restricted food at follow-up	0.47	0.45	−0.02	0.69
Purchased unlimited meal plan	0.31	0.29	−0.02	0.71
Used gym at baseline	2.20	1.95	−0.25	0.32
Used gym at follow-up	2.55	2.29	−0.26	0.21
Exercised outside at baseline	2.55	2.54	−0.02	0.95
Exercised outside at follow-up	1.15	1.10	−0.05	0.76
Used weight-loss supplement at baseline	0.05	0.05	0	0.97
Used weight-loss supplement at follow-up	0.07	0.03	−0.04	0.03**

**<0.05.

As a final robustness check, we estimate a two stage Heckman selection model to test whether conditioning on sample selection due to attrition (observed in *Table 8*) or roommate selection changes our results, by extrapolating our findings from the 144 observations in the paired roommate sample to all 634 females who responded to the fall survey. In the first stage, we estimate inclusion in our sample as a function of the student's response time (in days) in the fall, the fraction of the survey questions the student completed in the fall, the total time in minutes the student took to complete the fall survey, and the parental weight status. These variables are likely to be correlated with propensity to respond to the spring survey and none of them have a direct effect on weight gain or weight-related behaviors during the freshman year, thus making them valid first-stage instruments.[20] The results (*Table 11*) show that our instruments do predict inclusion in our sample, but controlling for selection did not change our results in the peer effects model (the second stage). The peer effect coefficient became slightly smaller while the coefficient of the own weight became larger; both remained statistically significant. In the end, however, we point out that, although our study is internally valid and we find little evidence of a lack of external validity, we caution against generalizing the results obtained in our unique sample to other populations, including other student populations.

Table 11. Heckman two-stage selection correction model.

	D.V. = own weight at the end of freshman year	**D.V. = own weight gain during freshman year**
Second stage		
Weight, at baseline	0.81 (14.84)***	−0.19 (3.58)***
Height, at baseline	0.94 (4.00)***	0.94 (4.00)***
Peer's weight, at baseline	−0.05 (2.08)**	−0.05 (2.08)**
Peer's height, at baseline	−0.3 (1.11)	−0.3 (1.11)
First stage		
Fall survey response lag (days)	0.01 (0.68)	
Fall survey completion time (min)	−0.01 (3.42)***	
Fall survey fraction questions completed	0.61 (3.75)***	
Mother overweight or obese (0/1)	−0.13 (1.65)*	
Father overweight or obese (0/1)	0.02 (0.19)	
Observations	624	
Uncensored observations	143	
Rho	0.98	
Wald test of independent equations	14.63***	

Notes: Robust *z*-statistics are in parentheses. Both models control for dormitory fixed effects. Errors are adjusted for clustering at the room level.
* <10%; ** <5%; *** <1%.

8. Summary and conclusions

Our analysis of the role of peer influences on weight gain and weight management behaviors for first year female college students suggests that such peer influences matter in important ways that may have practical implications for university administrators and more generally for public health efforts aimed at reducing obesity.

The relationship between a female student's weight gain during the freshman year and a randomly assigned roommate's starting weight is consistently negative in all of our models. Although this finding may seem counterintuitive at first (and seemingly contradictory to the social contagion idea purported in previous research), the results suggest that female students who weigh slightly more may already be engaging in weight management behaviors aimed at losing weight upon college entry. Those behaviors may influence their peers' behaviors and cause them to gain less weight. Although we interpret our analysis of behavior with caution due to small sample size, we do find evidence of positive peer influences in exercise frequency, choice of a meal plan, and use of weight loss supplements. Furthermore, we believe that the peer effects that we were able to uncover in our small sample are only a part of the overall behavioral mechanism that drives peer influences in weight gain among freshman students, and that many other behaviors are yet to be uncovered.

The results from this study are intriguing and raise more questions than they answer. Future large sample studies need to be focused on examining peer effects for males, on exploring interactions among behaviors using a structural model approach, as well as on exploring other behavioral mechanisms (such as use of psycho-stimulants, alcohol, and smoking) through which peer influences could be exerted.

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[1] All authors contributed equally.

[2] Based on authors' calculations using NHANES III (1988–1994) and Continuous NHANES (1999–2006). Over the same time period, obesity prevalence grew by 44%, 47%, and 44% for individuals age 30–39, 40–49, and 50 plus, respectively (see also: Mokdad et al., 1999 and Mokdad et al., 2001).

[3] While we refer to this bias as "selection," several other terms have been used to connote the same bias: correlated effects (Manski, 1993) and homophily (Christakis and Fowler, 2007).

[4] These influences are also labeled "correlated effects" (Manski, 1993), "confounding" (Christakis and Fowler, 2007), and "contextual effects" (Cohen-Cole and Fletcher, 2008a).

[5] Manski (1993) refers to it as "exogenous (contextual) effects." Note that Manski's (1993) definition of contextual effects is different from that of Cohen-Cole and Fletcher (2008a).

[6] See also the response of Fowler and Christakis (2008) to the Cohen-Cole and Fletcher (2008b) replication and a study by (Cohen-Cole and Fletcher, 2008a) and (Cohen-Cole and Fletcher, 2008b) that replicates the empirical strategy to investigate peer effects on acne, headaches, and height.

[7] Both Christakis and Fowler (2007) and Cohen-Cole and Fletcher (2008a) are aware of reverse causality and are careful to interpret their results as evidence of induction in social networks whereby peers influence each other.

[8] See Fletcher (2010) for a discussion of the validity of various instruments used in these studies.

[9] Overall, previous work suggests that peer effects do not seem to predict academic performance for most individuals, though there does seem to be some evidence of non-linearities. However, results from studies examining peer effects on attitudes and other non-academic behaviors are consistent with the notion of peers' influences (Kremer and Levy, 2003).

[10] We exclude students with multiple roommates in order to eliminate the possibility that two roommates were placed together because they both requested to be placed with an unobserved third roommate, thus ensuring random assignment.

[11] The final sample includes 48 roommate pairs where both roommates filled out the fall and the spring survey and both enter our sample, and 48 additional roommate pairs where only one of the roommates enters our sample because we do not have follow-up data on the other roommate.

[12] Note that model (1) is identical to $(Y_{i2}-Y_{i1})=\alpha_0+\beta_0 Y_{j1}+\gamma'_0 Y_{i1}+\varepsilon_i$, with $\gamma'_0=(\gamma_0-1)$.

[13] We also try controlling for room type. The major determinant of room type is occupancy, along with whether or not there is a common area, the type of bathroom, and a few other characteristics. Since we only include double-occupancy rooms, and because floor plans for a given occupancy

do not usually vary within a dormitory, room type variables insignificantly contributed to the model and were excluded. These results are available on request.

[14] We replicated the analysis after adjusting for dormitory-level clustering in addition to room-level clustering, using the “xtmixed” command in Stata 11.0. Adjusting for dormitory-level clustering increases the standard errors only slightly and does not change the significance of our findings qualitatively. The results are available upon request.

[15] We also repeated our analysis using estimates of waist circumference and total body fat following Burkhauser and Cawley (2008), and by converting the self-reported weight to an estimate of measured weight following Cawley and Burkhauser (2006); we find qualitatively similar results to those reported here.

[16] We do not report these results here; they are available upon request.

[17] This study may be underpowered for estimating small effect sizes. In the full sample of females, students who were heavier at baseline were significantly more likely to have been using weight loss supplements prior to college. The relationship with exercising outside of the gym remains insignificant in the full sample.

[18] All findings reported are also robust to controlling for “survey response lag”, or the number of days between the first solicitation email and the survey response date (Lindner et al., 2001).

[19] We also find that the distributions of weight and height in our sample are very similar to the weighted distribution of weight and height of 18-year olds in the 2008 Behavioral Risk Factor Surveillance System data.

[20] We acknowledge that parental weight status might be a questionable instrument as it might arguably belong in the second stage as well. We have also run all models without these instruments and the results are consistent with those presented here.