

1 Article

2 Association between Cognitive Restraint, 3 Uncontrolled Eating, Emotional Eating and BMI and 4 the Amount of Food Wasted in Early Adolescent 5 Girls

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13 **Abstract:** Understanding behavioral factors associated with obesity is of importance in addressing
14 this issue. This study examined the association between cognitive restraint, uncontrolled eating,
15 emotional eating and body mass index (BMI) and amount of food plated, consumed, leftovers, and
16 leftover food thrown into the trash (food wasted) in early adolescent girls nine to 13 years in O'ahu,
17 Hawai'i (n = 93). Food plated, consumed, leftovers, and food wasted were estimated using a three-
18 day mobile food record (mFR). Weight and height were measured to compute BMI (kg/m²). The
19 three-factor eating questionnaire provided a score from 0 to 100 for cognitive restraint, uncontrolled
20 eating, and emotional eating. Higher scores are indicative of greater cognitive restraint, uncontrolled
21 eating, and emotional eating. Pearson's correlation and general linear models were computed to
22 examine the relationship between three factor eating scores, BMI, and food plated, consumed,
23 leftovers, and food wasted. There was no clinically significant association between cognitive restraint
24 and amount of food wasted. Cognitive restraint was positively correlated with BMI (r=0.36, p<0.001)
25 and with BMI z score (r=0.40, p<0.001). Uncontrolled eating and emotional eating were positively
26 correlated with amount of leftover food at dinner (r=0.30, p=0.006; r=0.33, p=0.003, respectively).
27 Emotional eating was positively associated with percentage of leftover food at dinner (r=0.24, p=0.30).
28 Additional research should examine the specific roles of cognitive restraint, uncontrolled eating,
29 emotional eating and food waste in the development of obesity in adolescents.

30 **Keywords:** Early adolescents; mobile food record; food waste; plate waste; eating behavior; portion
31 size; dietary assessment; uncontrolled eating; cognitive restraint; emotional eating
32

33 1. Introduction

34 Rates of childhood obesity in the US are high. The National Health and Nutrition Examination
35 Survey 2011-2014 reported 17.0% of youths aged 2–19 years were considered obese [1]. In 2015, 13%
36 of high school students in Hawaii were obese [2]. This represents an increase over the past few
37 decades among students in Hawaii compared to 10% in 1999 [2]. Numerous factors at the individual,
38 interpersonal, environmental and macrosystem levels contribute to obesity. In determining courses

39 of action to reduce the rates of child obesity, understanding behavioral issues associated with obesity
40 would provide important insight.

41 One of the tools used to examine behaviors related to development of obesity is the Three-
42 Factor Eating Questionnaire (TFEQ) [3]. The TFEQ provides a score for cognitive restraint
43 (conscious restriction of food in order to control or lose weight), uncontrolled eating (tendency to
44 eat more than usual due to a loss of control over intake accompanied by subjective feelings of
45 hunger), and emotional eating (inability to resist emotional cues) [3]. While a number of studies
46 have examined these behaviors in adults and their relationship with weight, few have applied the
47 TFEQ to adolescents. Studies conducted with adolescent groups have generally yielded similar
48 results, such as a positive relationship between cognitive restraint and body weight. A study of
49 Turkish adolescents, for example, found body mass index (BMI) was significantly and positively
50 correlated to cognitive restraint and emotional eating [4]. Another study of adolescents in Canada
51 found rigid control (a severe restrictive state), disinhibition (high susceptibility to overeat) and
52 emotional susceptibility to overeat were positively related to BMI z-scores for the entire sample [5].
53 In a study of French adolescents, those who were obese used cognitive restraint more than the
54 normal-weight adolescents as a strategy for regulating dietary intakes [6]. Similarly, a study of
55 Spanish adolescents found those who were normal weight showed a significantly lower cognitive
56 restraint and higher uncontrolled eating than those who were not normal weight [7].

57 Of additional interest is the relationship between cognitive restraint, uncontrolled eating,
58 emotional eating and amount of food wasted in early adolescents. Food wasted has a significant
59 negative impact on the natural environment [8] and high financial costs [9]. Further, food wasted
60 may contribute to obesity if adolescents discard foods served as part of programs such as the
61 National School Lunch Program and replace those with foods higher in total energy [10]. Gaining a
62 better understanding of behaviors associated with wasting food will allow for development of
63 strategies to mitigate food waste and may contribute to obesity prevention efforts.

64 The relationship between behaviors assessed using the TFEQ and BMI and amount of food
65 wasted has not been examined in adolescents in Hawai'i, a group warranting examination given
66 current obesity rates and suboptimal dietary habits. The purpose of this secondary data analysis
67 was to examine the association between cognitive restraint, uncontrolled eating, emotional eating
68 and body mass index (BMI) and energy (kcal) of food plated, consumed, left over, and wasted in
69 early adolescent girls in Hawai'i.

70 2. Materials and Methods

71 2.1. Materials Study Design

72 This cross-sectional study was conducted in O'ahu, Hawai'i. Data were collected between
73 February and September 2015. The study was approved by the Institutional Review Board at the
74 University of Hawai'i at Manoa. Detailed methods have been published elsewhere [11] and are
75 described briefly below.

76

77 2.2. Participants

78 Girls nine to 13 years of age (n=93) residing in O'ahu, Hawai'i and their caregivers were recruited
79 through posting flyers and giving presentations at various sites, as well as through snowballing
80 techniques. Child assent and caregiver consent forms were completed prior to the start of data
81 collection.

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85 2.3. Study Protocol

86 Participants attended two contact sessions. In the first session, participants received instruction
87 for using the mFR to collect before and after images of all eating occasions over three days and parents
88 completed a demographic data form. The second session focused on reviewing the images, clarifying
89 content of the images and obtaining anthropometric measures from girls. Each participant received
90 \$50 in gift cards to a state-wide supermarket chain as an incentive.

91 2.4. Assessment of Food Waste

92 Each participant was provided with an Apple iPod preloaded with the mFR app and two small
93 square fiducial markers [12]. Participants were instructed to take a before image and an after image
94 of everything they ate or drank excluding water using the mFR app over three consecutive days,
95 including one weekend day.

96 The second session (one week later) involved a review of images collected. The images, as well
97 as a standard interview script to clarify content; the use of model cups, plates, bowls and measuring
98 cups as needed; and the reference marker in the images were used to estimate the quantity, brand,
99 type and ingredients of food plated and any food left over [12,13]. Leftover food was recorded as the
100 total amount of edible food that was plated and left uneaten. The mFR does not capture how leftovers
101 are disposed; therefore, during this session participants clarified if any leftover food were thrown
102 into the trash. Food thrown into the trash will be referred to as food wasted.

103 2.5. Anthropometry

104 Height and weight were collected during the second session using a calibrated scale and
105 stadiometer using a standard protocol [14]. BMI was calculated using height and weight and BMI z-
106 score was calculated according to the Centers for Disease Control and Prevention BMI z-score
107 guidelines for girls 5-19 years [15]. A BMI z-score of -3 or less represented severe thinness, -3 to -2
108 thinness, -2 to 1 healthy weight, 1 to 2 overweight, and greater than 2 obese [15].

109 2.6. Three-Factor Eating Questionnaire: Cognitive Restraint, Uncontrolled Eating, and Emotional Eating

110 The Three-Factor Eating Questionnaire-Revised 18 Items (TFEQ-R18) consists of 18 items on a 4-
111 point Likert scale (1=definitely true, 2=mostly true, 3=mostly false, 4=definitely false). Responses to
112 each of the 18 items are summated into scale scores for cognitive restraint, uncontrolled eating, and
113 emotional eating (see Table 1 for details). Cognitive restraint is composed of six items (e.g., I
114 deliberately take small helpings as a means of controlling my weight) to assess conscious restriction
115 of food intake in order to control body weight or to promote weight loss. Uncontrolled eating is
116 composed of 9 items (e.g., Sometimes when I start eating, I just can't seem to stop) and assesses the
117 tendency to eat more than usual due to a loss of control over intake accompanied by subjective
118 feelings of hunger. Emotional eating is composed of 3 items (e.g. When I feel anxious, I find myself
119 eating) assessing the inability to resist emotional cues. Higher scores in the respective scales are
120 indicative of greater cognitive restraint, uncontrolled, or emotional eating. The raw scale scores are
121 standardized to a 0-100 scale using the following formula.

122

- 123 • Standardized score = [(raw score-lowest possible raw score)/possible raw score range] × 100

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126 The reliability of each scale was computed using Cronbach's alphas. The overall reliability was
127 acceptable (Cronbach's alpha=0.82). The Cronbach's alphas for cognitive restraint, uncontrolled
128 eating, and emotional eating were 0.67, 0.83, and 0.75, respectively.

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134 2.7. Amount and Percentage of Food Plated, Consumed, Leftover and Wasted

135 Analyses were limited to those participants with at least two days of recording. RapidCalc, a data
136 entry program developed by the University of Hawai'i Cancer Center, was used for energy
137 analyses [16,17]. Three separate RapidCalc databases were created for total food plated, food left
138 over and food wasted. These three RapidCalc databases were then replicated and edited to provide
139 data by time of day. Time of day was broken down into four periods: 6-9am, 11-2pm, 5-8pm and all
140 other times. These time blocks represented breakfast, lunch, dinner and snacks, respectively [18].
141 RapidCalc automatically calculated total energy (kcal) per day for each dataset.

142 Data on total energy (in kcal) from food plated, left over and food wasted at lunch time were
143 exported for further analysis. Food consumed was assumed to be food plated – food leftover.
144 Percentage of energy from food leftover and wasted were calculated as follows:

- 145
- 146 • Percentage energy left over = (total energy left over/total energy plated) × 100
- 147 • Percentage energy wasted = (total energy wasted/total energy plated) × 100
- 148

149 2.7. Statistical Methods

150 Demographic variables were summarized using descriptive statistics such as mean and
151 percentage. Pearson's correlation coefficients were calculated to measure the association between
152 cognitive restraint, uncontrolled eating, emotional eating and BMI and the amount of food plated,
153 consumed, leftover, and wasted. We also computed partial correlation adjusting for age. To evaluate
154 the effect of each eating factor assessed using the questionnaire, we conducted separate general linear
155 models on the amount of food plated, consumed, leftover, and wasted adjusting for BMI z group and
156 age. BMI z group was categorized as obese/overweight (i.e., Z score >1) vs. normal/underweight (i.e.,
157 Z score ≤1). All statistical analyses were conducted in SAS version 9.4 and *p*-value <0.05 was
158 considered statistically significant.

159 3. Results

160 All 93 participants completed the study. Among them, nine participants did not meet the
161 acceptable mFR criteria or did not answer any of items on the TFEQ-R18. Consequently, their data
162 were removed from the final analysis and the final sample size was 84 participants.

163 Table 2 presents descriptive statistics. The mean age was 10.8 years (SD=1.3) and 48 (57%) girls
164 were Asian. Sixty-seven (83%) mothers recorded a total household income of \$60,000 USD or greater
165 and 49 (58%) mothers had at least attended and/or completed graduate school.

166 Table 3 shows descriptive statistics and correlations between cognitive restraint, uncontrolled
167 eating, emotional eating and BMI and energy from food plated, consumed, leftover, and wasted. The
168 means of cognitive restraint, uncontrolled eating, and emotional eating were 34.3 (SD=17.2), 41.5
169 (SD=18.6), and 22.9 (SD=21.4), respectively. There was no correlation between cognitive restraint and
170 energy from food plated, consumed, left over, or wasted. However, there was a significant correlation
171 between cognitive restraint and BMI. Cognitive restraint had a positive correlation with BMI ($r=0.36$
172 [partial $r=0.41$], $p<0.001$) and with BMI z score ($r=0.40$ [partial $r=0.41$], $p<0.001$). Uncontrolled eating
173 and emotional eating were positively correlated with energy from food leftover at dinner ($r=0.30$
174 [partial $r=0.34$], $p=0.006$; $r=0.33$ [partial $r=0.35$], $p=0.003$, respectively). Emotional eating was positively
175 associated with percentage of energy from food leftover at dinner ($r=0.24$ [partial $r=0.24$], $p=0.030$).

176 Table 4 presents results from the general linear models testing the association between energy
177 from food plated, consumed, leftover and wasted with each three factor eating score. After adjusting
178 for age and BMI z score group, energy from snack food discarded into the trash is expected to increase
179 by an average of 0.51 kcal/d ($p=0.021$) for every unit increase in cognitive restraint score. Total energy
180 of the plated breakfast would decrease by an average of -1.63 kcal/d ($p=0.044$) for every one unit
181 increase in cognitive restraint score. However, total energy plated and left over at dinner would
182 increase by an average of 4.24 kcal/d ($p=0.030$) and 1.67 kcal/d ($p=0.002$), respectively, for every one
183 unit increase in uncontrolled eating score. Similarly, the total energy plated and energy left over at

184 dinner would increase by an average of 3.40 kcal/d ($p=0.045$) and 1.51 kcal/d ($p=0.001$), respectively,
 185 with every one unit increase in emotional eating score. In addition, the percentage of energy leftover
 186 at dinner is expected to increase by 0.11% ($p=0.034$) with every one unit increase in emotional eating
 187 score.
 188

189 **Table 1.** Three-Factor Eating Questionnaire-Revised 18 Item

Item	Question	Scale
1	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.	UE
2	I deliberately take small helpings as a means of controlling my weight.	CG
3	When I feel anxious, I find myself eating.	EE
4	Sometimes when I start eating, I just can't seem to stop.	UE
5	Being with someone who is eating often makes me hungry enough to eat also.	UE
6	When I feel blue, I often overeat.	EE
7	When I see a real delicacy, I often get so hungry that I have to eat right away.	UE
8	I get so hungry that my stomach often seems like a bottomless pit.	UE
9	I am always hungry so it is hard for me to stop eating before I finish the food on my plate.	UE
10	When I feel lonely, I console myself by eating.	EE
11	I consciously hold back at meals in order not to weight gain.	CG
12	I do not eat some foods because they make me fat.	CG
13	I am always hungry enough to eat at any time.	UE
14	How often do you feel hungry?	UE
15	How frequently do you avoid "stocking up" on tempting foods?	CG
16	How likely are you to consciously eat less than you want?	CG
17	Do you go on eating binges though you are not hungry?	UE
18	On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?*	CG

190 CG = Cognitive Restraint Scale; UE = Uncontrolled Eating Scale; EE = Emotional Eating Scale.

191 *The 1–2 scores were coded 1; 3–4 scores were coded 2; 5–6 scores were coded 3; 7–8 scores were coded 4.

192

193 **Table 2.** Characteristics of Final Sample (n=84)

Continuous Variable	Mean \pm SD
Age,	10.8 \pm 1.3
BMI Z score	0.1 \pm 1.1
Categorical Variable	n (%)
Age category	
9-10 years	35 (42%)
11-13 years	49 (58%)
Race	
White	27 (32%)
Asian	48 (57%)
Other ^a	9 (11%)
Total household income	
\$0-\$59,999	14 (17%)
\$60,000 or more	67 (83%)
Mother's education level	
Graduated from a four-year college or university or less	35 (42%)

Attended and/or completed graduate school or more	49 (58%)
Body weight status	
>1 (Overweight or Obese)	16 (19%)
≤1 (Normal or Underweight)	68 (81%)

194 ^aOther race includes Native Hawaiian or Other Pacific Islander, American Indian or Alaska Native, Black or
195 African American and Some Other Race [24].

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Table 3. Correlation of cognitive restraint, uncontrolled eating, and emotional eating score with BMI and energy plated, consumed, leftover, and wasted (n=84)

Variable	Mean ± SD	Three Factor Eating Questionnaire, Correlation (Partial Correlation)		
		Cognitive Restraint	Uncontrolled Eating	Emotional Eating
<i>Anthropometry</i>				
BMI	18.9 ± 4.0	0.36*** (0.41***)	0.13 (0.22*)	0.19+ (0.26*)
BMI Z score	0.1 ± 1.1	0.40*** (0.41***)	0.11 (0.14)	0.20+ (0.22*)
<i>Whole Day</i>				
Total Plated (kcal/d)	1599.0 ± 416.1	0.05 (0.05)	0.18 (0.19+)	0.13 (0.13)
Total Consumed (kcal/d)	1418.0 ± 388.5	0.04 (0.04)	0.12 (0.12)	0.08 (0.08)
Leftover Food (kcal/d)	181.4 ± 168.2	0.04 (0.04)	0.17 (0.19+)	0.14 (0.15)
Food wasted (kcal/d)	94.9 ± 114.5	-0.05 (-0.05)	0.12 (0.13)	-0.04 (-0.04)
Food Wasted (%)	94.9 ± 114.5	-0.03 (-0.02)	-0.01 (0.00)	-0.14 (-0.14)
Leftover Food (%)	5.6 ± 6.3	-0.01 (0.00)	0.05 (0.07)	0.07 (0.08)
<i>Breakfast</i>				
Total Plated (kcal/d)	249.2 ± 139.5	0.03 (0.02)	-0.09 (-0.15)	-0.05 (-0.08)
Total Consumed (kcal/d)	220.0 ± 126.5	0.00 (-0.01)	-0.09 (-0.16)	-0.03 (-0.07)
Leftover Food (kcal/d)	29.2 ± 55.3	0.07 (0.07)	-0.03 (-0.03)	-0.06 (-0.06)
Food wasted (kcal/d)	14.1 ± 28.0	-0.06 (-0.06)	0.07 (0.07)	-0.09 (-0.09)
Food Wasted (%)	3.2 ± 6.1	-0.05 (-0.05)	0.13 (0.11)	-0.01 (-0.02)
Leftover Food (%)	5.7 ± 8.8	-0.06 (-0.07)	0.05 (0.02)	-0.04 (-0.06)
<i>Lunch</i>				
Total Plated (kcal/d)	430.1 ± 216.1	-0.01 (0.00)	-0.01 (0.00)	-0.04 (-0.03)
Total Consumed (kcal/d)	374.8 ± 201.2	0.03 (0.03)	-0.04 (-0.02)	-0.03 (-0.02)
Leftover Food (kcal/d)	55.3 ± 66.7	-0.09 (-0.10)	0.08 (0.07)	-0.04 (-0.05)
Food Wasted (kcal/d)	40.2 ± 59.1	-0.17 (-0.17)	0.04 (0.02)	-0.15 (-0.16)
Food Wasted (%)	6.8 ± 9.3	-0.07 (-0.07)	-0.07 (-0.07)	-0.19+ (-0.20+)
Leftover Food (%)	9.5 ± 10.4	0.01 (0.01)	-0.06 (-0.07)	-0.10 (-0.11)
<i>Dinner</i>				

Total Plated (kcal/d)	522.3 ± 317.7	-0.04 (-0.04)	0.18 (0.21+)	0.17 (0.19+)
Total Consumed (kcal/d)	468.6 ± 278.3	-0.08 (-0.07)	0.11 (0.14)	0.09 (0.11)
Leftover Food (kcal/d)	53.7 ± 89.5	0.09 (0.10)	0.30** (0.34**)	0.33** (0.35**)
Food Wasted (kcal/d)	25.4 ± 69.2	-0.02 (-0.02)	0.19+ (0.22*)	0.11 (0.12)
Food Wasted (%)	3.3 ± 6.8	-0.01 (-0.01)	0.08 (0.10)	-0.03 (-0.02)
Leftover Food (%)	7.5 ± 9.8	0.00 (0.01)	0.13 (0.14)	0.24* (0.24*)
Snack				
Total Plated (kcal/d)	398.6 ± 294.0	0.11 (0.12)	0.11 (0.15)	0.05 (0.09)
Total Consumed (kcal/d)	354.3 ± 263.8	0.12 (0.14)	0.13 (0.17)	0.05 (0.09)
Leftover Food (kcal/d)	44.4 ± 73.4	-0.01 (-0.03)	-0.03 (-0.01)	0.02 (0.03)
Food Wasted (kcal/d)	15.2 ± 34.2	0.19+ (0.19+)	-0.11 (-0.09)	-0.03 (0.00)
Food Wasted (%)	2.2 ± 4.8	0.16 (0.16)	-0.15 (-0.14)	-0.03 (0.00)
Leftover Food (%)	6.1 ± 8.8	0.05 (0.03)	0.00 (0.01)	0.04 (0.04)

199 +p<0.10; *p<0.05; **p<0.01; ***p<0.001. Partial correlation was computed adjusting for age.

200 ^aPercentage y left over = (total y left over/total y plated) × 100. ^bPercentage y wasted = (total y wasted/total y
 201 plated) × 100. y represents either total energy (kcal), or protein (g), grain (ounce), vegetables (cup), fruit (cup)
 202 or dairy (cup).
 203

204 **Table 4.** General Linear Model on Amount of Energy Plated, Consumed, Leftover, and Wasted, Adjusted for
 205 Baseline Characteristics

Response	Cognitive Restraint			Uncontrolled Eating			Emotional Eating		
	B	SE	P-value	B	SE	P-value	B	SE	P-value
Whole Day									
Total Plated (kcal/d)	1.40	2.79	0.616	4.61	2.57	0.077	2.87	2.25	0.206
Total Consumed (kcal/d)	1.13	2.61	0.667	2.88	2.43	0.239	1.69	2.12	0.429
Leftover Food (kcal/d)	0.28	1.12	0.806	1.73	1.04	0.101	1.19	0.91	0.194
Food Wasted (kcal/d)	-0.38	0.77	0.623	0.89	0.72	0.219	-0.22	0.63	0.722
Food Wasted (%)	-0.01	0.04	0.750	0.00	0.04	0.917	-0.05	0.03	0.167
Leftover Food (%)	-0.01	0.06	0.911	0.03	0.06	0.574	0.03	0.05	0.527
Breakfast									
Total Plated (kcal/d)	-0.36	0.87	0.679	-1.63	0.80	0.044	-1.00	0.70	0.156
Total Consumed (kcal/d)	-0.36	0.79	0.649	-1.33	0.73	0.074	-0.63	0.64	0.330
Leftover Food (kcal/d)	0.00	0.36	0.994	-0.30	0.33	0.368	-0.37	0.29	0.204
Food Wasted (kcal/d)	-0.23	0.18	0.200	0.00	0.17	0.979	-0.24	0.15	0.107
Food Wasted (%)	-0.03	0.04	0.449	0.03	0.04	0.464	-0.02	0.03	0.630
Leftover Food (%)	-0.07	0.06	0.257	-0.01	0.05	0.787	-0.05	0.05	0.279
Lunch									
Total Plated (kcal/d)	-0.04	1.45	0.979	0.01	1.36	0.996	-0.34	1.18	0.771
Total Consumed (kcal/d)	0.35	1.34	0.793	-0.26	1.26	0.837	-0.17	1.09	0.876
Leftover Food (kcal/d)	-0.39	0.44	0.380	0.27	0.42	0.526	-0.17	0.36	0.634
Food Wasted (kcal/d)	-0.64	0.39	0.105	0.06	0.37	0.877	-0.50	0.32	0.117

Food Wasted (%)	-0.04	0.06	0.538	-0.04	0.06	0.506	-0.09	0.05	0.069
Leftover Food (%)	0.02	0.07	0.778	-0.03	0.07	0.656	-0.05	0.06	0.415
<i>Dinner</i>									
Total Plated (kcal/d)	-0.39	2.10	0.855	4.24	1.92	0.030	3.40	1.67	0.045
Total Consumed (kcal/d)	-0.84	1.84	0.650	2.56	1.71	0.138	1.89	1.49	0.209
Leftover Food (kcal/d)	0.45	0.59	0.443	1.67	0.52	0.002	1.51	0.45	0.001
Food Wasted (kcal/d)	-0.02	0.46	0.964	0.93	0.42	0.031	0.47	0.37	0.212
Food Wasted (%)	0.00	0.05	0.934	0.04	0.04	0.345	-0.01	0.04	0.856
Leftover Food (%)	-0.01	0.07	0.914	0.07	0.06	0.242	0.11	0.05	0.034
<i>Snack</i>									
Total Plated (kcal/d)	2.14	1.96	0.278	1.99	1.84	0.282	0.87	1.60	0.587
Total Consumed (kcal/d)	1.98	1.76	0.264	1.91	1.65	0.251	0.60	1.44	0.676
Leftover Food (kcal/d)	0.16	0.49	0.740	0.09	0.46	0.852	0.27	0.40	0.496
Food Wasted (kcal/d)	0.51	0.22	0.021	-0.09	0.21	0.658	0.05	0.18	0.793
Food Wasted (%)	0.06	0.03	0.057	-0.03	0.03	0.264	0.00	0.03	0.914
Leftover Food (%)	0.04	0.06	0.443	0.02	0.05	0.775	0.03	0.05	0.504

206 B = parameter estimate. SE = Standard error.

207 General linear model was conducted on each row variable as a dependent variable and each column variable as
 208 an independent variable, controlling for age and BMI z score group (categorized as Z score >1 vs. Z score ≤1).
 209 Bold italic indicates that the column factor eating questionnaire is p-value <0.05.

210

211 4. Discussion

212 Among adolescent girls in Hawai'i, there was a positive correlation between cognitive restraint
 213 and BMI, as well as a positive correlation between both uncontrolled eating and emotional eating
 214 and food leftover at dinner. There was also a significant partial correlation between BMI and
 215 emotional eating, and BMI z-score and emotional eating.

216 The positive correlation revealed between restrained eating and BMI aligned with results of
 217 previous studies. In a study of French adolescents, for example, dietary restraint was positively
 218 correlated with overweight [20]. However, there was no significant increase in energy (kcal) intake
 219 with an increase in restrained eating, as was found in previous studies [21,22]. This increase in
 220 energy intake found in previous studies may be explained by the overeating that may result from
 221 dietary restraint, leading to a cycle of weight gain and restriction and unsuccessful restraint that
 222 fosters storing of excess energy. Those who are overweight or obese may also be more likely to be
 223 on a diet and restricting intake for weight loss. In the current study, there may be other factors that
 224 explain the positive correlation between restrained eating and BMI.

225 There was also a significant partial correlation found between uncontrolled eating and
 226 emotional eating and BMI. Previous studies have also revealed a positive relationship between
 227 these factors and weight [5,22]. A study of Dutch adolescents, for example, revealed that
 228 overweight children had higher disinhibition scores [22]. Similarly, a study of Spanish youth
 229 demonstrated that overweight participants scored higher on external eating, which involves a
 230 decreased sensibility to internal signals of hunger and satiety, compared to normal weight children
 231 [23]. Other studies, in contrast, have found a negative relationship, with lower uncontrolled eating
 232 scores in youth with higher BMI [7]. In the current study, uncontrolled eating or emotional eating

233 was also positively correlated with energy leftover at dinner. However, energy wasted at dinner
234 was not correlated with these eating behaviors; therefore, the leftover food at dinner may have been
235 eaten by someone else or stored for later consumption.

236 Except for snacks, cognitive restraint, emotional eating, uncontrolled eating were not
237 associated with food thrown into the trash (energy wasted). For snacks, there was 0.5 kcal of food
238 wasted per 1 unit increase in cognitive restraint score. Thus, from an environmental standpoint, this
239 relationship may not be of importance.

240 The current study has several limitations. Given the sampling technique used, results may not
241 be generalized to adolescents beyond those who participated. In addition, this is a cross-sectional
242 study, and is not enough evidence to establish a cause and effect relationship between eating
243 behaviors and BMI without further research.

244 5. Conclusions

245 Among adolescent girls in Hawai'i, there was a positive correlation between cognitive restraint
246 and BMI, as well as a positive correlation between both uncontrolled eating and emotional eating
247 and food leftover at dinner. Additional research is needed to examine the specific roles of these
248 behaviors in development of obesity in adolescents.

249

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263

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