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Relationship between Stress and Healthy Lifestyle Factors of College Students

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Objectives: We assessed the correlation between college students' perceived stress (PS) and healthy lifestyle factors (HLFs) in this cross-sectional study. Methods: Data were collected from 1396 undergraduates enrolled in an introductory nutrition course. We measured PS and 5 HLFs (physically active, healthy diet, non-smoker, non-binge drinker, healthy BMI). Results: The mean PS score was 15.0 ± 0.2 (maximum, 40) and the mean number of HLFs reported was 2.9 ± 0.03. Females were more likely to report 4-5 HLFs than males (31% vs 20%). We found a statistically significant inverse correlation between PS and HLFs for women (p < .01). Conclusions: Health promotion interventions that support healthy food choices, physical activity and low-risk substance use may reduce perceived stress in the college population.

***Key words*: stress; lifestyle; college health; university health; health behavior; lifestyle; nutrition; stress management**
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College represents an important transitional life stage for many young adults. Mental health has been of emerging concern on college campuses with rising rates of mental health issues reported nationwide in the past 5 years.[1] A large national survey conducted by the Association for University and College Counseling Center Directors (AUCCCD) revealed that anxiety and depression are just a few of the most common mental illnesses students present with at counseling centers.[2] In 2011, the American College Health Association-National College Health Assessment II (ACHA-NCHA II) survey was conducted to evaluate students' health behaviors and habits. This survey revealed that approximately 50% of undergraduate students self-reported experiencing overwhelming anxiety and 31% reported depression levels that made it difficult to function.[3] By 2016, data from the same survey revealed that anxiety and depression affected 62% and 39% of undergraduate students, respectively.[4] Reviews of the literature have shown that, among other risk factors, chronic stress is often cited by professionals as a major underlying cause of mental and physical illness.[5-7] Not surprisingly, millennials (defined as those between the ages of 18-34) report higher levels of stress than the baby boomer and mature age groups (49-67 years old and 68 years and older, respectively).[8]

Several factors contribute to the increase in stress experienced by college students including heightened academic demands, decreased social support, and financial burden.[9-12] Students' limited coping skills can enhance the impact of these stressors and diminish psychological well-being.[13] Millennials appear to recognize the negative impact of stress and are interested in better coping skills, according to a survey of the American Psychological Association (APA).[8] Without effective coping skills, attempts to manage stress may take the form of other unhealthy personal habits, as evidenced by national survey data.[8,14-16] Heightened perceived stress has been associated with lower participation in moderate and vigorous physical activity and longer periods of sedentary behavior among college students.[17-19] Similarly, the quality of the diet is affected by stress, with students with higher stress levels reportedly con-

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suming more calories, sweets and fast foods, and fewer servings of fruits and vegetables.[20-22] Increased alcohol consumption, binge drinking, and smoking are additional behaviors that students reportedly engage in when they are under stress.[23-25]

Independent of stress, college students in general appear to be a population in need of targeted health promotion activity to reduce the risks associated with chronic disease. National data from the 2016 ACHA-NCHA II survey revealed that only 44% of college students achieved the public health recommendation of at least 150 minutes of moderate to vigorous physical activity a week.[4,26] Dietary quality is low, with as few as 4% of college students reportedly consuming the recommended daily servings of fruits and vegetables.[4] Additionally, 10% of college students report cigarette smoking within the past 30 days, 33% report consuming 5 or more drinks in a sitting at least once in the past 2 weeks, and 37% are overweight or obese.[4] Given that weight status and health-related behaviors established during the college years often persist into adulthood, these observations warrant attention.[27,28] College students experience the independence to make their own decisions; yet, patterns of behavior adopted in college in response to stress may become entrenched, contribute to an unhealthful lifestyle, and have long-term implications with regards to chronic disease risk.[27,29]

To date, little research has been done to examine college students' stress in relation to multiple health-related factors. Despite previous research indicating that health behaviors often cluster together, influence outcomes including body weight, and serve as multifactorial contributors to chronic disease, the majority of available studies in college students examine only individual health behaviors.[30-32] Therefore, little is known about the impact of stress on multiple health-related factors in the college-aged population. The purpose of this study was to assess the relationship between perceived stress (PS) and 5 healthy lifestyle factors (HLFs) among undergraduate college students. We hypothesized that higher levels of PS would be associated with lower prevalence of HLFs in this population.

METHODS

Participants

Participants for this study were drawn from a base population of undergraduate college students who enrolled in an introductory nutrition course at a public university in the northeastern region of the United States (US) in one of 3 consecutive academic years (August 2012 through May 2015). The course, offered in both fall and spring semesters, is a popular undergraduate elective open to any student at the university and is a required course for students in the following majors: nutrition, ecogastronomy, exercise science, and athletic training. Students in this course were recruited by invitation to participate in the College Health and Nutrition Assessment Survey (CHANAS), an ongoing, cross-sectional study conducted at the university. At the beginning of each academic semester, we asked students to provide written informed consent to permit the collection of individual data, routinely generated in the setting of the course, to be used for research purposes. Participation in the CHANAS project was voluntary and had no effect on a student's grade in the course. To be included in this study, participants had to: provide consent, be between the ages of 18-24, not be pregnant, and provide data for all pertinent variables. The 2052 students who gave consent to participate represented 94% of the base population of students enrolled in the course during fall semester 2012 through spring semester 2015.

Demographics

Demographic information was acquired through the completion of the College Wellness Survey (CWS), a 77-item survey (Qualtrics, Provo, Utah) students completed online within the first month of the semester. Demographic questions included sex, age, race, and year of college.

Perceived Stress Scale

The Perceived Stress Scale (PSS) is a 10-item, short-form questionnaire used in research to assess the "degree to which situations in one's life are appraised as stressful" and taps into "how unpredictable, uncontrollable, and overloaded respondents find their lives."[33(pp 33,34)] Sample questions include: "In the last month, how often have you felt nervous and 'stressed'?" and "In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?" Responses are scored by participants on a Likert scale of 0 (never) to 4 (very often). A perceived stress score was computed by reversing the scores of the 4 positively worded questions and then totaling the scores for each of the 10 items. The PSS ranges from 0 to a maximum score of 40. Although the PSS is not meant to be categorized as "high," "moderate," or "low," as it is not a diagnostic instrument,[34] it's commonly used in research such that a lower score indicates a lower level of perceived stress and a higher score indicates a higher level of perceived stress. The PSS instrument has been previously validated for a college-age population and has a Cronbach's alpha of 0.89.[35] The Cronbach's alpha for the present study is 0.85.

Healthy Lifestyle Factors

Five HLFs, defined individually below, were selected and included: physically active, healthy diet, non-smoker, non-binge drinker, and body mass index (BMI) in the healthy range. Participants who met the criteria for each factor received a score of 1, and those who did not received a score of 0. The score for each of the 5 factors was summed, creating an HLF prevalence score ranging from 0 to 5. These HLFs were chosen to be similar to the 5 factors previously shown by Liu et al[36] in the Coronary Artery Risk Development in Adults (CARDIA) study, to predict low cardiovascular disease risk in middle age when maintained throughout young adulthood. Methodological differences from the CARDIA study are noted for each HLF.

Physical activity. In the current study, we evaluated physical activity via pedometer over a 7-day period. Prior to data collection, participants were taught how to accurately use the research-grade pedometers (SW200 Digiwalker, New Lifestyles; Lees Summit, MO) and pedometers were tested for accuracy via a 20-step test. Participants were instructed to follow their typical routine while wearing the pedometer. They were given a 2-week period to choose any 5 weekdays and 2 weekend days to wear the pedometer, for a total of 7 days. Participants self-reported daily step counts via a daily log sheet that was collected at the end of the 2 weeks. An average daily number of steps was determined by calculating the total steps taken divided by seven days. Although CARDIA researchers assessed physical activity via a questionnaire, we replicated the CARDIA study's method of using the highest 40% of average physical activity scores, ie, students who fell within the top 40% of sex-specific average daily step counts were categorized as physically active.

Diet quality. The current study assessed dietary intake via a 3-day food record, consisting of 2 non-consecutive weekdays and one weekend day. Accuracy of estimating portion sizes was enhanced by conducting portion demonstrations with food models during the laboratory portion of the course. Participants used the Diet Analysis software (Wadsworth, Cengage Learning) to code food records and generate average daily nutrient estimates. We selected the same 4 nutrients chosen in the CARDIA study and mimicked their methodology of calculating the diet score; however, the CARDIA researchers assessed diet via a food frequency questionnaire. The diet score was calculated by using the average intake values for calcium (mg), potassium (mg), fiber (g), and saturated fat (g). Sex-specific quintile scores were created for each nutrient, with a score of 1 = low to 5 = high used for calcium, potassium, and fiber and a score of 1 = high to 5 = low for saturated fat. The assigned score for each nutrient was summed to create a total diet score ranging from 4 to a maximum score of 20. As done in the CARDIA study, participants within the top 40% (score ≥ 13) were considered to have a healthy diet.

Smoking. The current study used a single item question to reduce participant burden in the 77-item CWS. This single item question in the CWS read: "Have you smoked at least 100 cigarettes in your entire life? (NOTE: 5 packs = 100 cigarettes)." Participants were able to indicate "yes," "no," or "I don't know." Those who responded "no" were categorized as non-smokers. Those who responded "I don't know" were removed from analysis. In the CARDIA study, smoking status was determined via a tobacco use questionnaire that assessed factors such as frequency of smoke inhalation, number of cigarettes smoked daily, and total number of years of regular smoking.

Binge drinking. Given the lifestyle factors pertinent to college students, we chose to focus alcohol consumption on binge drinking patterns. Binge drinking behavior was determined using a single question on the CWS that read, "Considering all types of alcoholic beverages, how many times during the past 30 days did you have 5 or more drinks (for men) or 4 or more drinks (for women) on occasion?" Participants were prompted to manually

Table 1
Participant Characteristics[a]

	Men	Women	All
N (%)	**411 (29%)**	**985 (71%)**	**1396**
Age (years)	18.9 ± 0.05	18.7 ± 0.03	18.8 ± 0.03
Class			
Freshman	54%	66%	63%
Sophomore	31%	23%	25%
Upperclassmen	15%	11%	12%
Caucasian/White	93%	97%	96%
Perceived Stress Score[b]	13.7 ± 0.31*	15.5 ± 0.20	15.0 ± 0.17
Step Count, per day	9591 ± 142	9605 ± 106	9601 ± 85
Diet Score[c]	12.0 ± 0.16	12.0 ± 0.11	12.0 ± 0.09
Binge Drinking Episodes	4.5 ± 0.22*	2.7 ± 0.11	3.2 ± 0.10
BMI[d] (kg/m^2)	24.5 ± 0.16	23.0 ± 0.10	23.5 ± 0.09
HLF Score[e]	2.6 ± 0.05*	3.0 ± 0.03	2.9 ± 0.03

***p < .01 for the difference between males and females**

Note.
a: All values reported as mean ± standard error, unless otherwise noted
b: Maximum perceived stress score = 40
c: Maximum diet score = 20
d: Body Mass Index
e: Healthy Lifestyle Factor Score, range 0-5

enter the number of times in the past 30 days they had binge drank, according to the stated criteria. Answers could range from 0 to 30 times in the past month. Participants who indicated 0 were categorized as non-binge drinkers. In the CARDIA study, alcohol intake was self-reported as a frequency of beer, wine, and liquor consumed per week and an average intake (mL) per day was computed.

Body mass index. Anthropometric data were collected by trained research assistants during the laboratory experience of the introductory nutrition course. Height measurements (cm) were acquired using a wall-mounted, calibrated stadiometer (Heightronic 235, QuickMedical, Issaquah, WA). Participants were asked to remove their shoes, and then make 4 points of contact with the wall before the research assistant recorded the measurement. Weight measurements (kg) were taken using a calibrated digital scale (#2000A, Life Measurement Inc, Concord, CA). Both height and weight measurements were taken twice and then averaged. The average values were used to calculate body mass index (BMI; kg/m^2). A healthy BMI was defined as being in the range of 18.5 to 24.9 kg/m^2.[37]

Data Analysis

Data are presented as means ± standard error (SE) unless otherwise indicated. Data distributions were checked and extreme outliers were removed before analysis. Outliers were determined using boxplot analyses (SPSS version 23; SPSS, Chicago, Illinois). Extreme outliers were identified as data points more than 3 times the interquartile range. Participants who had missing data for any of the 5 HLFs and/or PSS were also removed from the analysis (N = 512). As data collection occurred as part of classroom activities, missing data was primarily associated with absence from class or failure to complete assignments. Additionally, participants who were underweight (BMI < 18.5 kg/m^2) were

Table 2
Healthy Lifestyle Factor Prevalence

	Men	Women	All
N (%)	411 (29%)	985 (71%)	1396
Physically Active[a]	40%	40%	40%
Healthy Diet[b]	44%	45%	44%
Non-smoker[c]	91%	95%	94%
Non-binge Drinker[d]	25%*	40%	35%
Healthy BMI[e]	63%*	78%	73%

*p < .001 for the difference between males and females

Note.
a: Top 40% of sex-specific average daily steps
b: Top 40% of diet score (score ≥ 13)
c: Have not smoked at least 100 cigarettes in entire life
d: Indicated binge drank 0 times in the last 30 days
e: BMI 18.5-24.9 kg/m^2

removed from our sample (N = 54); given our focus on chronic disease risk, we considered only overweight and obese students "at risk" compared to those in the healthy BMI range. Descriptive statistics and frequencies were determined for all major variables such as age, sex, PS, each individual HLF, and total HLFs. T-tests were conducted to assess for sex differences among these variables. Analysis of covariance (ANCOVA) was used to identify mean differences between PS score with regards to HLF prevalence. In this test, continuous PS score was the dependent variable and HLF prevalence as a categorical variable (0-1, 2, 3, 4-5) was the independent variable. Main effects were compared via post hoc analyses using Fisher's Least Significant Difference test. The HLF variable was collapsed into 4 categories to enhance power given the low number of participants in the 2 most extreme categories. ANCOVA analyses were conducted to examine each HLF independently. PS remained the dependent variable and each dichotomous HLF was a fixed factor independent variable in separate analyses. Because of their confounding influence on PS and the HLFs, sex, hours of sleep, and limitations in activities due to physical, mental, or emotional problems served as covariates for this analysis. Average number of hours slept was calculated from self-reported average sleep and wake times. Limitation in activities was asked as a single-item question in the CWS, stated as: "Are you limited in any activities due to physical, mental, or emotional problems?" Age was not included as a covariate in this study given the already limited age range of the population (18-24 years). Spearman correlation was used to assess the relationship between PS scores and HLF scores. Both ANCOVA and Spearman correlation analyses were run utilizing the entire study cohort and then, stratified by sex. Chi-square analyses were conducted to evaluate differences in the proportion of overall and individual HLF prevalence, by sex. Significance was established at $p < .05$.

RESULTS

Of the 2052 participants who provided written consent to participate in the study, 1962 (96%) met the age requirement. After participants with missing data (N = 512) and/or an underweight BMI (N = 54) were removed, a total of 1396 participants were included in the analysis. Almost three-fourths of participants were female (Table 1). The population consisted primarily of white students (96%) in their freshman or sophomore year of college (88%) with an average age of 18.8 ± 0.03 years.

Perceived Stress

Perceived stress scores ranged from 0 to 36 in this sample, with the average score being 15.0 ± 0.17 (Table 1). Females reported significantly higher PS than males (15.5 ± 0.2 vs. 13.7 ± 0.31, $t = -5.0$, $p < .001$).

Healthy Lifestyle Factors

Average step counts and average diet scores were similar across sexes (Table 1). The average number of steps taken per day was 9601 ± 85 and the average diet score was 12.0 ± 0.09. Average BMI was in the healthy range for both males and females (Table 1).

By design, about 40% of the sample was categorized as physically active and having a relatively higher diet quality (Table 2). Only 6% of participants reported smoking. On average, females reported binge drinking 2.7 times in the past 30 days, whereas males binge drank 4.5 times in the past 30 days. More females than males refrained from

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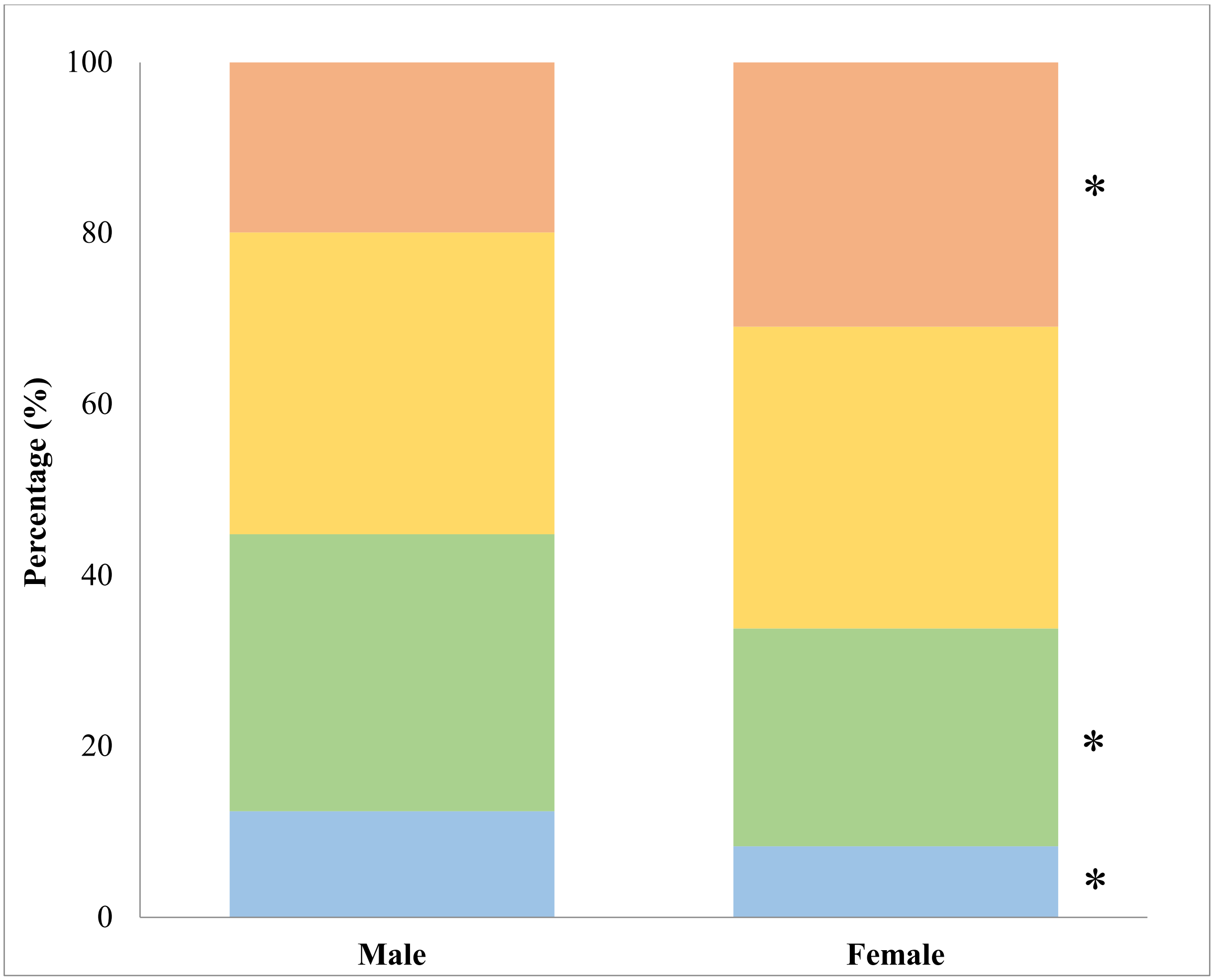
Figure 1
Proportion of Participants Reporting Healthy Lifestyle Factors



*** = proportion of those reporting the number of HLF differs from males, p < .05**

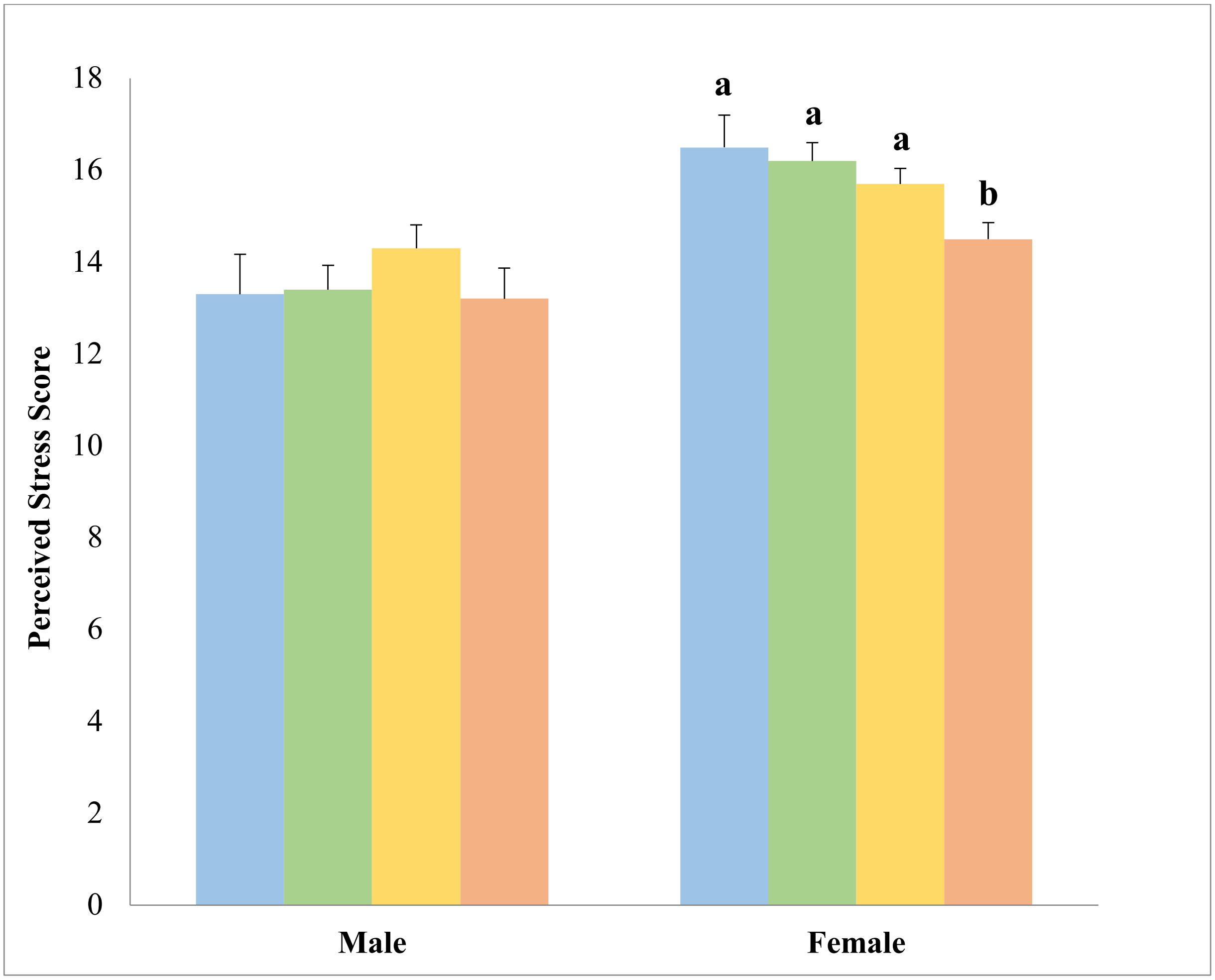
Note.
Bar sections represent the number of healthy lifestyle factors. Each color represents the following:

0-1 2 3 4-5

binge drinking in the past month (40% vs. 25%, χ^2 = 27.16, p < .001). The majority of participants in this sample (73%) had a healthy BMI. The percentage of females categorized as having a healthy BMI was significantly different from the percentage of males (78% vs. 63%, χ^2 = 30.84, p < .001).

Overall, participants reported an average of 2.9 ± 0.03 HLFs. On average, males had significantly fewer HLFs than females (2.6 ± 0.05 vs. 3.0 ± 0.03, t = -5.39, p < .001). Females were less likely to possess 0-1 and 2 HLFs and were more likely to exhibit 4-5 HLFs as compared to males (p < .05, Figure 1). Approximately 31% of females reportedly achieved 4-5 HLFs, whereas only 20% of males did. Moreover, 12% of males had 0-1 HLFs yet, only 8% of females did (Figure 1).

Figure 2
Perceived Stress by Healthy Lifestyle Factor Score



Bars with different letters are significantly different, p < .05

Note.
Bars represent the number of healthy lifestyle factors. Each color represents the following:

Perceived Stress and Healthy Lifestyle Factors

There was a weak, but statistically significant negative correlation between PS and total HLF score (rho = -0.070, $p < .01$). When stratified by sex, no significant correlation was observed among males (rho = -0.025, $p = .62$). However, the negative correlation was observed between PS and HLF score in females and it was stronger in magnitude (rho = -0.116, $p < .01$).

When controlling for sex, hours of sleep, and limitation in activities, there was an overall significant main effect between PS score and total HLF score ($F = 3.54$, $p < .05$). All covariates were significant in this test. When stratified by sex, this same effect was observed only among females ($F = 4.19$, $p < .01$). Female students who possessed 0-1, 2,

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or 3 HLFs had significantly higher PS scores than those who achieved 4-5 HLFs (16.5 ± 0.7, 16.2 ± 0.4, 15.7 ± 0.3 vs. 14.5 ± 0.4, $p < .01$), as seen in Figure 2. The perceived stress of male students varied minimally, if at all, in relation to total HLF score ($F = 0.83$, $p = .481$) (Figure 2).

Comparison of perceived stress to each individual lifestyle factor was conducted using ANCOVA. Of the 5 HLFs, only smoking status and physical activity showed a significant association with perceived stress in this analysis. Smokers had significantly higher perceived stress scores than non-smokers (16.3 ± 0.7 vs. 14.9 ± 0.2, $F = 4.02$, $p < .05$). Additionally, students who were relatively more physically active reported significantly lower perceived stress scores than those who were less physically active (14.5 ± 0.3 vs. 15.3 ± 0.2, $F = 6.36$, $p < .05$). When stratified by sex, the relationship between physical activity and PS was only observed among females ($F = 1.82$, $p < .05$), not among males ($F = 0.37$, $p = .435$). None of the other individual lifestyle factors exhibited a significant relationship with perceived stress in sex-specific analyses.

DISCUSSION

To our knowledge, few other studies have assessed the relationship between college students' perceived stress and multiple chronic disease risk factors. Of note, we observed a significant inverse association between female students' PS levels and HLF prevalence. As colleges and universities continue to address the growing mental health needs of their undergraduate populations, these findings suggest that the investment of campus resources into the support of healthy behavioral choices may help to reduce students' perception of stress.

Our reported findings are consistent with 2 other cross-sectional studies involving university students and add to the evidence of a relationship between mental health and health behaviors. Kwan et al[31] assessed 8 health risk behaviors and 5 mental health outcomes among 837 Canadian undergraduate students using the National College Health Assessment (NCHA) survey, a validated instrument with demonstrated reliability. Of the 3 distinct subgroups of students that emerged from their analyses, these authors identified a "high risk" group characterized by low probabilities of fruit and vegetable intake, physical activity, and adequate sleep along with high probabilities of smoking and binge drinking behavior, among other characteristics. Most notably, this subgroup reported poorer mental health than the other 2 groups and they reported significantly higher stress levels. In a sample of 410 students in the United Kingdom, Dodd et al[32] identified 3 clusters of health behaviors among 5 lifestyle risk factors. Almost half of the students in this study (46%) fell into the "unhealthy/high risk group" and were found to have a low frequency of physical activity, poor fruit and vegetable intake, and were occasional or regular smokers. This group also displayed significantly higher perceived stress levels than the other 2 clusters.

Most other research on this topic only assesses students' stress levels in relation to individual health behaviors. Thus, in addition to our primary analyses that considered health-related factors collectively, we also looked at them individually to compare our findings more broadly to other literature. Our findings demonstrated that PS was most consistently associated with physical inactivity and smoking status, and effects were stronger in women than in men. Although the other 3 HLFs did not display a significant relationship with PS, they each showed a general trend of increased PS among those who did not meet the criteria for the HLF (data not shown). We found the consistency of our findings to be mixed compared to the available literature.

Much of the literature shows a relationship observed between PS and physical inactivity. A national, cross-sectional study of over 14,000 undergraduate college students in the US found an inverse relationship between physical activity and mental health.[19] The authors concluded that meeting the recommendations for vigorous physical activity resulted in lower odds of reporting PS and poor mental health. Similarly, a study among 275 Puerto Rican college students revealed that those with lower levels of physical activity had PS levels in the highest tertile and that 68% of students had more sedentary activity during times of increased stress.[17] Additionally, a semester-long intervention study of 531 undergraduate students found that those enrolled in a stress management, physical activity, or cardiovascular fitness course reported a decrease in PS by the end of the semester, whereas the control group reported an increase in PS.[38] This study in particular highlights the potential effectiveness of utilizing physical activity as a stress reduction intervention among college students. Our finding of an overall inverse relationship between physical activity and stress is consistent throughout the literature. Collective evidence supports the plausible effectiveness of incorporating physical activity into stress reduction programs and recommendations for college-aged populations.

Consistent with our findings, other authors have reported a relationship between PS and smoking status. In a cohort of Chinese students, researchers found a statistically significant linear trend between smoking and stress, such that greater cigarette consumption (cigarettes/day) was associated with higher PS levels.[25] Additionally, a study of 441 students enrolled at a Midwestern metropolitan community college in the US also found that higher stress scores were associated with current smoking behavior.[39]

A number of studies have examined the relationship between stress and college students' diet quality. For example, a cross-sectional study of students from 7 Chinese cities found that those with a higher frequency of sweets, ready-to-eat food, and snack food consumption and lower frequency of fruit consumption reported higher levels of PS.[25] Similar results were seen in a cohort of first-year students from Germany, Poland, and Bulgaria where higher consumption of sweets, cookies, snacks, and fast food and lower consumption of fruits and vegetables was associated with higher PS among female students.[21]

That our study did not find evidence of an independent relationship between PS and diet quality could be related to our method that defined diet quality relative to that of the study population. It is also plausible that changes in appetite or food preferences may occur when an individual is experiencing increased stress, a concept that we did not measure. A study of 272 female students from a Midwestern university who completed a 45-item stress-eating survey found that 63% of participants self-reported increased appetite when stressed.[22] These students consumed more sweet foods such as desserts, chocolate, and candy than students who reported a decreased appetite or no appetite change in response to stress. Similar results were observed in a multi-experimental study in which female students were placed in either a stressful or non-stressful situation and given 4 snack options – M&M's, chips, peanuts, and grapes.[40] Students in the stress group ate more M&M's than those in the non-stress group and students in the non-stress group ate more grapes than those in the stress group. In their second experiment, the researchers assessed stress and eating patterns of male and female students and found that, of the students who reported overeating when stressed, 73% consumed foods they would normally avoid. Insight into the negative consequences of these behaviors can be seen among those with eating disorders. This type of overeating behavior is descriptive of binge eating disorder (BED), the most prevalent eating disorder in the US that is also associated with a high prevalence of obesity.[41] Given that peak incidence of onset of BED occurs in the late teens to early 20s, the approximate age of most college students, it is crucial that stress, health-related habits, and food environments on college campuses are addressed to help prevent the development of more chronic conditions including BED.[42]

Throughout the literature, there is an observed relationship between PS and changes in body weight. A cross-sectional survey of 268 first-year London college students found that students' stress scores were positively correlated with self-reported weight change.[43] Specifically, higher scores for stress severity and frequency were associated with a greater likelihood of having experienced either weight gain and weight loss. This association was stronger among female students. Additionally, a longitudinal study at an East Coast university in the US following 396 freshmen students from the beginning to the end of one academic year found sex differences in stress' relationship with weight change.[44] Males often reported a decrease in weight due to stressors such as peer pressure, whereas females reported an increase in weight due to high academic stress. Our study is unable to confirm or refute these observations because we measured weight status, not weight change. As well, only about one-fourth of participants in our sample were in the overweight or obese weight category.

Conversely, inconsistent results have been observed in relation to stress and binge-drinking behaviors. Our results did not show a significant relationship between PS and binge drinking. Additionally, a study of 1876 French undergraduate students also found no evidence of an association between PS score and regular alcohol use or binge-drinking.[45] In contrast, a much smaller study involving 179 undergraduate students enrolled in an introductory communication course at a public university in the US documented a relationship between stress and the number of days students binge drank.[24] Specifically, students with higher levels of PS at baseline subsequently reported a higher frequency of binge drinking 2 weeks later.

It is important to note that the variations in results across the literature are likely due to the use of different definitions and/or methodologies for each of the chosen variables, including how perceived stress was measured. This brings to light the need for more studies that use standardized data collection methodologies and definitions for exposure and outcome variables to allow for better comparisons. Additionally, the literature on this topic includes populations from widely different geographical areas including the US, Asia, and Europe. Differences in health behaviors and differences in perceived stress are influenced by culture, social norms, socioeconomic status, and a variety of other demographic features. Furthermore, differences in the prevalence and the variability of both exposures and outcomes within any given study population influence the ability to detect meaningful associations. Given these realities, it is important to be thoughtful when interpreting and generalizing the findings from any one study.

An interesting finding is the sex differences that arose in our analysis, both with PS levels and HLF prevalence: females had higher average PS levels but demonstrated a higher prevalence of HLFs than males. Our findings are consistent with others that have found females reporting higher stress levels than males;[32,36,44,45] however, sex differences between men and women as it relates to health factors are more challenging to contrast as they are only occasionally measured and observed.[21,23,40,43-45] This limits our ability to compare our results or draw definitive conclusions as to why females showed certain relationships that males did not. Nonetheless, the weight of the larger body of evidence presented indicates that stress is a problem for college students, health-related factors are associated with stress, and intervention strategies may need to target sex-specific behavioral priorities.

Limitations

The cross-sectional nature of this study precludes an understanding of temporality of the observed relationships. Whether low HLF prevalence leads to increased stress levels, or increased stress levels result in unhealthful behaviors and overweight remains unknown. Thus, future research on this topic using longitudinal study designs is warranted. As mentioned, the generalizability of our results is limited to that of a medium-sized, suburban New England university. Although this sample was generally representative of the university as a whole and was adequately powered with a large sample size, it was relatively homogeneous, consisting primarily of white, female students in their freshman or sophomore year. This feature limits the variability in our exposure and outcome measures, to some extent. Additionally, the smaller number of males compared to females in this cohort may have limited our ability to detect associations in our analyses stratified by sex. A larger, more diverse male sample may help determine if there is a true lack of relationship between PS and HLFs among males or if the relationship is modified by sex. Confirmation of effect modification by sex would strengthen our understanding regarding the need for sex-specific interventions.

The findings of our study may be affected to some degree by bias because participants were enrolled in an introductory nutrition course, and therefore, may have been more health conscious or inclined to practice healthy lifestyle habits than the general student population. However, given that this large course fulfills a biological sciences general education requirement and is completed by approximately 35% of all graduates at the university, a broad array of students from varying academic majors enroll in the course. Also, self-selection bias is limited in this cohort due to the ease of enrollment in the study which resulted in a higher participation rate (>90%) than other studies with extensive recruitment processes.

Although we used a cross-sectional study design, data collection occurred throughout a semester-long period; this may introduce some measurement error. For example, stress, smoking status, and binge drinking were measured via questionnaire after the third week of the semester whereas physical activity, diet and BMI were measured in the second and third months of the semester. Therefore, the stress measure may not accurately reflect students' stress levels at precisely the same time when physical activity, diet and body weight were measured. Another consideration of the study is the diet score that was used to capture the healthfulness of the diet. Our study represented diet quality via 3-day intakes of 4 selected nutrients (3 correlated with healthy food intake including dairy, fruits, vegetables, and whole grains, and one correlated with unhealthy food intake including animal and trans fats). This limits our ability to compare our findings to studies using more comprehensive diet quality scores (eg, Healthy Eating Index). Also, relative cut-points were applied when determining HLF adherence for physical activity and diet quality, by design, versus utilizing at-risk cut points. This may have reduced the ability to detect associations. Specifically, sex differences between males and females could not statistically differ from each other. Finally, we acknowledge that of the 5 HLFs investigated, weight status is unique as it is not a behavior, rather it is an outcome. Further, weight status is not entirely independent of the other 4 health factors. Our choice of including weight status as a health-related factor was based on prior work of CARDIA study investigators.[36]

The limitations of our research are balanced by the strengths of our methodologies including the large sample size, high rate of participation, and the use of ongoing monitoring and training of research staff to ensure a high degree of validity and reliability of data collection and management. Furthermore, the use of measured anthropometrics and research-grade pedometers increases our confidence in these objective measures as compared to self-reported information.

IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

Our findings contribute to a literature that reveals a relationship between college students' perceived stress and health-related factors. Our conclusions will be useful to researchers, practitioners, and policymakers interested in improving the mental and physical health and wellbeing of college students.

Improvements in mental health and physical well-being of young adults (ages 18-25) are priority health objectives of *Healthy People 2020.*[46,47] However, additional research is needed to further our understanding of the interrelationships between stress and lifestyle behaviors during the collegiate experience. To our knowledge, there are few studies assessing students' perceived stress and multiple health-related behaviors. In addition, there are limited studies investigating sex differences and few that provide an understanding of the directionality of the relationship because most investigations are cross-sectional. Our findings highlight the need for longitudinal studies that incorporate objective measures to strengthen our understanding of the relationship between stress and health-related behaviors and outcomes like weight status and weight change.

The results of this study provide a rationale for interventions to mitigate students' stress levels through promotion of healthy lifestyle behaviors, specifically healthy diet, physical activity, and low-risk substance use which may, in turn, promote healthy weight. These findings can inform the work of college health practitioners as well as those responsible for aspects of the campus environment that promote healthy food choices and opportunities for physical activity on campus. It appears important also to consider interventions tailored to the unique needs of female and male students.

Policymakers can apply the results of this study to allocate resources in ways that benefit student mental health and wellbeing on college campuses, whether investing in direct behavioral services, campus clubs and activities like intramural sports, and/or environmental changes that support healthy lifestyle habits. Intervening at this transitional life stage may foster the development of sustainable behaviors that may lower the burden of chronic disease experienced as this population ages into middle adulthood and becomes role models for the next generation.

•Longitudinal research that incorporates objective measures of personal behaviors and health outcomes, and research that investigates sex-differences, is needed to best inform public health practice and policy.

•Policymakers can advocate for resources to enhance direct behavioral services, clubs and activities including intramural sports, and/or environmental changes that promote physical and mental well-being of college students.

•Public health campaigns can call attention to student stress and use social media resources to raise awareness, provide education, direct attention to campus activities and resources, and advocate for screening and visits to student health services for those in need of support.

•College health service practitioners can provide stress management workshops, general health, nutrition and wellness classes, peer support groups, safe alcohol consumption resources, and individualized assessment and counseling services to help students develop healthy habits.

•Environmental actions can be prioritized to increase the availability and identification of healthier food choices in the dining hall, increase options for social physical activity, and improve the walkability or ride-ability of campus by investing in lighted walking paths and bike lanes.

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Human Subjects Approval Statement

The study protocols and procedures were reviewed and approved by the Institutional Review Board for the Protection of Human Subjects in Research at the University of New Hampshire, Durham, NH (IRB #5524).

Conflict of Interest Declaration

The authors have no conflicts of interest to declare.

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