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Eating Behaviors, Mental Health, and Food Intake are Associated with Obesity in Older Congregate Meal Participants

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Abstract

The relationship between eating behaviors, food intake, and mental health and the occurrence of obesity in older adults has rarely been investigated. Therefore, the objective of this study was to establish the associative links of these factors with two measures of obesity: class I obesity as indicated by body mass index (OB-BMI; BMI ≥ 30kg/m^2) and class I obesity as indicated by waist circumference (OB-WC; WC ≥ 43 inches for men and ≥ 42 inches for women). Older adults participating in the Older American's Act (OAA) congregate meal program (N = 113, mean age = 74 years, 74% female, 45% African American) were assessed. Eating behaviors (cognitive restraint, uncontrolled eating, and emotional eating), food groups group choices (sweets, salty snacks, and fruits), and mental health indices (depression, anxiety, and stress) were recorded by questionnaire and related to measured occurrence of OB-BMI and OB-WC. In a series of multivariate logistical regression models, we found cognitive restraint to be consistently and robustly associated with both measures of obesity. In the fully adjusted model, cognitive restraint, consumption of sweets, anxiety, and lack of depression were associated with OB-WC. In summary, we found an association of obesity with abnormal eating behaviors, certain food group intakes, and mental health symptoms in this population. These findings may guide the development of future weight management interventions in a congregate meal setting.

INTRODUCTION

The prevalence of obesity is increasing in the older adult population; in 2003, 31.0% of older adults reported a BMI of > 30 kg/m^2 compared to 35.4% in 2012.(1) In recent reviews of the literature, obesity was associated with numerous co-morbidities, which included not only physical health problems such as diabetes, cardiovascular disease, and physical frailty, but also mental health concerns (depression, anxiety, and stress). It is estimated that obese individuals are approximately 55% more likely to develop depression and 25% more likely to develop anxiety.(2–5) Dietary patterns and abnormal eating behaviors are also thought to be associated with obesity in older adults, but the findings, to date, from studies of these associations in this population are inconsistent (6) or limited (7–9).

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The goal of the Older Americans Act Nutrition Programs (OAANP) is to reduce hunger and food insecurity, promote socialization, and support health and wellbeing.(10) In 2011, OAANP served 88.6 million congregate meals to more than 1.7 million seniors in community settings.(11) While the reduction of hunger is an important goal of the OAANP, obesity often paradoxically occurs along with food insecurity in older adults. Older adults participating in the OAANP have a high prevalence of obesity (12), obesity-related health problems (13), mental health conditions (8), poor nutritional status (14, 15), and food insecurity (12, 16).

Although the fact that OAANP targets a low-income and minority population may contribute to the relatively high prevalence of obesity seen in some studies of this group (12), it is also possible that other factors are important, such as inappropriate eating behaviors, including cognitive restraint (CR; conscious restriction of food intake to control body weight), uncontrolled eating (UE; eating more than usual because of a loss of control over intake), and emotional eating (EE; overeating during emotional mood state). For example, among Georgia's congregate meal program participants, obesity was associated with inappropriate eating behaviors, especially CR and EE (9) and with a higher intake of sweets (17). However, the associations of obesity with eating fruits and salty snacks, UE, depression, anxiety, and stress were attenuated when controlled for potential confounders. Moreover, the findings differed depending upon how obesity was characterized (body mass index versus waist circumference). Therefore, the purpose of this study was to build on these previous efforts to identify the independent associations of eating behaviors, food patterns, and mental health symptoms with two measures of obesity in fully adjusted multiple regression models. The results of this study will be useful in developing healthy weight management programs that promote better eating behaviors and mental health among congregate meal participants.

METHODS

Sample

In this cross-sectional study, individuals 60 years of age and older were recruited from four Area Agency on Aging (AAA) senior centers in northeast Georgia that provided congregate meals and other services to older adults. The Institutional Review Boards on Human Subjects of the University of Georgia, the Georgia Department of Human Services, and the Athens Community Council on Aging approved questionnaires and procedures. Written, informed consent was obtained from participants. Procedures were explained and consent forms were read to participants. Excluded individuals comprised homebound participants or those unable to understand the informed consent and/or answer questions as determined by the interviewer. These recruitment procedures yielded 124 participants. Due to missing data (n = 11) this report focuses on the 113 participants who had responses for obesity (BMI and WC), eating behaviors (CR, UE, and EE), food group intakes (sweet, salty, fruit, vegetables, whole grains, and milk), mental health (depression, anxiety, and stress), physical activity, physical function, food insecurity, health (self-reported health, diabetes, heart disease, high blood pressure, and arthritis), and demographics (age, race, education, and gender). One hundred and six individuals who received one or more meals at the senior center declined to

participate. Non-participants (n = 106) differed significantly from study participants (n = 113) in mean age (77 vs. 74 years, $p = 0.05$) and race (30% vs. 45% black, $p = 0.05$), but there was no significant difference in gender (67% and 75% female, $p = 0.23$).

Assessments

Body weight is less reflective of body composition in older compared to younger adults due to an age-related decline in lean muscle mass and increase in central adiposity. To improve precision, we assessed obesity by two measures; one based on body weight (BMI) and one more indicative of visceral adiposity (waist circumference). Body weight was measured to the nearest 0.1 pound using a portable digital scale (model HD-317; Tanita Inc., Tokyo, Japan), with clothes on and without shoes, while height was measured with a stadiometer (model IP0955; Invicta Plastics Limited, Leicester, England) according to standard guidelines, in either bare feet or wearing light socks.(8) BMI, defined as [(weight (pounds)/ height (inches)^2)×703] was then calculated and BMI categories were derived using the NIH clinical guidelines.(18) BMI was dichotomized into two categories, obese (OB-BMI) defined as a BMI ≥ 30 kg/m^2 and non-obese BMI < 30 kg/m^2. WC was measured with a tape measure to the nearest 0.1 inches by following NIH guidelines.(18) The WC threshold values used were validated BMI-specific cut-off measurements (19) and reflected BMI class I obesity (> 30 kg/m^2). WC measurements ≥ 43 inches for men and ≥ 42 inches for women were categorized as obese (OB-WC) and measurements < 43 inches for men and < 42 inches for women as non-obese.

Eating behaviors, CR, UE, and EE were all assessed by one questionnaire: The Three Factor Eating Questionnaire R-18. This includes 18 questions (response categories: 1 = never; 2 = rarely; 3 = sometimes; 4 = always).(20) As previously reported (9), it was found that participants understood these one-word response categories better than the original categories (definitely false, mostly false, mostly true, and definitely true). All questions were changed from “I” to “you” because questionnaire was read to the participants. Item 1 was reworded from this original question, “When I smell a sizzling steak or juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal” and replaced with, “When you see any of your favorite foods, do you find it very difficult to keep from eating, even if you have just finished a meal?” These changes were incorporated to improve measurement of the difficulty of controlling dietary patterns when an external stimulus was present; de Lauzon et al, made similar changes and tested the reliability of the questionnaire in the general population.(7) The three eating behaviors’ summary scores were created by summing the responses to the questions that corresponded to CR (six questions), UE (nine questions), and EE (three questions). Each eating behavior was recoded as either low (= 0) or high (= 1), according to the median split.

The intake of sweets and salty snacks (adapted from the Block food frequency questionnaire), fruits and vegetables (21), whole grains (22) and milk (23) were assessed as follows: “How many times a day do you eat something sweet, such as candy, cookies, cakes, pie, donuts, ice cream?” (range = 0 to 7), “How many times a day do you eat a salty snack, such as chips, French Fries, pretzels?” (range = 0 to 7), “How many servings of fruits and 100% fruit juices do you usually have each day?” (range = 0 to 7), “How many servings of

vegetables do you usually eat each day?" (range = 0 to 7), "How often do you eat whole wheat or whole grain bread, such as 100% whole wheat bread?" (range = 0 times per week to 3 times per day), "How often do you eat whole grain cereals, such as oatmeal, Cheerios®, bran flakes or bran cereals?" (range = 0 times per week to 3 times per day), "How often do you drink milk as a beverage including soy milk?" (range = 0 times per week to 3 times per day), and "How often do you eat milk on cereal including soy milk?" (range = 0 times per week to 3 times per day). Summary scores were created for total whole grain and milk intake by summing food categories and then dividing them by 7 to determine frequency of intake per day. Food group variables were dichotomized based on the distribution of the responses for each variable and/or nutritionally meaningful category into two groups, either the lowest two tertiles or the highest tertile.

Mental health was assessed with the Depression Anxiety Stress Scale-21; this instrument includes seven questions per variable to assess depression, anxiety, and stress in the past week (0 = did not apply to me at all; 1 = applied to me to some degree or some of the time; 2 = applied to me to a considerable degree or a good part of time; 3 = applied to me very much or most of the time).(24) A summary score was created for each indices and categorized into severity.(24) For the purposes of this study, participants' findings were assigned to one of two categories (0 = low symptoms; 1 = had symptoms that were mild, moderate, or severe).

Physical activity was assessed using our previously established methods (8), using the Behavior Risk Factor Surveillance Survey (BRFSS) question, "How many days of the last seven days did you participate in at least 30 minutes of moderate physical activity?". Responses were dichotomized (< 5 vs. ≥ 5 days per week). Participants' physical function was assessed using the Short Physical Performance Battery as previously described (8) summary performance scores were defined as poor to moderate (0 to 9) and good (10 to 12).

Food insecurity was measured using the augmented 6-item US Household Food Security Survey Module.(25) One point was scored for affirmative responses to each statement; responses were summed to create a six-item summary score. Possible summary scores ranged from 0 to 6 and for the purpose of this study were categorized as "secure" for summary scores 0 to 1 and "insecure" for summary scores 2 to 6.

Confounding variables included self-reported health and chronic health conditions adapted from BRFSS.(26) Socio-demographic variables included age, gender, and education and are the same categories used in a previous study.(9)

Statistical Analyses

Data was analyzed using the Statistical Analysis System (SAS Institute, Cary, NC). Descriptive statistics including frequencies and means were calculated. Spearman correlation coefficients were used to assess the relationship of the continuous measures of BMI and WC with eating behaviors, food group intakes, and mental health indices (data not shown). BMI, WC, eating behaviors, food groups, mental health and other variables were dichotomized as previously described (9), and relationships with the two measures of obesity (OB-BMI and OB-WC) were assessed with chi-square analyses (Table 1).

A series of multivariate logistical regression models analyses were used to assess the independent associations of the dichotomized variables with obesity (OB-BMI and OB-WC): model 1 included eating behaviors only; model 2 included all model 1 variables plus the mental health variables; model 3 included all model 2 variables plus the food group variables sweets, salty snacks, and fruit; model 4 included all model 3 variables plus physical activity, physical function, food insecurity; model 5 included all model 4 variables plus self-reported health and health conditions (diabetes, high blood pressure, heart disease, arthritis); and model 6 included all model 5 variables plus the demographic variables (age, race, sex, education). Odds ratios are reported for the independent variables of interest, which were eating behaviors (CR, UE, and EE), food group intake (sweets, salty snacks, and fruit), and mental health (depression, anxiety, and stress).

RESULTS

The sample was composed of 113 congregate meal participants, the mean age was 74, 74% were female, and 45% were black. Mean BMI was 31 kg/m^2 and 54% had a BMI ≥ 30. Mean WC for men was 45 inches, and WC for women was 39 inches; 40% were classified as obese using WC cut off measure reflecting BMI class I obesity.(19) Chronic health conditions were prevalent: 39% reported diabetes, 74% high blood pressure, 28% heart disease, and 63% arthritis.

The bivariate association of characteristics of eating behaviors, mental health, and food intake with obesity (OB-BMI and OB-WC) showed that obese participants defined by both measures of obesity were more likely to report CR ($p \leq 0.01 - p \leq 0.001$) and UE ($p \leq 0.05 - p \leq 0.01$) compared to non-obese, but only obese participants defined by OB-BMI were more likely to engage in EE behaviors ($p \leq 0.0001$) (Table 1). Additionally, compared to the non-obese participants, obese participants were more likely to be anxious, whether obesity was defined by OB-BMI ($p \leq 0.10$) or OB-WC ($p \leq 0.01$). However, no relationship was seen between obesity and depression or stress. Finally, compared to the non-obese participants, obese participants defined by OB-WC were more likely to consume sweets two or more times a day ($p \leq 0.05$) and less likely to consume 3 or more servings of fruit per day ($p \leq 0.07$).

Six multivariate logistical regression models were used to assess the independent associations of the eating behaviors, food group servings, and mental health with both measures of obesity, when controlled for potential confounders. The models for each obesity variable are shown in Tables 2 and 3. For both measures of obesity, CR was robustly associated with an increased risk of adiposity (Tables 2 and 3), while reporting symptoms of anxiety was associated with increased risk of obesity defined by OB-WCB (Table 3) by at least 4-fold in the final fully adjusted model (model 6).

Similar to our previous findings (8), in the final model (model 6) of Table 2, when controlling for all confounding variables, reporting CR increased the risk of obesity by 4-fold ($p \leq 0.01$), while a 3-fold increase in risk of obesity was seen when reporting EE behavior ($p \leq 0.05$).

In model 5 of Table 3, CR (OR = 4.1, CI 1.3 – 12.7, $p \leq 0.01$), sweets (OR = 6.6, CI 1.9 – 23.2, $p \leq 0.01$), fruit intake (OR = 0.3, CI 0.1 – 0.8, $p \leq 0.05$), and anxiety (OR = 5.3, CI 1.4 – 20.8, $p \leq 0.05$) were consistently and significantly associated with an increased risk of obesity defined by OB-WC. When controlled for demographics in the final model (model 6) the negative relationship with fruit intake was attenuated (OR = 0.6, CI 0.2 – 2.0, $p \leq 0.10$); however, reporting depression remained negatively associated with obesity in this final model (OR = 0.1, CI 0.0 – 0.9, $p \leq 0.05$).

DISCUSSION

This paper expands our previous findings on the associations of obesity with eating behaviors, dietary patterns, and mental health, confirming previous conclusions (9) that CR and EE are robustly associated with OB-BMI (Table 2), even when controlled for confounding factors such as food group intake. The following discussion of our findings will focus primarily on the models exploring the relationship of these factors with OB-WC, because waist circumference has been associated to a greater extent than BMI with obesity-related co-morbidities (2, 27) including diabetes (28), dyslipidemia (29), coronary heart disease (30), inflammation (31), and mortality in older adults (32).

As seen in the fully adjusted model of Table 3, CR was associated with obesity, which confirms and extends our previous observation in this sample.(9) Similar to other findings (33), we discovered that obesity assessed by BMI, but not WC, was associated with EE. The positive association of EE with BMI and not WC may be due to our small sample size. Further longitudinal research is needed to identify the relationship between eating behaviors and various measures of adiposity in older adults.

In the fully adjusted model, similar to the prior findings in this sample, frequency of eating sweets (17) remained positively associated with OB-WC, and in most models fruit consumption was negatively associated with obesity (Table 3). The association of sweet intake with abdominal adiposity is likely due to the frequency of consumption, high-energy content, and possibly increased consumption of fructose.(34, 35) The availability of sweets (e.g. cinnamon rolls, candy bars, soft drinks) rather than healthy snacks (fresh fruit, 100% fruit juice, low-fat granola bars) may increase the frequency of sweets consumption in this sample as previously discussed.(17)

Anxiety was robustly associated with OB-WC even in the fully adjusted model (Table 3). However, as we considered this association, we suspected that several questions in the anxiety subscale might be symptoms of obesity-related health problems rather than of anxiety. We felt this was the case for two questions found to be significantly associated with OB-WC. There was a relatively high affirmative response among obese participants for the questions, “Were you aware of the action of your heart (e.g., sense of heart rate increase, heart missing a beat) in the absence of physical exertion?” and “Did you experience difficulty breathing (e.g. excessively rapid breathing, breathlessness) in the absence of physical exertion?” Our observation is similar to others in that obesity is known to be linked to increased heart rate and difficulty breathing.(36) These changes such as elevated heart rate may however be due to changes in fundamental physiological mechanisms causing

increased sympathetic activity (37) and sympathovagal balance (38) with resultant hypertension, insulin resistance, hyperlipidemia, and renal dysfunction (39, 40). This has particular relevance for obese older adults because an elevated heart rate is an independent predictor for mortality (41), and Carnethon et al (42) found that a higher heart rate at baseline was associated with diabetes and mortality. Difficulty breathing is one of many common respiratory symptoms in obese individuals and it is postulated that the causes are due to reduced functional residual capacity of the lungs reduction in lung volume due to abdominal distribution of fat, decreased lung compliance (e.g. closure of airways, increased alveolar surface area, increased blood volume), increased oxygen cost due to increased breathing frequency, and disproportional distribution of VO_2 caused by increased adiposity. (43) Therefore, even though breathing difficulties and increased heart rate are symptoms of anxiety, the lack of association of obesity with psychological symptoms found in the other anxiety subscale questions suggest that the anxiety subscale is identifying serious symptoms of obesity and obesity related disorders instead of symptoms of anxiety. Further research is needed to disentangle the physical and psychological associations between obesity and anxiety in this population.

Depression was associated with only one measure of obesity, OB-WC, and only in the fully adjusted model, but as can be seen in Table 3 this was a negative relationship such that those with symptoms of depression were less likely to be obese. The association of obesity and depression is complex and this negative association has also been observed by others.(44, 45) Our cross-sectional study design does not permit us to fully examine the potentially multi-directional relationships of depression and obesity in this population.

The findings that the odds of being obese were increased with anxiety, decreased with depression, and were not associated with stress suggest a complex relationship between mental health and obesity in this sample. Also of concern is that two of the anxiety-related questions may be capturing the physical symptoms of obesity and not anxiety *per se*. Thus it may be important to continue to explore the relationship of obesity with both eating behaviors and mental health and to refine the measures of mental health, especially anxiety. More in-depth research and collaborations with psychologists are needed to further explain the relationship between anxiety and obesity in this group.

Practical implications

Additional research and interventions are needed to address the potential problem of high intake of sweets as a causal contributor to obesity and creating a healthy food environment for these congregate meal participants.(17) By including in the dialog the seniors being served, senior center directors, AAA directors, vendor and congregate meal dietitians, and nutritionists in the State Unit on Aging, progress could be made toward goals such as exchanging unhealthy foods for healthy snacks in the senior center, exploring new ways to create healthy and palatable congregate meals that seniors enjoy and eat, and establishing guidelines that regulate unhealthy outside food being taken into the senior centers. Current education programs focus mainly on the health benefits of fruits, vegetables, whole grains, and low fat meats and milk products. In the future, nutrition education programs could provide more information on the potential health risks of high intakes of processed foods

that contain large amounts of energy, sugar (high fructose corn syrup, sucrose, and related ingredients), saturated fat, and trans fats, as well as how to decrease the intakes of energy and foods with these ingredients. Previous nutrition education interventions (8, 21, 46, 47) have successfully increased the intake of fruit and vegetables, increased physical activity and physical function, and improved hemoglobin A1C, therefore, well-designed education programs focused on foods and healthy weight management are likely to meet with success.

Abnormal eating behaviors (e.g., CR, UE, and EE) need to be addressed in this aging cohort. In younger populations, some successful weight loss programs have specifically targeted these three inappropriate eating behaviors. For example, Keranen et al (48) utilized intensive counseling in individual and group settings to identify eating behaviors, recognize the situations in which they emerge, learn about the consequences of participating in these behaviors, and monitor their improvements in their food choices. However, there is little research specifically addressing how to target these eating behaviors in weight loss programs for older adults.

This study is not without limitations. Eating behaviors and mental health were self-reported in questionnaires and not clinically diagnosed. Food group intake was assessed subjectively, but the questions were adapted from the validated Block food frequency questionnaire (49) and BRFSS (50). This study was cross-sectional and therefore doesn't lend itself to a causal inference of obesity with eating behaviors, food intake, or mental health symptoms; however, the robust associations of obesity with CR and intake of sweets warrants further investigation.

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TAKE AWAY POINTS

- Obesity is, and will continue to be, a major health issue facing the aging population. Through the identification of modifiable behaviors, changes can be made to reduce the detrimental impact of obesity on health care costs, chronic health conditions, disability and mortality.(51–54)
- This study presents information regarding the association of obesity with abnormal eating behaviors, food intake, and mental health symptoms that may be useful for the development of future weight management strategies in a congregate meal setting.
- Strategies to consider include (1) creating a healthy food environment focused on reducing the availability of unhealthy food choices and replacing them with healthier, nutrient dense options; (2) developing an educational program that explains the impact foods, ingredients, and excess energy have on the aging body; and (3) collaboration with dietitians for one-on-one and group counseling.
- We have reported previously that congregate meal participants can improve many aspects of their nutrition, physical activity and chronic disease self-management.(15) Thus, the results of this study can be used as part of the process to develop multidisciplinary interventions that target eating behaviors, food intake, and mental health to improve healthy weight management.

TABLE 1

Bivariate Associations of Eating Behaviors, Mental Health, and Food Group Intake with Obesity in Congregate Meal Participants

		BMI Class I Obesity		WC Class I Obesity	
		< 30kg/m^2 n = 52	≥ 30kg/m^2 n = 61	Low risk n = 68	High risk n = 45
	n	%	%	%	%
Age (years)					
< 70	37	30	70//	49	51‡
≥ 70	76	54	46	66	34
Gender					
Male	29	45	55	38	62//
Female	84	46	54	68	32
Race/ethnicity					
White	62	47	53	60	40
Black	51	45	55	61	39
Education					
< 8 years	19	74	26//	74	26
≥ 8 years	94	40	60	57	43
Cognitive restraint					
< 14 (median split)	51	63	30¶	56	29//
≥ 14 (median split)	62	37	70	44	71
Uncontrolled eating					
< 16 (median split)	53	58	38§	56	33§
≥ 16 (median split)	60	42	62	44	67
Emotional eating					
< 6 (median split)	48	60	28¶	49	33
≥ 6 (median split)	65	40	72	51	67
Depression					
No symptoms (0)	91	83	79	81	80
Mild to extreme (1 to 5)	22	17	21	19	20
Anxiety					

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		BMI Class I Obesity		WC Class I Obesity	
		< 30kg/m^2 n = 52	≥ 30kg/m^2 n = 61	Low risk n = 68	High risk n = 45
	n	%	%	%	%
No symptoms (0)	89	87	72‡	88	64//
Mild to extreme (1 to 5)	24	13	28	12	36
Stress					
No symptoms (0)	106	94	93	96	91
Mild to extreme (1 to 5)	7	6	7	4	9
Sweets					
< 2 times/day	84	75	74	86	62§
≥ 2 times/day	29	25	26	18	38
Salty snacks					
< 1 times/day	72	65	62	68	58
≥ 1 times/day	41	35	38	32	42
Fruit					
< 3 servings/day	77	69	67	62	78‡
≥ 3 servings /day	36	31	33	38	22
Vegetables					
< 4 servings /day	82	81	66‡	74	71
≥ 4 servings /day	31	19	34	26	29
Whole grains					
< 2 times/day	65	56	57	57	58
≥ 2 times /day	48	44	43	43	42
Milk					
< 2 times /day	73	63	56	65	64
≥ 2 times /day	40	37	44	35	36
Food insecurity					
Secure (0 to 1)	81	73	70	75	67
Insecure (2 to 6)	32	27	30	25	33
Moderate physical activity					
< 5 days/week	68	50	69§	57	64

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		BMI Class I Obesity		WC Class I Obesity	
		< 30kg/m^2 n = 52	≥ 30kg/m^2 n = 61	Low risk n = 68	High risk n = 45
	n	%	%	%	%
≥ 5 days/week	45	50	31	43	36
Physical function					
Poor to moderate (0–9)	67	62	57	57	62
Good (10–12)	46	38	43	43	38
Self-reported health					
Poor to fair (0–1)	41	29	43	29	47‡
Good to excellent (2–5)	72	71	57	71	53
Diabetes					
No	69	71	52§	72	44//
Yes	44	29	48	28	56
Heart disease					
No	81	77	67	76	64
Yes	32	23	33	24	36
High blood pressure					
No	29	35	18§	28	22
Yes	84	65	82	72	78
Arthritis					
No	42	42	33	40	33
Yes	71	58	67	60	67

For demographic variables (age, gender, sex, education) the rows within an obesity category add up to 100; for all other variables the columns within a variable add up to 100.

Health conditions: diabetes; heart disease; high blood pressure; and arthritis were self-reported.

Significance level:

‡trend at $p \leq 0.10$;

§significant at $p \leq 0.05$;

//significant at $p \leq 0.01$;

¶significant at $p \leq 0.001$.

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TABLE 2

Associations of BMI Class I Obesity with Eating Behaviors, Dietary Intake, and Mental Health: Multivariate Regression Models

	Variables	C statistic	Cognitive Restraint OR (95% CI)	Uncontrolled Eating OR (95% CI)	Emotional Eating OR (95% CI)	Sweets OR (95% CI)	Salty Snacks OR (95% CI)	Fruits OR (95% CI)	Depression OR (95% CI)	Anxiety OR (95% CI)	Stress OR (95% CI)
Model 1	Eating behaviors	0.73	3.3 (1.4, 7.5)§	1.3 (0.5, 3.1)	2.8 (1.2, 6.7)‡						
Model 2	+ Sweets, salty snacks, and fruit	0.74	3.3 (1.4, 7.6)§	1.3 (0.6, 3.2)	2.9 (1.2, 7.3)‡	0.8 (0.3, 2.0)	1.0 (0.4, 2.4)	0.9 (0.4, 2.2)			
Model 3	+ Depression, anxiety, stress	0.76	3.3 (1.4, 7.7)§	1.4 (0.5, 3.5)	3.0 (1.2, 7.8)‡	0.7 (0.3, 2.0)	0.9 (0.3, 2.3)	0.8 (0.3, 2.0)	0.8 (0.2, 3.0)	2.4 (0.8, 7.7)	0.5 (0.1, 3.9)
Model 4	+ Food insecurity, moderate physical activity, and physical function	0.78	4.1 (1.6, 10.3)§	1.3 (0.5, 3.5)	3.0 (1.1, 7.9)‡	0.6 (0.2, 1.6)	0.9 (0.4, 2.4)	0.9 (0.3, 2.3)	0.6 (0.2, 2.4)	2.6 (0.8, 8.4)	0.8 (0.1, 6.0)
Model 5	+ Self reported health, diabetes, hypertension, heart disease, and diabetes	0.78	4.0 (1.5, 10.4)§	1.2 (0.4, 3.5)	2.8 (1.0, 7.8)‡	0.6 (0.2, 1.9)	0.9 (0.3, 2.6)	1.0 (0.4, 2.6)	0.6 (0.1, 2.3)	2.3 (0.6, 8.0)	0.8 (0.1, 6.6)
Model 6	+ Demographics	0.84	4.8 (1.7, 13.7)§	0.9 (0.3, 2.8)	3.1 (1.0, 9.9)‡	0.7 (0.2, 2.3)	1.0 (0.3, 3.0)	1.1 (0.3, 3.2)	0.4 (0.1, 1.9)	2.2 (0.6, 8.8)	1.2 (0.1, 11.3)

*Dependent variable is non-obese (BMI < 30 kg/m^2, n = 52) vs. obese (BMI ≥ 30 kg/m^2, n = 61).

†Each eating behavior coded as the median split; sweets, salty snacks, and fruit as the upper tertile vs. lower two tertiles; depression, anxiety, and stress coded as normal versus mild, moderate or severe. As indicated, models controlled for these potential cofounders: food insecurity, physical activity, physical function, self-reported health, health conditions, and demographics.

Significance level:

‡significant at $p \leq 0.05$;

§significant at $p \leq 0.01$;

//significant at $p \leq 0.001$;

¶significant at $p \leq 0.0001$.

TABLE 3

Associations of WC Class I Obesity with Eating Behaviors, Dietary Intake, and Mental Health: Multivariate Regression Models

	Variables	C statistic	Cognitive Restraint OR (95% CI)	Uncontrolled Eating OR (95% CI)	Emotional Eating OR (95% CI)	Sweets OR (95% CI)	Salty Snacks OR (95% CI)	Fruits OR (95% CI)	Depression OR (95% CI)	Anxiety OR (95% CI)	Stress OR (95% CI)
Model 1	Eating behaviors	0.70	2.7 (0.7, 4.8)‡	2.0 (0.9, 4.8)	1.2 (0.5, 2.8)						
Model 2	+ Sweets, salty snacks, and fruit	0.77	3.3 (1.3, 8.2)§	2.1 (0.8, 5.4)	0.9 (0.4, 2.5)	3.1 (1.2, 8.1)‡	1.6 (0.6, 4.0)	0.3 (0.1, 0.8)‡			
Model 3	+ Depression, anxiety, stress	0.81	3.1 (1.2, 8.1)‡	2.2 (0.8, 5.9)	1.0 (0.3, 2.7)	3.0 (1.1, 8.2)‡	1.5 (0.6, 4.0)	0.2 (0.1, 0.7)§	0.4 (0.1, 2.2)	6.1 (1.8, 20.2)§	1.2 (0.3, 5.7)
Model 4	+ Food insecurity, moderate physical activity, and physical function	0.81	3.1 (1.1, 8.1)‡	2.2 (0.8, 6.0)	1.0 (0.3, 2.8)	3.1 (1.1, 8.7)‡	1.5 (0.6, 4.0)	0.2 (0.7, 0.6)§	0.5 (0.1, 2.3)	6.0 (1.8, 20.0)§	1.1 (0.2, 5.6)
Model 5	+ Self reported health, diabetes, hypertension, heart disease, and diabetes	0.84	4.1 (1.3, 12.7)§	1.2 (0.4, 3.9)	1.1 (0.3, 3.9)	6.6 (1.9, 23.2)§	1.2 (0.4, 3.5)	0.3 (0.1, 0.8)‡	0.2 (0.0, 1.6)	5.3 (1.4, 20.8)‡	2.0 (0.3, 14.1)
Model 6	+ Demographics	0.89	4.3 (1.2, 15.2)‡	1.1 (0.3, 4.3)	1.9 (0.5, 8.1)	16.8 (3.2, 87.3)//	1.1 (0.3, 3.9)	0.6 (0.2, 2.0)	0.1 (0.0, 0.9)‡	8.9 (1.9, 42.7)§	2.9 (0.3, 27.7)

*Dependent variable is non-obese (WC Class I Obesity, < 43 inches for men, < 42 inches for women, n = 68) vs. obese (WC ≥ 43 inches for men, ≥ 42 inches for women, n = 45).

†Each eating behavior coded as the median split; sweets, salty snacks, and fruit as the upper tertile vs. lower two tertiles; depression, anxiety, and stress coded as normal versus mild, moderate or severe. As indicated, models controlled for these potential cofounders: food insecurity, physical activity, physical function, self-reported health, health conditions, and demographics.

Significance level:

‡significant at $p \leq 0.05$;

§significant at $p \leq 0.01$;

//significant at $p \leq 0.001$;

¶significant at $p \leq 0.0001$.