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College Students' Health Behavior Clusters: Differences by Sex.

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***Objective*: The study purpose was to identify clusters of weight-related behaviors by sex in a college student populations. *Methods*: We conducted secondary data analysis from online surveys and physical assessments collected in Project Young Adults Eating and Active for Health (YEAH) with a convenience sample of students on 13 college campuses in the United States. We performed 2-step cluster analysis by sex to identify subgroups with homogeneous characteristics and behaviors. We used 8 derivation variables: healthy eating; eating restraints; external cues; stress; fruit/vegetable intake; calories from fat; calories from sugar-sweetened beverages; and physical activity. Contribution of derivation variables to clusters was analyzed with a MANOVA test. *Results*: Data from 1594 students were included. Cluster analysis revealed 2-clusters labeled "Healthful Behavior" and "At-risk" for males and females with an additional "Laid Back" cluster for males. "At-risk" clusters had the highest BMI, waist circumference, elevated health risk, and stress and least healthy dietary intake and physical activity. The "Laid Back" cluster had normal weights and the lowest restrained eating, external cues sensitivity, and stress. *Conclusion*: Identified differences in characteristics and attitudes towards weight-related behaviors between males and females can be used to tailor weight management programs.**

***Key words*: college students; health; weight; clusters; sex**

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Young adults are at particularly high risk for unhealthy, unwanted weight gain [1,2] and such gain can increase obesity risk in later adulthood.[3,4] This unwanted weight gain in young adulthood is also associated with increased risk of developing many chronic diseases including type 2 diabetes, heart disease, stroke, and certain types of cancer.[5] Weight gain among young adults is especially common in the first year of college, with an average weight increase of approximately 1.55 kilograms in the first year.[6,7] College weight gain has been linked to poor dietary behavior, increased alcohol intake, decreased physical activity, irregular sleep patterns, and increased academic stress.[8-21] College students themselves have identified lack of time, lack of self-regulation (including motivation and self-control), food costs, convenience of less nutrient-dense foods, limited availability of nutrient-dense foods, "all-you-can-eat" meal plans, living situations, social norms, increased independence in food choice, and other social issues as influencing their dietary behaviors.[22-28] There is currently a lack of evidence-based programming or strategies available to prevent unwanted weight gain or reduce unwanted weight in college populations.[2,29] More information on factors associated with unwanted weight gain during college is need-

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ed to develop these needed interventions.

Multiple factors have been indicated to play a role in weight gain among college students. For example, there have been differences in body mass index (BMI) categories[15] or unwanted weight gain patterns found between sexes,[9,30] but these studies have produced inconsistent outcomes. Some studies have reported male college students gained more weight[28,30] or were more likely to be obese[15] than female students, whereas other studies found female students gained more weight than male students.[9] Many studies noted this difference in unwanted weight gain by sex is likely due to differences in personal characteristics among sexes that influence weight management behavior such as dietary physical activity habits, stress levels, residence, influence of their environment, emotional eating, and dietary restraint, among other factors, and how they influence behavior.[8,9,15,24,27,28,30,31] For example, Kapinos, Yakusheva, and Eisenberg found obesogenic aspects of the campus food environment, specifically access to campus dining, significantly influenced the weight of female college students, but not male students.[24] In addition, Bennett, Greene, and Schqartz-Barcott found stress frequently influenced female students' eating patterns, which were often followed by guilt; however, male students' eating patterns were more influenced by boredom or anxiety, usually not experiencing post-consumption guilt.[31] However, these factors are usually studied and described separately rather than in combination, as they would usually act in real-world situations.

Cluster analysis has been used to sort individuals in groups by identifying homogenous factors to study these factors by sex; allowing the multiple factors to be considered in combination.[32] Although previous research has identified clusters of college students by their health behaviors,[33] there was a lack of focus on how clustered behavioral groups vary by sex. Understanding how multiple factors associated with unwanted weight gain interplay in homogeneous subgroups of the college population by sex will inform the development of effective, targeted prevention programs on college campuses. Therefore, the purpose of this study was to identify clusters of weight-related health behaviors by sex among a college student population.

METHODS

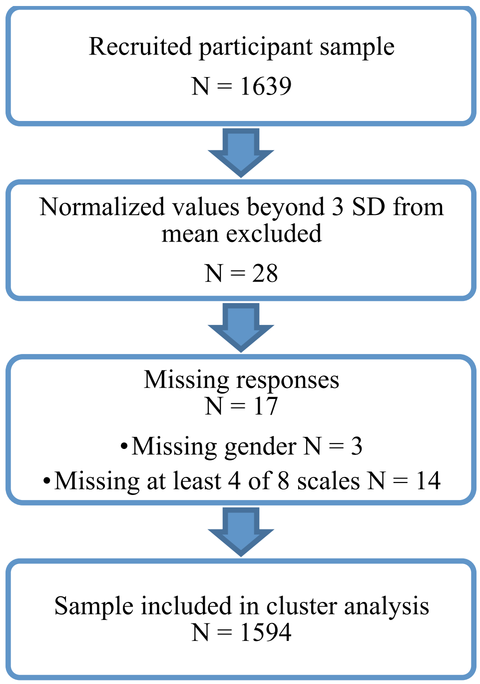
A secondary analysis of data from the Project Young Adults Eating and Active for Health (YEAH) was used to identify homogenous subgroups among male and female college students. The YEAH study was a community-based participatory research study and intervention based on the PRECEDE-PROCEED model.[34] The primary goal of the YEAH study was to prevent unhealthy weight gain in 18 to 24-year-old college students on 13 college campuses in the United States.

Each university partner recruited students to participate in the health-related intervention through verbal and electronic announcements, flyers, and ads in student newspapers. Participation eligibility included being a full-time first-, second-, or third-year student; having a non-health related academic major (eg, nutrition, exercise science, and/or health promotion); having a body mass index (BMI) ≥ 18.5 (calculated based on self-reported height and weight); not having any condition that would prevent participation in an intervention to prevent unhealthy weight gain (eg, life-threatening illness, pregnancy, or medical restrictions); and being between 18 and 24 years of age.

Data Collection

At baseline, participants (N = 1639) completed online surveys and in-person physical assessments. The surveys collected demographic data and assessed: (1) stress level using the Cohen Perceived Stress Scale (PSS) (14 items);[35] (2) life satisfaction with family, friends, school, self-, living environment, romatic relationships, physical appearance, job satisfaction, and overall using the Brief Multidimensional Students' Life Satisfaction Scale: College Version (BMSLSS-C) (9 items);[36] (3) dietary intake using the National Cancer Institute (NCI) Fat Screener (17 items),[37] NCI Fruit and Vegetable Screener (10 items),[38] and Sugar-Sweetened Beverages, Energy Drinks, and Coffee Intake questionnaire (15 items);[39] (4) routine and compensatory eating restraint, emotional eating, and external cues to eating using Schembre's Weight Related Eating Questionnaire (WREQ) (16 items);[40] (5) physical activity using the International Physical Activity Questionnaire (IPAQ) (9 items);[41,42] (6) outcome expectations, personal barriers, and self regulation using Schembre's Physical Activity Behavior Questionnaire (PABQ) (15 items);[43] and (7) mealtime behavior intention and self-regulation using the Self-instruction for Healthful Mealtime Behavior Intention and Self-regulation of Healthful Mealtime Behavior, created for the Project YEAH study.[34] The PSS, BMSLSS-C, WREQ, and PABQ were developed and validated using a college population.[35,36,40,43] In addition, the PSS, WREQ, and PABQ are measured on a 5-point likert scale and the BMSLSS-C is measured on a 7-point likert scale.[35,36,40,43] The dietary measures also were validated, but for the general adult population, with these questionnaires providing percentage of total energy consumed from fat per day,[37] total cups of fruits and vegetables consumed per day,[38] and calories consumed from sugar-sweetened beverages per day.[39] The validated IPAQ questionnaire provided estimates for total time spent doing different physical activity tasks per week, reported in Metabolic Equivalent of Task (METS), as well as total time reported sitting each week.[41,42] The information gathered with the IPAQ questionnaire was also used to calculate the METS for vigorous, moderate, and walking tasks as well as categorize participants into low, moderate, or high activity levels.[42] Self-instruction for intention for healthful mealtime behavior (ie, plan-

Figure 1
Process of Determining the Final Sample Size



ning, choosing and assembling healthful meals) was measured with 6 items and self-regulation for engaging in healthful mealtime behavior was measured using 4 items based on the social cognitive determinants of eating.[34]

As part of the physical assessment, trained personnel measured weight, height, and waist circumference in duplicate using standardized procedures (without shoes, socks, and excessive clothing and after voiding). All research assistants completed standardized anthropometric assessment training, and inter-rater reliability was determined to be >80% at each institution. Weight was recorded using digital scales to the nearest 0.1 kilogram (kg) with duplicates averaged and measurements repeated if there was > 0.2 kg difference between measurements. Height was recorded using digital stadiometers to the nearest 0.1 centimeter (cm) with a repeated measurement and then averaged. Both height and weight measurements were repeated if there was > 0.2-cm/kg difference, respectively; the measurements were repeated until 2 measurements were obtained within 0.2 cm/kg, respectively. BMI was calculated (kg/m^2) and categorized by standard BMI criteria (18.5-24.9 normal weight; 25-29.9 overweight; and ≥ 30 obese).[44] Waist circumference was measured using Gulick non-stretchable tension tape at the level of the iliac crest. Waist measurements were within 0.5 cm, recorded to the nearest 0.1 cm, repeated, and averaged. Participants were considered at an "elevated health risk" if they had an increased waist circumference (≥102 cm for men and ≥ 88 cm for women)[45] and were categorized in either the overweight or obese category for BMI.

Data Analysis

Surveys were analyzed using SPSS (version 21.0, 2012, SPSS, Inc., Chicago, IL). Cluster analysis was performed for each sex to identify subgroups with homogeneous characteristics and behaviors. Two-step cluster analysis was used combining sequential and hierarchical agglomerative methods pre-clustering and then sub-clustering data. The log-likelihood measure was used as a distance measure. The number of clusters was determined by automated cluster selection based on largest relative increase in distance between the 2 closest clusters defined by the Schwarz Bayesian Criterion (ie, BIC).[46]

Data preprocessing for cluster analysis was performed, including variable selection, variable normalization, outlier removal, and missing value imputation. Variable selection is critical for deriving meaningful clusters not only for interpretability but also for algorithmic effectiveness.[47] In our study, 8 derivation variables (with intent to include as many variables as possible) were selected among more than 50 variables collected to ensure (1) good coverage of a variety of heath behavior characteristics, and (2) low inter-correlation among them. These variables were selected based on a combination of the research team's domain experts and judgments (covering variables of the greatest interest) and algorithm (avoiding strong correlation among those selected). Independence among the variables was confirmed ($-0.4<r<0.4$) before being entered into analysis. Thus, the following derivation variables were used: healthy eating, WREQ restraints, WREQ external cues, Cohen's stress score, total cups of fruits and vegetables per day, percent fat calories in diet, calories from sugar-sweetened beverages, and total METs. All these derivation variables were transformed into normal distribution using the equal-area method described by Darlington.[48] If any of an individual's normalized values for a derivation variable was beyond 3 standard deviations from the mean, it was considered an outlier and removed before further analysis. Thus, 28 individuals were not included in the analysis. Three other participants were omitted due to not having identified their sex. An additional 14 participants were omitted due to missing data for at least 4 scales out of the 8 used in the cluster analysis. For the remaining individuals, missing values were imputed using sex-specific means based on remaining records. Thus, data for 1594 individuals were included in the cluster analysis. Figure 1 provides an illustration of the process of reaching the final sample size for the study.

Cluster validation was performed both internal-

Table 1
Demographic and Health-related Characteristics: Male and Female Participants

	Total (Male & Female) (N = 1594)			Females (N = 1077)			Males (N = 517)		
Derivation Variables	mean ± standard deviation								
Healthy Eating	3.22	±	0.73	3.32	±	0.69	3.02	±	0.74
WREQ Restraints	2.13	±	0.83	2.27	±	0.82	1.84	±	0.73
WREQ External Cues	2.82	±	0.92	2.89	±	0.91	2.66	±	0.92
Cohen's Stress Score	22.60	±	7.08	23.37	±	6.96	20.91	±	6.83
Total Fruit/Veg (cups)	2.72	±	2.32	2.53	±	2.02	3.00	±	2.43
Percent Fat in Diet	31.23	±	5.09	31.07	±	4.99	31.46	±	4.75
Sugar Sweetened Beverages (Kcal)	164.53	±	292.19	129.66	±	179.85	207.66	±	275.63
Total METs	2268.50	±	1714.45	1995.61	±	1497.26	2831.06	±	1866.61
Validation Characteristics	mean ± standard deviation								
BMI	24.14	±	4.37	23.97	±	4.53	24.53	±	4.01
Waist Circumference (cm)	82.63	±	11.01	81.74	±	11.09	84.56	±	10.59
	percentage of participants								
BMI Categories (%)									
Normal Weight	67.67			69.92			61.90		
Overweight	23.47			21.45			28.82		
Obese	8.86			8.64			9.28		
Increased Waist Circumference (%)	14.67			18.20			7.74		
At Elevated Health Risk (%)	14.61			16.90			10.25		
Additional Characteristics	mean ± standard deviation								
Age	19.34	±	1.09	19.30	±	1.06	19.42	±	1.11
	percentage of participants								
Freshman (%)	38.27			38.38			38.79		
Race/Ethnicity (%)									
White, non-Hispanic	69.37			70.97			68.06		
Black, non-Hispanic	12.06			12.11			11.23		
Hispanic/Latino	6.03			5.81			6.39		
Other	12.53			11.11			14.32		
International (%)	7.80			7.16			9.00		
Live on Campus (%)	74.56			75.19			73.14		
In a Committed Relationship (%)	42.20			44.56			37.25		
Work at Least Part-time (%)	49.00			51.61			42.69		
	mean ± standard deviation								
Grain Intake (servings)	3.26	±	1.48	3.18	±	1.44	3.41	±	1.54
Whole Grain Intake (servings)	2.08	±	1.50	2.05	±	1.44	2.13	±	1.60
IPAQ Activity (MET-min/week)									
Vigorous METs	1155.09	±	1289.02	944.17	±	1070.71	1579.42	±	1549.15
Moderate METs	388.14	±	522.02	356.26	±	486.18	388.14	±	522.02
Walking METs	767.35	±	652.29	724.54	±	625.86	2839.12	±	1937.49
	percentage of participants								
IPAQ categories (%)									
Low Activity	42.96			38.53			52.21		
Moderate Activity	42.89			44.92			38.96		
High Activity	14.15			16.54			8.83		

Table 2
Cluster Analysis of Female Participants Using Emotional/Psychological, Diet, and Physical Activity Variables

	Females (N = 1077)			At-risk Cluster (N = 650)			Healthful Behavior Cluster (N = 427)			p-value [a]		Effect Size [b]
Derivation Variables						mean ± standard deviation						
Healthy Eating	3.32	±	0.69	2.97	±	0.57	3.87	±	0.47	<.0001	***	0.411
WREQ Restraints	2.27	±	0.82	2.04	±	0.70	2.60	±	0.87	<.0001	***	0.106
WREQ External Cues	2.89	±	0.91	2.95	±	0.89	2.79	±	0.93	.004	**	0.011
Cohen's Stress Score	23.37	±	6.96	24.57	±	7.08	21.57	±	6.37	<.0001	***	0.043
Total Fruit/Veg (cups)	2.53	±	2.02	1.78	±	1.44	3.67	±	2.24	<.0001	***	0.192
Percent Fat in Diet	31.07	±	4.99	32.91	±	4.79	28.30	±	3.88	<.0001	***	0.222
Sugar Sweetened Beverages (Kcal)	129.66	±	179.85	176.91	±	207.71	57.89	±	86.31	<.0001	***	0.097
Total METs	1995.61	±	1497.26	1594.20	±	1286.10	2622.44	±	1587.45	<.0001	***	0.118
Validation Characteristics												
BMI	23.97	±	4.53	24.30	±	4.96	23.47	±	3.73	.002	**	0.008
BMI Categories (%)										.007	**	0.009
Normal Weight	69.92			67.08			74.24					
Overweight	21.45			22.31			20.14					
Obese	8.64			10.62			5.62					
Waist Circumference (cm)	81.74	±	11.09	82.80	±	11.88	80.11	±	9.56	<.0001	***	0.014
Increased Waist Circumference (%)	18.20			20.62			14.52			.014	*	0.006
At Elevated Health-risk [c] (%)	16.90			19.23			13.35			.015	*	0.006
Additional Characteristics												
Age	19.30	±	1.06	19.26	±	1.08	19.35	±	1.03	.181		0.001
Freshman (%)	38.38			41.59			33.49			.010	**	0.006
Race/Ethnicity (%)										<.0001	***	0.040
White, non-Hispanic	70.97			64.63			80.71					
Black, non-Hispanic	12.11			16.86			4.82					
Hispanic/Latino	5.81			6.28			5.08					
Other	11.11			12.23			9.39					
International (%)	7.16			6.71			7.86			.557		0.000
Live on Campus (%)	75.19			77.99			70.91			.012	*	0.006
In a Committed Relationship (%)	44.56			47.57			39.95			.018	*	0.005
Work at Least Part-time (%)	51.61			48.12			56.90			.006	**	0.007
Grain Intake (servings)	3.18	±	1.44	3.20	±	1.44	3.15	±	1.44	.544		0.000
Whole Grain Intake (servings)	2.05	±	1.44	1.80	±	1.40	2.42	±	1.42	<.0001	***	0.044
Self-rated Healthiness of Diet (%)										<.0001	***	0.162
Healthy	9.45			1.24			21.88					
Somewhat Healthy	75.40			76.24			74.12					
Unhealthy	15.15			22.52			4.00					

(continued on next page)

ly and externally.[49] For internal cluster validation, we evaluated the stability of clustering results using subsamples.[50] More specifically, cluster stability was confirmed by running the same clustering procedure using a subset of the samples and comparing consistency of the result with the entire sample. For each sex group, the samples were randomly divided into 10 equal partitions, and an iterative process was used to rerun the analysis using 9 of these partitions (ie, leaving one partition out at a time). Consistency with the original clustering results was measured by the Rand Index.[51]

Weight status (such as BMI and risk groups) was used for external validation. The purpose of such validation variables was to check the association between health behavior clusters discovered against the weight status as the "ground truth."

Table 2 (continued)
Cluster Analysis of Female Participants Using Emotional/Psychological, Diet, and Physical Activity Variables

	Females (N = 1077)			At-risk Cluster (N = 650)			Healthful Behavior Cluster (N = 427)			p-value [a]		Effect Size [b]
Self-rated Level of Fat from Diet (%)										<.0001	***	0.131
High	17.64			26.75			3.78					
Medium	72.98			69.83			77.78					
Low	9.38			3.42			18.44					
IPAQ Activity (MET-min/week)												
Vigorous METs	944.17	±	1070.71	685.21	±	891.85	1337.85	±	1194.04	<.0001	***	0.069
Moderate METs	356.26	±	486.18	289.68	±	455.25	457.40	±	514.00	<.0001	***	0.030
Walking METs	724.54	±	625.86	642.75	±	559.88	850.80	±	698.02	<.0001	***	0.024
IPAQ categories (%)										<.0001	***	0.096
Low	38.53			27.15			55.79					
Moderate	44.92			50.08			37.12					
High	16.54			22.78			7.09					
PA Outcome Expect	4.07	±	0.84	3.90	±	0.87	4.33	±	0.73	<.0001	***	0.044
PA Personal Barriers	2.30	±	0.85	2.48	±	0.84	2.01	±	0.78	<.0001	***	0.058
PA Self-regulation	2.48	±	1.03	2.14	±	0.90	2.99	±	1.00	<.0001	***	0.137
Healthful Meal Intent	3.32	±	0.72	3.03	±	0.65	3.77	±	0.57	<.0001	***	0.254
Healthful Meal Behavior	3.41	±	0.73	3.05	±	0.63	3.94	±	0.52	<.0001	***	0.350
WREQ Emotional Eating	2.29	±	1.02	2.37	±	1.05	2.18	±	0.95	.003	**	0.006
Satisfaction with Life	5.23	±	0.76	5.14	±	0.76	5.36	±	0.73	<.0001	***	0.024

Note.
Derivation Variables: Wilks' $\lambda = .410$, $p < .001$, $\eta^2 = .590$

Validation Characteristics: Wilks' $\lambda = .985$, $p < .001$, $\eta^2 = .015$

Additional Characteristics: Wilks' $\lambda = .549$, $p < .001$, $\eta^2 = .451$
a = The p-values for continuous variables are based on t-tests of each variable between clusters. The p-values for categorical variables are based on $\chi2$ tests of each variable between clusters.
b = Effect size for continuous variables are the η^2 statistics from MANOVA within each variable group. Effect sizes for categorical variables are phi-squared of each variable against the clustering.
c = Participants were considered at an "elevated health risk" if they had an increased waist circumference (≥ 102 cm for men and ≥ 88 cm for women)48 and were categorized in either the overweight or obese category for BMI.

If the clusters had a high level of correspondence with the weight status, then our clustering results would help link to corresponding weight status. Clusters were validated against BMI and waist circumference categories using multiple analyses of variance (MANOVA). The association between cluster assignments and health risk categories was assessed using Chi-square tests. *Post hoc* Tukey tests were used to identify sources of differences among clusters if more than 2 clusters were found.

To see the contribution of derivation variables to the clusters, a multivariate analysis of variance (MANOVA) was performed to evaluate effect sizes of the derivation variables while using the cluster ID as the dependent variable. Effect sizes were calculated for continuous and categorical variables. Effect sizes for continuous variables were the η^2 statistics from MANOVA within each variable group. Effect sizes for categorical variables were phi-squared of each variable against the clustering.

RESULTS

Participants (N = 1594) were young adults (19.3±1.1 years) who were mostly white (69%) and residing on campus (75%) (Table 1). Approximately 32% of students were overweight or obese. There were 1077 female participants (67.6%) and 517 male participants (32.4%), as summarized separately in Tables 2 and 3.

Variables considered relevant to body weight but not included as derivation variables, due to high correlations, are provided in the descriptive tables for informational purposes. They are listed, along with the demographic and lifestyle variables, in the group called "Additional Variables."

Cluster Analysis

Cluster analysis revealed a 2-cluster solution labeled as "Healthful Behaviors" and "At-risk" for female participants (Table 2). Female participants in the "Healthful Behaviors" cluster had a lower BMI

Table 3
Cluster Analysis of Male Participants Using Emotional/Psychological, Diet and Physical Activity Variables

	Males (N = 517)	Healthful Behavior Cluster (C1) (N = 159)	Laid Back Cluster (C2) (N = 226)	At-risk Cluster (C3) (N = 132)	p-value [a]	Effect Size [b]	Ad justed p-Values[c] C1-C2	C1-C3	C2-C3
Derivation Variables	mean ± standard deviation								
Healthy Eating	3.02 ± 0.74	3.72 ± 0.48	2.78 ± 0.63	2.58 ± 0.57	<.0001	0.394	<.0001	<.0001	.003
WREQ Restraints	1.84 ± 0.73	2.38 ± 0.75	1.36 ± 0.36	2.00 ± 0.63	<.0001	0.365	<.0001	<.0001	<.0001
WREQ External Cues	2.66 ± 0.92	2.50 ± 0.84	2.37 ± 0.87	3.32 ± 0.77	<.0001	0.183	.294	<.0001	<.0001
Cohen's Stress Score	20.91 ± 6.86	20.13 ± 5.59	17.90 ± 5.70	27.07 ± 6.16	<.0001	0.287	.001	<.0001	<.0001
Total Fruit/Veg (cup)	3.00 ± 2.43	4.14 ± 2.83	2.99 ± 2.28	1.60 ± 0.99	<.0001	0.182	<.0001	<.0001	<.0001
Percent Fat in Diet	31.46 ± 4.75	28.33 ± 4.11	32.42 ± 4.18	33.70 ± 4.51	<.0001	0.189	<.0001	<.0001	.029
Calories from Beverages	207.66 ± 275.63	99.44 ± 142.93	196.67 ± 236.66	357.18 ± 376.03	<.0001	0.135	.001	<.0001	<.0001
Total METs	2831.06 ± 1866.61	3663.01 ± 1930.90	2713.46 ± 1904.31	2046.57 ± 1248.09	<.0001	0.096	<.0001	<.0001	.003
Validation Characteristics									
BMI	24.53 ± 4.01	24.35 ± 3.39	23.93 ± 3.82	25.77 ± 4.71	<.0001	0.035	.554	.007	<.0001
BMI Categories (%)					.003	0.031			
Normal Weight	61.90	61.01	68.14	52.27			.542	.503	.012
Over weight	28.82	32.70	24.78	31.06			.336	1.000	.730
Obese	9.28	6.29	7.08	16.67			1.000	.026	.023
Waist Circumference (cm)	84.56 ± 10.59	83.70 ± 9.05	83.01 ± 10.10	88.24 ± 12.19	<.0001	0.042	.801	.001	<.0001
Increased WC (%)	7.74	5.03	5.75	14.39	.004	0.021	1.000	.033	.030
At Elevated Health Risk [d] (%)	10.25	6.92	7.52	18.94	.001	0.028	1.000	.010	.006
Additional Characteristics									
Age	19.42 ± 1.11	19.35 ± 1.12	19.44 ± 1.03	19.45 ± 1.22	.671	0.005	.702	.734	.999
Freshman (%)	38.79	42.77	36.77	37.40	.461	0.003	.845	1.000	1.000
Race/ Ethnicity (%)					.006	0.040			
White, non-Hispanic	68.06	70.34	67.53	66.09			1.000	1.000	1.000
Black, non-Hispanic	11.23	2.76	15.46	14.78			.001	.003	1.000
Hispanic/Latino	6.39	7.59	5.67	6.09			1.000	1.000	1.000
Other	14.32	19.31	11.34	13.04			.175	.711	1.000

(continued on next page)

and waist circumference than those in the "At-risk" cluster and were less likely to be at elevated health risk. Dietary variables (healthy eating score, fruit and vegetable intake, and percent of calories from fat) contributed most to the distinctions between the clusters (ie, the largest effect sizes [η^2]). The "Healthful Behaviors" cluster demonstrated more healthful dietary patterns (higher fruit and vegetable intake, fewer calories from fat and sugar sweetened beverages), more physical activity, and less perceived stress than those in the "At-risk" cluster. A subsequent analysis found additional differences between clusters. Female participants in the "Healthful Behaviors" cluster had greater satisfaction with life, more positive physical activity outcome expectations, lower perceived barriers to physical activity, more ability to self-regulate, more positive health beliefs for self-instruction for intent for healthful meals, more positive self-regulation for healthful meal behavior, and lower levels of emotional eating. Differences in demographics between clusters also were identified. More female participants in the "Healthful Behaviors" cluster were upper classmen, lived off campus, not in a relationship, white, and working at least part-time.

Male participants presented 3 clusters, labeled "Healthful Behaviors," "At-risk" and "Laid Back" (Table 3). Healthy eating score, restrained eating,

Table 3 (continued)
Cluster Analysis of Male Participants Using Emotional/Psychological, Diet and Physical Activity Variables

	Males	Healthful Behavior Cluster (C1)	Laid Back Cluster (C2)	At-risk Cluster (C3)			Ad justed p-Values[c]		
	(N = 517)	(N = 159)	(N = 226)	(N = 132)	p-value [a]	Effect Size [b]	C1-C2	C1-C3	C2-C3
International (%)	9.00	8.23	8.97	10.00	.872	0.001	1.000	1.000	1.000
Live on Campus (%)	73.14	74.68	72.85	71.76	.848	0.001	1.000	1.000	1.000
Committed Relationship (%)	37.25	35.22	39.19	36.43	.714	0.001	1.000	1.000	1.000
Work at Least Part-time (%)	42.69	41.14	40.44	48.46	.303	0.005	1.000	.781	.524
Grain Intake (servings)	3.41 ± 1.54	3.65 ± 1.56	3.38 ± 1.46	3.18 ± 1.61	.032	0.027	.205	.026	.457
Whole Grain Intake (servings)	2.13 ± 1.60	2.79 ± 1.58	1.96 ± 1.59	1.63 ± 1.39	<.0001	0.097	<.0001	<.0001	.125
PA Outcome Expect	4.09 ± 0.81	4.40 ± 0.64	4.03 ± 0.83	3.82 ± 0.85	<.0001	0.059	<.0001	<.0001	.048
PA Personal Barriers	2.04 ± 0.88	1.73 ± 0.71	1.99 ± 0.83	2.50 ± 0.95	<.0001	0.136	.010	<.0001	<.0001
PA Self-regulation	2.66 ± 1.05	3.20 ± 0.99	2.53 ± 1.01	2.26 ± 0.95	<.0001	0.102	<.0001	<.0001	.034
Healthful Meal Intent	2.96 ± 0.80	3.67 ± 0.51	2.64 ± 0.73	2.68 ± 0.66	<.0001	0.369	<.0001	<.0001	.867
Healthful Meal Behavior	3.17 ± 0.78	3.81 ± 0.57	3.02 ± 0.68	2.65 ± 0.62	<.0001	0.355	<.0001	<.0001	<.0001
WREQ Emotional Eating	1.69 ± 0.78	1.67 ± 0.69	1.43 ± 0.57	2.16 ± 0.96	<.0001	0.159	.006	<.0001	<.0001
Satisfaction with Life	5.32 ± 0.79	5.39 ± 0.67	5.58 ± 0.68	4.85 ± 0.87	<.0001	0.135	.140	<.0001	<.0001

Note.
Derivation Variables: Wilks' $\lambda = .220$, $p < .001$, $\eta^2 = .531$

Validation Characteristics: Wilks' $\lambda = .956$, $p < .001$, $\eta^2 = .022$

Additional Characteristics: Wilks' $\lambda = .254$, $p < .001$, $\eta^2 = .496$

a = The p-values for continuous variables are based on one-way ANOVAs of each variable among clusters. The p-values for categorical variables are based on χ^2 tests of each variable between clusters.
b = Effect size for continuous variables are the η^2 statistics from MANOVA within each variable group. Effect sizes for categorical variables are phi-squared of each variable against the clustering.
c = The p-values for continuous variables are adjusted using Tukey multiple comparisons of means. The p-values for categorical variables are adjusted based on pairwise comparison of proportions with Bonferroni adjustments.
d = Participants were considered at an "elevated health risk" if they had an increased waist circumference (≥ 102 cm for men and ≥ 88 cm for women)48 and were categorized in either the overweight or obese category for BMI.

and perceived stress contributed most to the distinction among the identified clusters (largest effect sizes [η^2]). The "At-risk" cluster had the highest BMI and waist circumference and persons were more likely to be at elevated health risk than those in the other clusters. The "Healthful Behaviors" cluster had the highest healthy eating and restraint scores, consumed the most fruits and vegetables, had the highest physical activity, and had the lowest consumption of fat and sugar sweetened beverages. Those in the "Laid Back" cluster had the lowest restrained eating, sensitivity to external cues, and perceived stress scores. The "At-risk" cluster had the lowest intake of fruits and vegetables, the least physical activity, and the highest consumption of fat and sugar sweetened beverages as well as the highest perceived stress and external cues scores. Subsequent analysis found that male participants in the "At-risk" cluster had the highest emotional eating and lowest satisfaction with life scores. The "Laid Back" cluster had the lowest levels of emotional eating. Furthermore, the "Healthful Behaviors" cluster reported the highest intakes of whole grains, self-instruction for health belief intent, and self-regulation for health belief behavior scores. The only difference in demographic factors among clusters was race. Fewer black male participants were found to be in the "Healthful Behaviors" than in the "At-risk" or "Laid Back" clusters.

DISCUSSION

Many of the behavior patterns observed between clusters for both sexes were similar to what is reported in the published literature on behaviors associated with increased risk of overweight/obesity; including those with higher BMIs had lower levels of physical activity, lower fruit and vegetable consumption, lower life-satisfaction, more emotional eating, and higher susceptibility to external food cues.[9,18,33,52,53] Both male and female participants in the "Healthful Behaviors" groups had more positive physical activity outcome expectations and lower perceived barriers to physical activity and also reported higher levels of physical activity. Future research utilizing experimental designs are needed to determine if focusing on increasing positive physical activity outcome expectations and lowering perceived barriers would result in increases in physical activity among college students.

The discovered relationship between emotional eating and external food cues with weight status for most of both male and female participants in this study was supportive of previous research that indicated increased BMI was associated with impulsivity and inhibitory control deficits. [54-56] These deficits identified in previous research included factors of external food cues producing overeating responses, and emotional eating and taste preferences dictating food choice.[54-56] Because this study did not evaluate overeating or taste influences, future research is needed to determine if differences between sexes exist regarding the relationship between overeating, influence of taste preferences, emotional eating, and responses to external food cues among college students.

This study revealed for most participants an association between lower levels of physical activity and higher BMI levels, along with other unhealthy habits, which was consistent with existing studies.[18,33,53] However, this was not true for the unique cluster of "Laid Back" male participants who had lower BMI levels and lower levels of physical activity than the "Healthful" male participants. The "Laid Back" cluster of male participants having less optimal health-related diet and physical activity behaviors, but healthy weights, was possibly the most important and unique finding of this study.

One fundamental difference for this unique group was that this group of "Laid Back" male participants had much lower stress than other groups (even lower than the "Healthful Behaviors" groups in both male and female participants). A more in-depth study of these "Laid Back" male students is needed to understand the relationships among their weight-related behaviors and other characteristics. The long-term impact of less favorable health-related behavior on health outcomes for individuals in this "Laid Back" cluster is unknown, and additional research is needed.

The proportion of male participants in this "Laid Back" cluster (44%) was higher than the 34% of male college students in a similar "psychologically secure" cluster found by Greene et al.[33] Although, many of the factors measured and used in the cluster analysis differed between our study and Greene et al's study, the patterns for perceived stress, dietary restraint, physical activity, fruit and vegetable intake, BMI, and waist circumference were similar in both. The observed increase from 34% in Greene's study to the 44% found in our study may indicate an increase in the numbers of male students who are "Laid Back"/"psychologically secure." Future research needs to determine if the percentage of male college students is increasing in this category, and if increasing, the causal factors associated with those increases.

It is also unclear why a "Laid Back" cluster emerged in male but not female participants. Future research needs to investigate the absence of this "Laid Back" group among female college students. Besides the absence of this "Laid Back" group among female participants, there were other differences unique to the female participants in this study. Variables that contributed most to differences between the 2 female clusters, particularly the association of BMI and healthy eating behaviors of lower intake of fat and sugar-sweetened beverages, are consistent with previous research.[57-61] For example, female participants in the "At-risk" cluster consumed more energy from fat and sugar sweetened beverages, consumed fewer vegetables, and were more likely to be overweight/obese than the female participants in the "Healthful Behaviors" cluster who consumed less energy from fat and beverages and more vegetables. Similar patterns were found when comparing male participants in the "Healthful Behavior" cluster to those in the "At-risk" cluster.

An example of this would be the need to differentiate between male participants categorized as being "Laid Back" or "Healthful Behaviors." Although they may both have a healthy BMI, they likely need different health promotion messaging. Although emotional eating and weight outcomes may be stereotyped as an issue for female students, we found a stronger relationship among emotional eating, life dissatisfaction, and BMI for male than for female participants. The relationship for men between emotional factors and BMI was not consistent between groups. The "Laid Back" male participants had low levels of restrained eating, sensitivity to external cues, emotional eating, perceived stress, and had a lower BMI; the male participants in the "At-risk" cluster, had an increased BMI and had the highest rates of emotional eating and lowest satisfaction with life scores between both sexes. Although emotion-related issues are important factors to consider when developing interventions for many college students of both sexes, our findings indicating the potential need to focus on emotional eating and life satisfaction for some male college students were unanticipated. However, it is important to emphasize that not all male students may need a focus on emotional issues, especially not "Laid Back" male students, and may not respond favorably to interventions utilizing that focus area. Tailoring of interventions to meet different groups' needs appears warranted.

Although there are some areas that may benefit from tailoring to meet differing needs by sex, there are also areas of foci that appear to be beneficial for inclusion in weight management interventions designed for both sexes. Common dietary factors important in weight management interventions on college campuses for most male and female students include: increased fruit, vegetable, and whole grain intake; reduced fat and sugar-sweetened beverage intake; and increased levels of physical activity. Other factors indicated by this study important to include in college weight management interventions seeking to improving dietary quality include improving abilities to self-regulate dietary intake, increasing intent to eat healthy meals, developing more positive self-regulation for healthful meal behavior, addressing restrained eating patterns, and lowering levels of emotional eating. There are also stress management and mental health factors (include overall satisfaction with life) that appear appropriate areas on which to focus weight management interventions for both sexes. However, the primary focus of this study being on diet and physical activity could lead to the possible limitation of omitting the influence of other potential factors not measured.

In evaluating the results of this study, the limitation of using a cross-sectional study design should be noted, meaning the associations identified cannot identify causal relationships. Cross-sectional studies also do not allow for an understanding of how behaviors may change over time. Differences in assessment tools used between different cross-sectional studies limits the ability of researchers to make comparisons across studies. Although a strength of this 13-campus collaboration was that participating institutions tended to be large, land-grant universities, this study was a convenience sample and was not necessarily representative of a larger college population. However, the prevalence of overweight/obesity in this college sample was comparable to the 2015 American College Health Association's National College Health Assessment (32% and 35%, respectively).[62] Future research that incorporates a greater diversity of institutions would allow for stronger generalizability to larger college populations.

Overall this research revealed a number of factors that may be appropriate to consider when developing interventions for the prevention of undesirable or excessive weight gain in young adult populations. A focus on dietary and physical activity factors, as well as emotional eating and stress management as a part of an obesity prevention intervention would be especially appropriate for most, but not all, college students. Screening for differing health behaviors and tailoring of subsequent interventions are needed. Female college students in the "At-risk" cluster may benefit from a focus on emotional eating, stress management, and health behavior choices; female students in the "Healthful Behavior" cluster likely would benefit from interventions focusing on maintaining and supporting their healthy lifestyles. Male college students may require additional screening to identify if they are in a "Healthful Behaviors" group or a "Laid Back" group, as different messages may be more effective for each group. Importantly, when developing interventions for males in the "At-risk" cluster, issues of stress and emotional eating need to be addressed. The results of this research may be useful in developing tailored weight management interventions with young adult populations.

Human Subjects Approval Statement

All study procedures were approved by the Institutional Review Boards at all participating universities.

Conflict of Interest Disclosure Statement

All authors of this article declare they have no conflicts of interest.

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