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## Changes in Eating and Physical Activity Behaviors Across Seven Semesters of College: Living On or Off Campus Matters

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### Abstract

The transition from adolescence to adulthood is an important period for establishing behavioral patterns that affect long-term health and chronic disease risk. Nelson and colleagues speculated that developmental changes and changes in living situation may play an important role in the nutrition and physical activity behaviors of college students. Data from the University Life Study, a longitudinal study of college students that includes web-based surveys administered 14 consecutive days each semester, were used to examine fruit, vegetable, and sugared soda consumption, physical activity, and sedentary activity behaviors across seven semesters. Estimates for each semester were calculated to determine the frequency with which students consumed fruits, vegetables, and sugared soda, engaged in moderate to vigorous physical activity, and engaged in sedentary activities. Four models, estimated with HLM 6.04, were used to predict changes in these behaviors across the seven semesters. Living on or off campus was included to determine if this explained additional variance. Results indicated that few college students consumed fruits and vegetables or exercised at optimal levels during the seven semesters surveyed. Daily fruit and vegetable consumption and daily physical activity declined significantly from the first to the seventh semester. For both of these findings, living off campus exacerbated the problem. Average number of hours of sedentary behaviors declined over time, as did number of days on which at least one sugared soda was consumed. Living location did not explain additional variance in these positive trends. Implications for policy, practice, and future research are discussed.

### Keywords

adolescents; college students; nutrition; obesity; physical activity; prevention

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The transition from adolescence to adulthood is an important period for establishing behavioral patterns that affect long-term health and chronic disease risk. However, many college students engage in behaviors that decrease the likelihood of optimal health and increase the likelihood of overweight and obesity (Huang et al., 2003; Levitsky, Halbmaier, & Mrdjenovic, 2004; Racette, Deusinger, Strube, Highstein, & Deusinger, 2008). Several studies have examined freshman year weight gain, with most supporting a significant weight gain less than the mythical freshman 15 pounds (Cluskey & Grobe, 2009; Mihalopoulos, Auinger, & Klein, 2008; Morrow et al., 2006; Vella-Zarb & Elgar, 2009). Importantly, studies that have looked beyond the freshman year have demonstrated that weight gain continues throughout years of college study (Racette et al., 2008). In fact, college students are gaining weight at a rate almost 6 times that of the general population (Mihalopoulos et al., 2008). Even in the absence of weight gain, the nutritional status of college students is far from optimal. Only one in three college students consume a diet consistent with national recommendations across a variety of food groups (Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007). Eating patterns are typically low for fruit, vegetables, and dietary fiber (Georgiou et al., 1997; Greene et al., 2011; Huang et al., 2003; Racette et al., 2008) and high in fast food and alcohol (Nelson, Lust, Story, & Ehlinger, 2009; Vella-Zarb & Elgar, 2009).

In addition to poor dietary behaviors, many college students further compromise their health by frequently drinking sugar-sweetened beverages (SSBs). SSBs have been associated with increased energy intake and body weight (Vartanian, Schwartz, & Brownell, 2007), cardiometabolic risk (Duffey, Gordon-Larsen, Steffen, Jacobs, & Popkin, 2010), and diabetes (Schulze, Manson, & Ludwig, 2004). West et al. (2006) found that many (65%) college students consumed at least one SSB daily. SSB intake increases between childhood and young adulthood (Demory-Luce, Morales, & Nicklas, 2004), making the college years a particularly important time to establish healthy beverage choices.

As with their dietary behaviors, most college students' physical activity patterns are not at optimal levels and deteriorate over time. One in three college students are sedentary and tend to become less physically active throughout their college years (Huang et al., 2003; Kolodinsky et al., 2007; Morrow et al., 2006; Racette et al., 2008; Vella-Zarb & Elgar, 2009). Eating practices and physical activity behaviors may be influenced by living situations (e.g., dorm, off campus) and whether the situation includes roommates or parents (Kapinos & Yakusheva, 2011; Nelson, Laska, Graham, Moe, & Van Riper, 2010). Dormitory living can present considerable heterogeneity in relation to the spatial distribution of eating and physical activity places. For example, male students who lived in a dorm with a dining hall were more likely to eat more frequent meals and snacks, and female students were more likely to gain weight and exercise less frequently (Kapinos & Yakusheva, 2011). However, compared with students who lived on campus, off-campus students were less likely to consume a large variety of fruits and vegetables (Brunt & Rhee, 2008). Although a lack of place for physical activity has been identified as a barrier to exercise, proximity between dorm and campus gyms appears to influence utilization (Greaney et al., 2009). Female students who lived in a dorm further from the campus gym exercised there less often (Kapinos & Yakusheva, 2011). Proximity did not influence male students' physical activity patterns.

Research suggests that changes in living situation, years of college study, gender, and environmental factors may be associated with nutrition and physical activity behaviors and weight changes in college students. The University Life Study can advance our understanding of how these behaviors change over time and how living on or off campus may play a risk or protective role in their development. The purpose of this study was to (a) describe the prevalence of key eating and activity behaviors among college students over seven semesters of college, (b) explore changes in eating and physical activity behaviors as students progress through college, and (c) explore how living on or off campus is associated with dietary and physical activity patterns.

The current study was conducted at a large university in the Northeastern United States where, among all undergraduate students, 37% live in university-owned or -operated housing. First-year students are required to live in one of seven on-campus housing complexes. Each complex has a Commons area with dining options that include an “All you care to eat” choice served cafeteria style and individual meals offered at retail locations. Students must purchase a basic meal plan with options to upgrade. The campus has two large fitness facilities, four swimming pools, tennis, basketball, racquetball, and squash courts, an indoor ice rink, and soccer fields for student use. Students are required to take three credits of health or physical education, with 62 different activity-based courses.

## Method

Data used in the current analyses were drawn from the University Life Study, a longitudinal study of daily life experiences among college students. The University Life Study used a measurement burst design, with a semester survey followed by 14 consecutive daily surveys during each of seven semesters (fall freshman year through fall senior year). At recruitment, eligible participants were first-year, first-time, and full-time students. A stratified random sampling procedure was used to achieve a diverse sample with respect to gender and race/ethnicity. During the first week of fall classes, recruitment letters were sent to selected students. E-mail invitations followed, with secure links to the surveys administered via the World Wide Web. Students were invited to complete a semester survey and then 14 consecutive daily surveys. This procedure was repeated for the subsequent six semesters of data collection. Data collection took place during the same time periods in the fall and spring. Data were not collected during final exams or spring break. Students received an incentive (\$25 in Semester 1, increasing incrementally to \$40 in Semester 7) to complete the semester survey and were then eligible for the \$3 per daily survey incentive with a bonus (\$8 to \$18) if they completed all 14 surveys. Participants provided an electronic signature on an online consent form. The study was approved by the institution’s institutional review board and was protected by a federal Certificate of Confidentiality. In total, 746 students (65.6% response rate) completed the baseline semester survey, and 608 students completed the final semester survey, representing an overall retention rate of 81.5% across the seven semesters. A quarter (25%) of the final sample reported Hispanic/Latino ethnicity. Among non-Hispanic/ Latinos, 36% identified as European American, 31% as Asian American/ Pacific Islander American, 21% as African American, and 12% as more than one race. Completion rates for the daily surveys were high across the seven semesters, with most (79% to 88%) participants completing at least 12 of 14 daily surveys each semester.

## Personal Characteristics

At baseline, students were asked to report their gender. Males were coded as “1.” In each semester, students were asked to report their height and weight. These variables were used to calculate body mass index (BMI).

## Living Situation

Students were asked to report where they were living each semester. These variables were coded as on campus (residence hall) or off campus (apartment, with parents, other house, etc.). Students who reported living with their parents were excluded from the current analyses, because the nutrition environment could be quite different from other off-campus living situations. The percentage of students living with their parents in any given semester ranged from 1.3% in Semester 1 to 4.7% in Semester 7.

## Dietary Behaviors

Each of the 14 daily surveys included dietary items from the Youth Risk Behavior Survey (Centers for Disease Control and Prevention, 2005). Participants were instructed to answer for the previous day, for example, “This survey is about Friday [yesterday] from the time you woke up until you went to sleep.” Students reported the number of times they ate “Fruit (not including fruit juice),” “Green salad,” “Carrots,” and “Other vegetables (not including green salads or potatoes),” or “Drank a can, bottle, or glass of soda or pop such as Coke, Pepsi, or Sprite (not including diet soda or diet pop).” Response options were 0, 1, 2, 3, 4, and 5+ times. Fruit, carrots, green salad, and other vegetable variables were summed and aggregated over the 14 days to create an average daily fruit and vegetable variable.

## Physical Activity Behaviors

Each day, participants were asked, “From the time you woke up until you went to sleep, how much time did you spend doing the following activities?” “Working out/playing sports,” “Watching TV,” “Playing video or computer games,” and “Surfing the web” were 4 of the 19 daily activities for which students were asked to provide time estimates, with possible responses of “did not do,” “did do for up to 30 minutes,” “did do for 30 minutes to 60 minutes,” “did do for one hour,” and then increasing by hour increments to *10+ hours*. Working out/playing sports was used as a proxy measure for moderate to vigorous physical activity based on the metabolic equivalent–minutes outlined in the “Physical Activity Guidelines Advisory Committee Report” (Physical Activity Guidelines Advisory Committee, 2008). Discretionary sedentary activities, those not related to academics or work (e.g., time spent watching TV, playing video/computer games, and surfing the web), were summed and aggregated to create a sedentary activity variable. Physical activity and sedentary activity variable categories were recoded so that less than 30 minutes was recoded as 0.5 and from 30 to 60 minutes was recoded as 0.75. The midpoint was used for the remaining categories so that 1 to 2 hours was recoded as 1.5m and so forth, with the final category of 10+ hours recoded as 10.

Means and standard deviations were calculated for each semester across the 14 days surveyed for the number of times fruits, vegetables, and sugared soda were consumed,

number of hours students engaged in working out/playing sports, and the number of hours students spent in sedentary activities. Four models, estimated with *HLM* 6.04, were used to test changes over time in these behaviors. Estimates were created for each dependent variable each semester, and the slope was tested for significance. Because of skew in the total number of days exercised and days sugared soda was consumed, a Poisson distribution was used. Average fruit and vegetable consumption and average number of hours spent in sedentary activity were normally distributed so a linear model was used. Predictor variables included gender, semester (with Semester 1 centered at 0), and living on or off campus (off campus coded as 1). To determine if nonrespondents at Semester 7 were systematically different from respondents, means for the dependent variables were tested at Semester 1 using analysis of variance.

## Results

At Semester 1, the mean age of respondents was 18.4 years ( $SD = 0.4$ ). About half (49.2%) were male. Men had a mean BMI of 23.6 kg/m<sup>2</sup> ( $SD = 3.7$ ), and women had a mean BMI of 22.8 kg/m<sup>2</sup> ( $SD = 4.3$ ). As noted earlier, almost all (98.1%) students lived on campus in residence halls during Semester 1; by Semester 7, 12.3% lived in residence halls. The most common off-campus living situations during Semester 7 (fall of senior year) were apartments or houses (71% of students). No significant differences were found between students who responded at Semester 7 (e.g., completed the study) and those who did not respond (e.g., non-completers) for any of the four dependent variables at Semester 1, indicating that differences detected in these variables are not likely the result of nonresponder bias.

### Dietary Behaviors

Tables 1 and 2 provide cross-sectional point estimates by semester. Changes across semesters are presented in the figures. During their first semester, college students consumed fruits and vegetables on average 2.37 times per day (Table 1). Students did not consume fruits and vegetables more frequently in any of the remaining six semesters (Table 1). Sugared soda consumption showed a reverse pattern toward lower risk. During their first semester, students consumed sugared soda at an average of 0.58 times a day, meaning that on average students did not drink a sugared soda everyday (Table 1). By the fall of their senior year, the average was 0.37 (Table 1). Each semester, more than one third of students consumed fruits and vegetables at least one time every day, whereas few (less than 12%) consumed at least one sugared soda every day (Table 2).

### Physical Activity

On average, each semester, students engaged in less than 1 hour of moderate to vigorous physical activity a day. During their first semester, students engaged in this type of physical activity for 0.43 hours (about 26 minutes) a day. During the fall of their senior year, students engaged in moderate to vigorous activity on average 0.30 hours (about 18 minutes per day). “The Physical Activity Guidelines Advisory Committee Report” indicated a number of health benefits resulting from at least 30 minutes of moderate to vigorous activity at least 5 days a week for adults. Fewer than 10% of students met that threshold in any semester

surveyed (Table 2). More than a quarter did not engage in 30 minutes of moderate to vigorous activity on any day surveyed (Table 2). During most of the semesters, students engaged in about 2 hours of discretionary sedentary activity each day (Table 1). However, during the spring of their junior year and fall of their senior year, students spent close to 1.5 hours in sedentary activities (Table 1).

### Changes in Dietary and Physical Activity Behaviors Across the Seven Semesters

Figures 1 to 4 present trends in dietary and physical activity variables across the seven semesters. The estimates presented were generated from the *hierarchical linear model* models and vary slightly from the cross-sectional point estimates because of differences in the *N* for each model. The number of times students consumed fruit and vegetable each day declined significantly by 14% across the seven semesters with no gender differences (Figure 1). The total number of days students engaged in at least 30 minutes of moderate to vigorous physical activity also declined; however, males were more likely to exercise than females (Figure 2). The frequency of physical activity declined by 6% each semester. When this 6% reduction is compounded from Semester 1 to Semester 7, the implication is that students engaged in these physical activities 31% less often in their seventh semester than when they entered college. For females, this means a decrease from 1.93 days across the 14 days surveyed to 1.33 days. Males engaged in moderate to vigorous physical activity on 73% more days than females, but this behavior also declined 6% each semester from 3.34 days in Semester 1 to 2.30 days in Semester 7.

Living off campus exacerbated declines in both fruit and vegetable consumption and moderate physical activity. Compared with when they lived on campus, students living off campus consumed fruits and vegetables on 0.15 (or 7%) fewer occasions each day and engaged in moderate to vigorous physical activity for 30 minutes or more on 21% fewer days. These reductions are in addition to the declines previously described.

Two positive trends emerged. The average number of hours students engaged in discretionary sedentary activities declined (Figure 3) as did the number of days students drank at least one sugared soda (Figure 4). Gender differences were observed for both behaviors. Across the seven semesters, females reduced their time in sedentary activities by 35% from 1.88 hours per day in their first semester to 1.22 in their seventh semester. Males engaged in sedentary activities on average about 30 minutes (0.51 hours) more per day than females. Their sedentary activity declined by 28% from 2.39 to 1.73 hours per day. Similarly, the number of days students consumed at least one sugared soda declined (Figure 4). During their first semester females consumed at least one sugared soda on average on 1.89 days (3.82 days for males) across the 2 weeks surveyed. By their senior year, students consumed sugared soda on 50% fewer days. Living location did not explain additional variance in these positive trends.

## Discussion

The college years are an ideal time to provide structured support for health behaviors. During this period, many students live independently for the first time. They transition from home environments in which routines have been structured by parents and other

organizations to a university environment in which they must create new routines and daily habits.

Consistent with previous research, our study found that critical health behaviors, including fruit and vegetable consumption (Greene et al., 2011; Huang et al., 2003; Racette et al., 2008) and physical activity (Huang et al., 2003; Kolodinsky et al., 2007; Morrow et al., 2006), were not at optimal levels throughout students' college careers. On average, students consumed fruits and vegetables fewer than three times a day, suggesting that these foods are not consumed at each meal. In addition, our findings support previous research indicating that college students' fruit and vegetable intake and physical activity deteriorate over time (Huang et al., 2003, Morrow et al., 2006).

Living off campus compounds the declines in fruit and vegetable consumption and physical activity. Off-campus students may encounter several barriers to eating fruits and vegetables and exercising. College students report high workloads and lack of time and transportation to facilities as barriers to physical activity participation (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006; Silliman, Rodas-Fortier, & Neyman, 2004). These barriers existed for students in the current study as the large campus has only two fitness centers. Several private gyms are located in the downtown area but are small and not close to much of off-campus housing. Interpersonal issues may also play a role in fruit and vegetable consumption. Many students share apartments and houses with roommates and must negotiate how food will be purchased, prepared, and shared. It is possible that low-cost, quick preparation foods are easier to "agree" on, prepare, and keep fresh.

Our findings are inconsistent with previous research on SSBs, which found that many college students drink at least one SSB daily. This discrepancy could be because our survey asked only about sugar-sweetened soda and did not capture the full range of SSBs. Because of this college's requirement that first-year students live on campus and purchase a dining plan, all have access to unlimited amounts of sugar-sweetened soda. In their later years, this is not the case. Finally, the amount of time students engaged in discretionary sedentary activities declined as students progressed through college. As students progress through college, their workloads and extracurricular demands increase, leaving less time for discretionary sedentary activities.

Gender differences were found for all variables except fruit and vegetable consumption. Men were more likely to engage in both positive (physical activity) and negative (sedentary activities and sugared soda consumption) health behaviors. The distance between living location and fitness facilities was not measured in the current study but could interact with gender as in previous research (Kapinos & Yakusheva, 2011) and should be assessed in future studies. Additionally, those conducting future research or developing interventions should consider access, safety, comfort in the environment, and competing priorities for both men and women. Although this study did not examine racial differences, future analyses should address these as they could have important implications for intervention design.

Our study had several limitations. First, our dietary items measured frequency with which foods were consumed, not actual serving sizes. Second, the study did not measure distances

to fitness locations or food outlets, which could help explain the mechanisms for the off-campus housing effect. Finally, although our sample was diverse, it represents a single university population. Caution should be used when generalizing results.

Our study has several important implications. Students' dietary quality and activity levels could increase with university support provided on arrival as many behaviors are established during this time frame (Cluskey & Grobe, 2009; Mihalopoulos et al., 2008). Both structural interventions as well as individual behavior change programs should be considered. For instance, the university in the current study requires first-year students to live on campus and purchase a meal plan. This creates an incentive for students to eat on campus in one of the dining commons. Offering fresh fruits and vegetables as an "all you can eat" option while making soda "pay as you go" would be one way to create disincentives for excess sugar consumption. An opt-out system could be used for fitness, with student activity fees paying for university gym memberships and fitness classes. In addition to structural changes, universities could provide evidence-based programs in addition to the 3 credits of health and physical activity to help new students establish or improve eating and physical activity behaviors. Such programs could be a requirement similar to first-year alcohol use programs and could help frame the importance of establishing good dietary and physical activity behaviors. Finally, making fitness opportunities social by providing a mechanism for students with similar interests to find each other early in their college experience could help students establish health-promoting behaviors and sustain these behaviors over time.

Support for college students' health behaviors should not end after the initial transition period. Barriers to healthy food selection and physical activity behaviors should be examined within the context of the broader university community and the living options for students. Many junior and senior students' decision to move into off-campus housing seems to exacerbate poor dietary and physical activity behaviors. Creative partnerships between universities and local communities could improve the food environment for these students. For instance, fruit stands and farmers' markets could be established close to off-campus housing and promoted through student organizations. Also, transportation to local grocery stores could be provided in a way that accommodates students' schedules and their need to carry multiple shopping bags (e.g., designated space on buses). Local community gyms could offer special rates, and campus gyms could provide lockers in which students could leave workout gear throughout the week, thereby eliminating the barrier of carrying a separate gym bag each day.

Daily behaviors and routines have the potential to affect students' health status during college and into adulthood. Intervention during this period could be an effective method of achieving population-level reductions in overweight and obesity.

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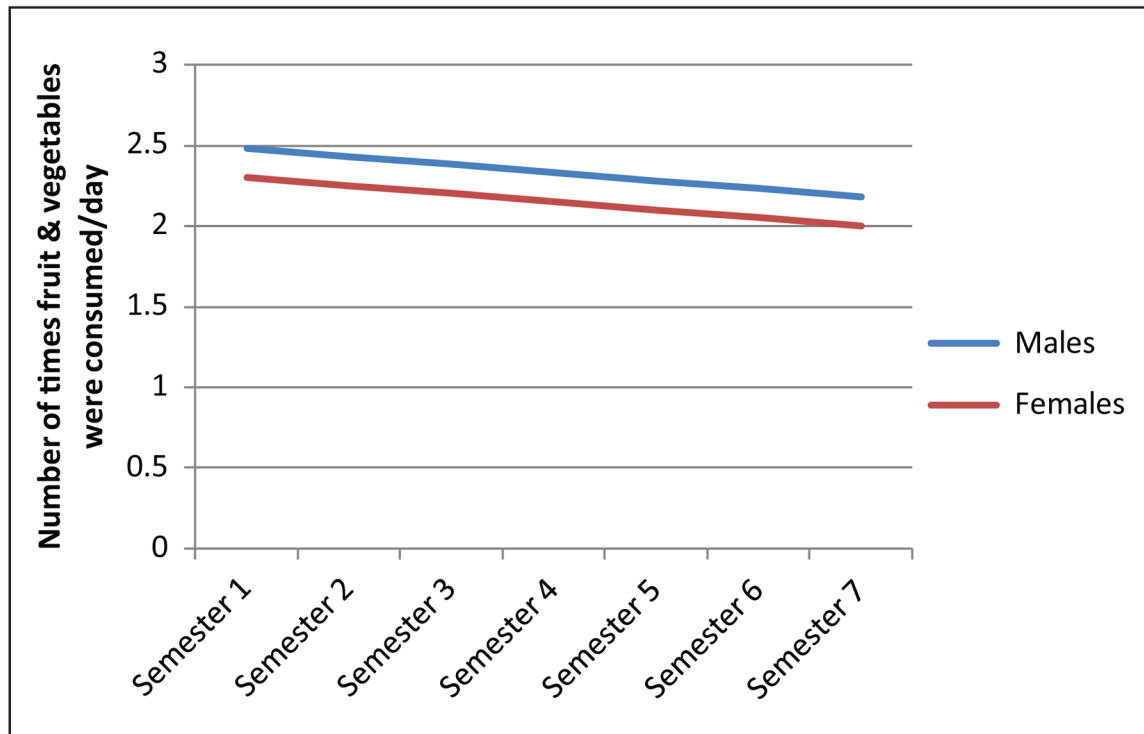
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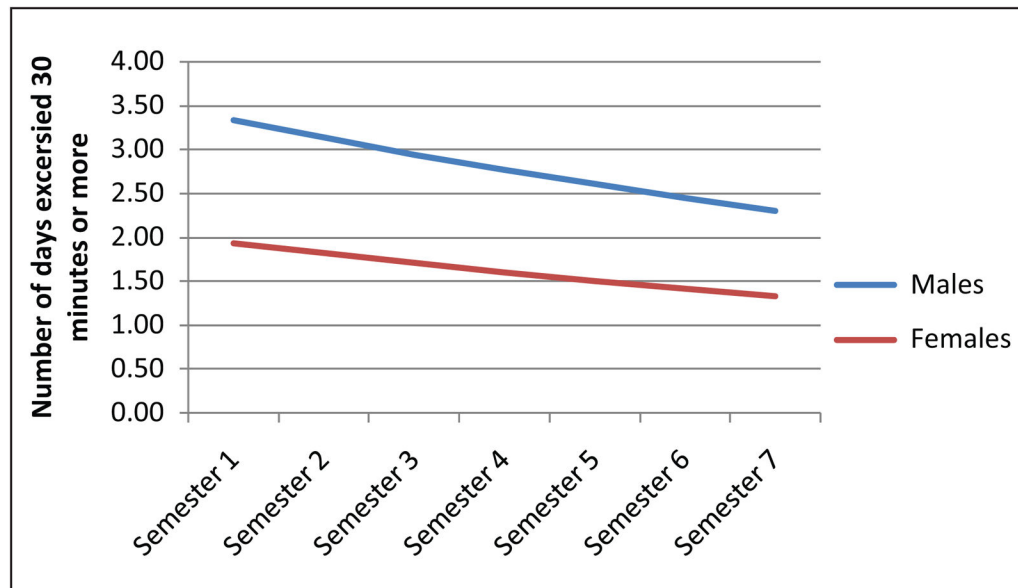
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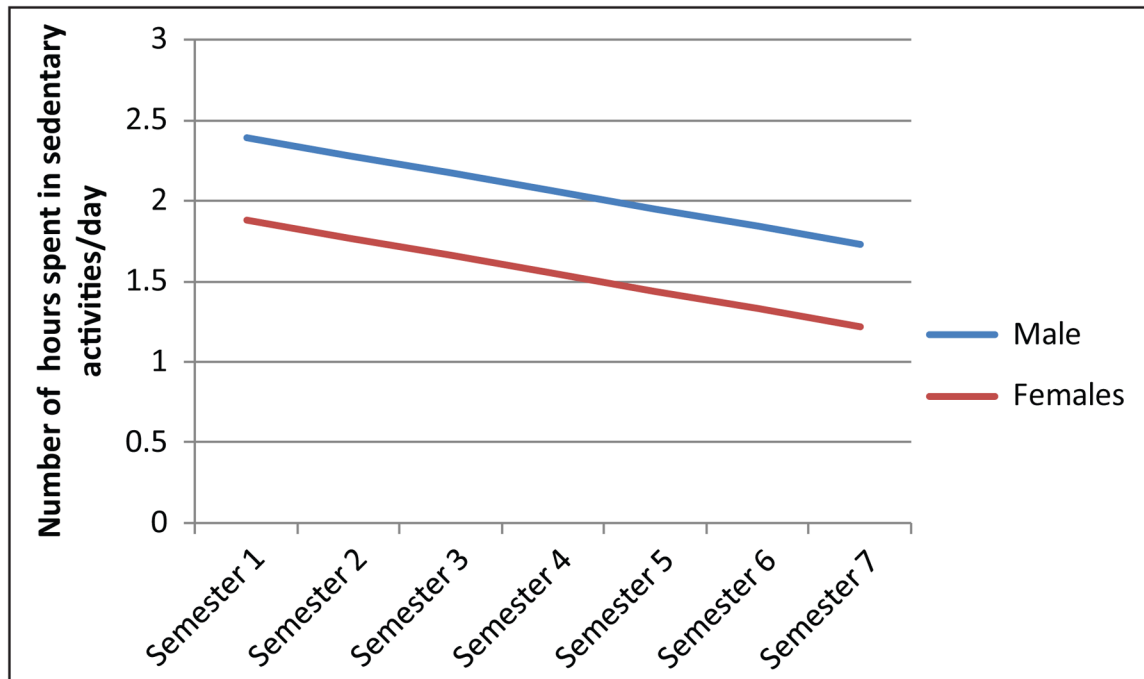
**Figure 1.**

Average number of times students consumed fruits and vegetables per day across the 14 days surveyed.

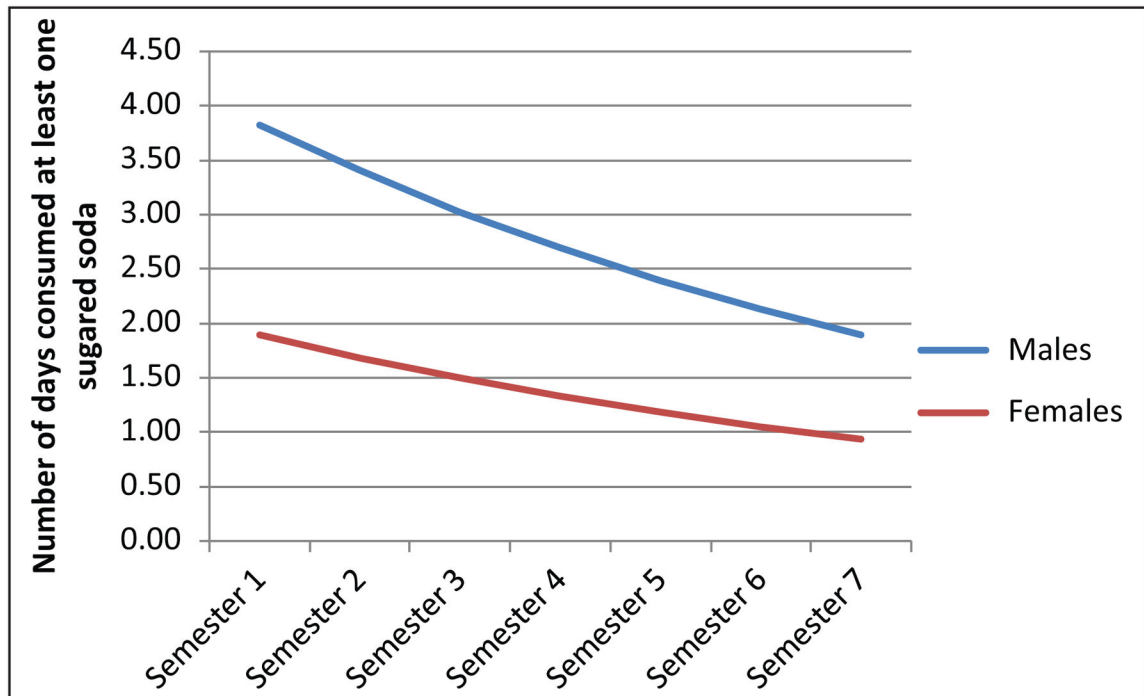
*Note.*  $N = 732$ . Slope is significant. Gender is nonsignificant.



**Figure 2.**  
Total number of days students engaged in at least 30 minutes of moderate to vigorous physical activity across the 14 days surveyed.  
*Note.*  $N = 733$ . Slope is significant. Gender is significant.



**Figure 3.** Average number of hours students engaged in discretionary sedentary activity per day across the 14 days surveyed.  
*Note.*  $N = 733$ . Slope is significant. Gender is significant.



**Figure 4.** Total number of days students consumed at least one sugared soda across the 14 days surveyed.

*Note.*  $N = 731$ . Slope is significant. Gender is significant.

Table 1

Frequency With Which College Students Consumed Fruits, Vegetables, and Sugared Soda and Engaged in Physically Active or Sedentary Behaviors by Semester.

Eating and Activity Variable	Mean (SD)						
	Semester 1 (Fall 2007)	Semester 2 (Spring 2008)	Semester 3 (Fall 2008)	Semester 4 (Spring 2009)	Semester 5 (Fall 2009)	Semester 6 (Spring 2010)	Semester 7 (Fall 2010)
Number of times fruits and vegetables were consumed per day	N = 704; 2.37 (1.78)	N = 606; 2.36 (1.82)	N = 622; 2.11 (1.70)	N = 618; 2.19 (1.77)	N = 593; 2.00 (1.71)	N = 574; 2.02 (1.61)	N = 571; 1.91 (1.58)
Number of times sugared soda was consumed per day	N = 704; 0.58 (0.69)	N = 606; 0.49 (0.64)	N = 622; 0.48 (0.62)	N = 618; 0.41 (0.54)	N = 593; 0.41 (0.59)	N = 574; 0.37 (0.56)	N = 571; 0.37 (0.54)
Number of hours engaged in sports/ working out per day	N = 716; 0.43 (0.50)	N = 624; 0.43 (0.48)	N = 639; 0.34 (0.46)	N = 640; 0.42 (0.52)	N = 612; 0.27 (0.41)	N = 596; 0.40 (0.54)	N = 590; 0.30 (0.44)
Number of hours engaged in sedentary activities per day	N = 716; 2.18 (1.47)	N = 605; 2.27 (1.60)	N = 639; 1.59 (1.19)	N = 640; 1.61 (1.26)	N = 612; 1.64 (1.20)	N = 596; 1.56 (1.30)	N = 590; 1.58 (1.17)

**Table 2**

Percentage of Students Who Consumed Fruits and Vegetables, Sugared Soda, and Engaged in Physical Activity and Sedentary Behaviors by Semester.

Eating and Activity Variable	Percentage of Students						
	Semester 1 (Fall 2007)	Semester 2 (Spring 2008)	Semester 3 (Fall 2008)	Semester 4 (Spring 2009)	Semester 5 (Fall 2009)	Semester 6 (Spring 2010)	Semester 7 (Fall 2010)
Consumed fruits and vegetables at least one time on all the days surveyed	N = 704; 41.6	N = 606; 39.8	N = 622; 37.0	N = 618; 35.6	N = 593; 34.4	N = 574; 34.8	N = 571; 34.0
Drank at least one sugared soda on all the days surveyed	N = 704; 10.9	N = 605; 8.4	N = 622; 8.7	N = 618; 6.8	N = 592; 7.3	N = 574; 5.4	N = 570; 6.0
Participated in at least 30 minutes of sports/working out on 10 or more days	N = 716; 8.9	N = 624; 8.3	N = 639; 4.7	N = 640; 8.7	N = 612; 4.9	N = 596; 6.4	N = 590; 3.6
Participated in at least 30 minutes of sports/working out on none of the days surveyed	N = 716; 26.3	N = 624; 25.2	N = 639; 35.5	N = 640; 31.4	N = 612; 45.6	N = 596; 33.2	N = 590; 39.8
Engaged in sedentary activities for less than 2 hours all the days surveyed	N = 716; 9.6	N = 625; 10.7	N = 639; 16.6	N = 640; 18.3	N = 612; 16.8	N = 596; 22.3	N = 590; 19.7