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Assessment of the dining environment on and near the campuses of fifteen post-secondary institutions

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Abstract

Objective: The present study evaluated the restaurant and dining venues on and near post-secondary campuses varying in institution size.

Design: The Nutrition Environment Measures Survey for Restaurants (NEMS-R) was modified to evaluate restaurants as fast food, sit down and fast casual; and campus dining venues as dining halls, student unions and snack bar/cafés. ANOVA with *post hoc* Tukey's *B* and *T* tests were used to distinguish differences between dining venues and associated institutions by size.

Setting: The study was conducted at fifteen US post-secondary institutions, 2009–2011.

Subjects: Data presented are from a sample of 175 restaurants and sixty-eight on-campus dining venues.

Results: There were minimal differences in dining halls by institution size, although medium-sized institutions as compared with small-sized institutions offered significantly more healthful side dish/salad bar items. Dining halls scored significantly higher than student unions or snack bar/cafés on healthful entrées, side dish/salad bar and beverages offerings, but they also had the most barriers to healthful dietary habits (i.e. all-you-can-eat). No differences were found by restaurant type for NEMS-R scores for total restaurant dining environment or healthful entrées and barriers. Snack bars had more healthful side dishes ($P=0.002$) and fast-food restaurants had the highest level of facilitators (i.e. nutrition information; $P=0.002$).

Conclusions: Based on this evaluation in fifteen institutions, the full campus dining environment provides limited support for healthy eating and obesity prevention. The quality of campus dining environments can be improved via healthful offerings, providing nutrition information and other supports to facilitate healthy eating and prevent unwanted weight gain.

Keywords
Campus eating environment
Restaurant evaluation
Meal healthfulness
Community-based participatory research

The eating habits of college students are generally poor^(1,2) and healthful eating is often not a high priority for them⁽³⁾. For example, only one in twenty students eats

the recommended five or more daily servings of fruits and vegetables⁽⁴⁾. Poor diet is negatively correlated with weight status in college students^(2,5), with more than one-third being overweight (BMI = 25.0–29.9 kg/m²) or obese (BMI ≥ 30.0 kg/m²)⁽⁶⁾. Obesity in late adolescence predicts obesity later in life⁽⁷⁾, thereby increasing the risk for CVD, hypertension and diabetes⁽⁸⁾. Research evidence indicates that a complex interplay of personal and environmental

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factors influence students' dietary habits and weight. College students select foods based on taste, time, schedule, convenience, cost, physical/social environments, and some for health or weight control reasons^(9,10).

Ecological models for health behaviour change such as PRECEDE-PROCEED⁽¹¹⁾ posit the importance of environmental influences upon dietary behaviours and weight status. University campus dining environments can either promote or inhibit healthy eating and weight control choices by young adults. For instance, female students residing in dormitories with on-site dining gained more weight during their freshman year than counterparts without on-site dining⁽¹²⁾, and freshmen living on campus gained more weight than students commuting from home⁽¹³⁾. However, students living on campus ate more fruit, vegetables and dairy products than students in off-campus apartments⁽¹⁴⁾. Beyond the food available in the campus dining environment, other factors can facilitate students' selection of healthful foods. Students who utilize point-of-selection nutrition labels in dining halls often report improved food choices⁽¹⁵⁾ and reduced energy content of meals^(16,17) compared with those not using nutrition labels. College students' eating habits improved when exposed to point-of-selection messages promoting taste, satiety, body leanness, energy value and health⁽¹⁸⁾. Price reduction strategies also encouraged selection of healthier food items^(19,20). As an 'all-you-can-eat restaurant', dining halls are poised to influence, either positively or negatively, students' food choices by the array of foods offered and the techniques used to promote them.

Although there is evidence of a relationship between the campus food environment and students' dietary habits and weight⁽¹²⁻²⁰⁾, there is insufficient evidence regarding the causal linkages⁽²¹⁾ and a lack of clarity on how to define and describe the campus dining environment. Students no longer eat their meals only in the dining halls; they have a variety of options on and off campus from which to choose (union, food courts, snack bars, restaurants, vending and stores). Although grocery stores near college campuses provided a wide array of healthful alternatives, convenience stores on and near campus⁽²²⁾ and campus vending machines⁽²³⁾ provide few healthful foods and are more obesogenic. Numerous studies describe and evaluate food store and restaurant environments⁽²⁴⁻²⁶⁾, yet little attention has been given to college campus dining environments. A tool is necessary to describe and evaluate varying campus dining environments. This tool and the evaluation it enables are the essential preliminary steps for understanding baseline campus environments and for guiding intervention programme developers and policy makers in their efforts to create campus dining environments fully supportive of healthy eating. Thus, the purpose of the present study was to develop and pilot-test a tool to evaluate the restaurant and dining venues on and near post-secondary campuses at geographically diverse institutions varying in student enrolment size.

Methods

A team of researchers collaborating on the US Department of Agriculture Multistate Research Project entitled 'Promoting Healthful Eating to Prevent Excessive Weight Gain in Young Adults' assessed the dining environment on thirteen university campuses, one residential post-secondary training programme and one technical college. Steering committees composed of diverse teams of stakeholders (i.e. students, faculty, staff, administrators and community members) at each institution guided the research process using the principles of community-based participatory research (CBPR); more specifically, the PRECEDE-PROCEED model⁽¹¹⁾. The present study comprised one portion of the full CBPR project. Each campus team established a geographic boundary extending at least 1.5 miles from its campus edge. This boundary definition was selected because many students live on or near campus, and the 1.5-mile radius was used to evaluate other aspects of this PRECEDE-PROCEED environmental assessment⁽²⁷⁾. Given this was CBPR and not a standardized public health evaluation, each team identified the restaurants and on-campus dining venues within the boundaries that were most frequented by students and hence relevant for evaluation. Approximately 20 % of the restaurants frequently used by students were located beyond the perimeters and were also included to ensure adequate representation of dining venues frequented by students. Institutional Review Board approval was not necessary because no human subjects were involved.

Instrument

Although nearly 150 different measures are available to evaluate accessibility, availability, affordability and quality of the food or restaurant environment⁽²⁴⁻²⁶⁾, at the time of the present study none of these fully captured the unique mix of school, worksite, home and neighbourhood environments defining typical post-secondary institutions. Thus, the reliable Nutrition Environment Measures Survey for Restaurants (NEMS-R)⁽²⁸⁾ was adapted for the present study to make it more applicable to the college-age population and post-secondary institution campuses. This tool was also adopted because the Nutrition Environment Measures Survey for Stores (NEMS)⁽²⁹⁾ was used for the evaluation of stores on and near campuses⁽²²⁾. All modifications were guided by a literature review^(14,30,31), an analysis of the campus environment⁽³²⁾, stakeholders and study researchers. The modified surveys were reviewed by five experts for face validity, comprehensiveness and clarity, and subsequently were pilot-tested at two north-eastern US college campuses. The surveys were refined based on experts' comments and pilot testing.

The NEMS-R is designed to evaluate restaurants, including sit down, fast food and fast casual⁽³³⁾ restaurant types.

This instrument assesses facilitators of (e.g. nutrition information) and barriers to (e.g. super-size portions) healthful eating, and the availability of healthy entrées, entrée salads, fruits, vegetables and beverages. To be rated as 'healthy', entrées and entrée salads must meet standards⁽³⁴⁾ for energy, total fat and saturated fat.

Off-campus restaurants

For off-campus restaurants, the NEMS-R was updated to reflect current eating trends by deleting the assessment of 'low-carb' items and adding availability of vegetarian menu items⁽³⁵⁾. In addition, assessment of children's menus was omitted because this was not the target population of interest.

On-campus dining venues

On-campus dining facilities frequently have features unlike those of typical restaurants. Thus, the NEMS-R was modified to capture these unique features, resulting in the creation of the Nutrition Environment Measures Survey–Campus Dining (NEMS-CD). As shown in Table 1, a detailed review of salad bars (i.e. numbers of fresh, low-fat and no-sugar added fruit and vegetables, low-fat protein sources, and low-fat/fat-free dressings) was added. Because on-campus dining facilities supply most or all of the food consumed by college students residing on campus, the NEMS-CD also was expanded to incorporate a broader array of healthy eating constructs, such as those in the Dietary Guidelines for Americans⁽³⁴⁾,

Table 1 Comparison of dining environment constructs for assessing restaurant (NEMS-R) and campus dining (NEMS-CD) venues

Restaurant dining environment constructs*,†	Sub-score range	Campus dining environment constructs*	Sub-score range
Healthy Entrées	0 to 9	Healthy Entrées	0 to 12
<ul style="list-style-type: none"> ● Main dish ● Main dish salad ● Low-fat/fat-free salad dressing 		<ul style="list-style-type: none"> ● Main dish ● Main dish salad ● Low-fat/fat-free salad dressing 	
Healthy Side Dishes	0 to 15	Healthy Side Dishes/Salad Bar	0 to 35
<ul style="list-style-type: none"> ● Non-fried vegetables ● No-added sugar fruit ● Vegetarian options‡ ● Baked chips ● Whole-wheat bread 		<ul style="list-style-type: none"> ● Non-fried vegetables ● No-sugar added fruit ● Vegetarian options ● Baked chips ● Whole grain items (e.g., brown rice, quinoa, whole-wheat bagels, pizza, and bread) ● Salad bar: fresh fruits and vegetables, low-fat protein sources and low-fat or fat-free dressings at 'salad' and other self-serve 'bars' ● Healthy cereals: (<7 g sugar and/or ≥4 g fibre) 	
Healthy Beverages	0 to 9	Healthy Beverages	0 to 18
<ul style="list-style-type: none"> ● Low- and non-fat milk ● 100% fruit juice ● Diet soda 		<ul style="list-style-type: none"> ● Low- and non-fat milk plus alternatives (i.e. soya and rice) ● 100% fruit juices: number of labelled ● Diet soda and other low-calorie beverages 	
Facilitators of Healthy Eating	0 to 30	Facilitators of Healthy Eating	0 to 30
<ul style="list-style-type: none"> ● Nutrition information available ● Signs encouraging healthy choices ● Reduced-size portions offered 		<ul style="list-style-type: none"> ● Nutrition information available ● Signs encouraging healthy choices ● Reduced-size portions offered 	
Barriers to Healthy Eating	–15 to 0	Barriers to Healthy Eating	–15 to 0
<ul style="list-style-type: none"> ● Signs encouraging unhealthy eating (e.g. high-fat sides) ● Signs encouraging overeating (e.g. super-size portions) ● Large portion sizes ● All-you-can-eat 		<ul style="list-style-type: none"> ● Signs encouraging unhealthy eating ● Signs encouraging overeating ● Large portion sizes ● All-you-can-eat 	
Price	–9 to 3	Price	–14 to 5
<ul style="list-style-type: none"> ● Combo meals (e.g. sandwich, side and drink) ● Charge to share ● Reduced costs less ● Healthy foods cost more 		<ul style="list-style-type: none"> ● Combo meals ● Charge to share ● Reduced portion size costs less ● Healthy foods costs more ● Dining hall contracts available: full board, by meal, by food ● Salad bar priced by weight 	
Total NEMS-R* points	–24 to 66	Total NEMS-CD§ points	–29 to 100

*Adapted from Nutrition Environment Measures Survey for Restaurants (NEMS-R)⁽²⁸⁾.

†Low-carb not assessed, given it is a less popular dietary management strategy; children's menus were not evaluated given the target population was the college environment.

‡Added to the original NEMS-R instrument.

§Nutrition Environment Measures Survey–Campus Dining (NEMS-CD).

including availability and variety of 100% fruit juices, whole grains^(36,37), dairy alternatives (e.g. soya milk), cereals (all and those with low sugar/high fibre)⁽³⁸⁾ and vegetarian options⁽³⁵⁾. Evaluation of pricing was adjusted to account for dining contracts.

NEMS-CD was used to evaluate on-campus eating venues, including dining hall cafeterias, student union/food courts and snack bars/cafés. A dining hall serves students with meal plans and their guests. A student union/food court is open to students, faculty/staff and the public, typically on a pay-per-item basis, with some venues also accommodating meal plans. Snack bars/cafés and other small dining venues on campus generally charge on a pay-per-item basis and are open to the public.

Scoring

The scoring procedures for NEMS-R and NEMS-CD followed the original NEMS-R protocols⁽²⁸⁾. Sub-scores are described in Table 1. In brief, a total dining environment quality score was calculated for each dining establishment by summing the scores for each construct assessed. Scores for restaurants could range from -24 to +66 points. On-campus dining scores could range from -29 to +100 points; the additional points resulted from the survey modifications. Positive points were awarded for availability of nutrition information and healthful options and for a greater selection of foods rated as healthy. Negative points were given for barriers to healthful eating, such as signs encouraging overeating (e.g. 'Get five sandwiches for only...') or an extra charge for a shared entrée.

Data collection

Sample

Using stakeholder input, each post-secondary institution selected a sample that represented 20% of all off-campus restaurants within its geographic boundary, 20% of all (or at least one) campus dining halls, 20% (or at least one) of all campus student union/food courts and 20% of all campus snack bars/cafés. Some establishments slated for evaluation were eliminated if the data collector found that they did not meet criteria for assessment (e.g. served coffee only and no assessable food items sold). All data collectors carried a letter from the lead researcher at their institution that described the study to present upon request by dining establishment employees. Data were collected from December 2008 to March 2009 and May to June 2011.

Data collector training

Standard NEMS-R instructions were modified to include the adaptations described above and expanded to include instructions for the NEMS-CD. One investigator attended a NEMS training⁽³⁹⁾ in October of 2008 (www.cdc.gov/prc/training/practitioners/nutrition-environment-measures-survey.htm) and modified the materials (manual, data

collection/entry tools and PowerPoint presentation) used to train the data collectors on each participating campus. Each data collector reviewed all materials and then participated in an online training seminar lasting ~2h. After the training, data collectors practised with the modified tools at restaurants and campus dining venues not included in the study sample. A trained campus coordinator at each institution reviewed practice data collection results and worked with data collectors to clarify any deviations from the instrument scoring standards.

Prior to data collection, inter-rater reliability (IRR) was established on each campus by having each data collector independently evaluate the same establishment on the same day. The IRR scores were derived by comparing the number of constructs that were scored similarly by the data collector and the campus coordinator. Additional dining venues were assessed until all data collectors at an institution achieved an IRR greater than 80%. Once this agreement level was reached, data collectors began assessing the sample of dining venues.

Data analysis

The SPSS statistical software package version 18.0 was used for data analysis, which was completed in winter 2011. Institution size affects the number and variety of dining venues and potentially the extensiveness of services provided. Thus, to permit meaningful comparisons, institutions were categorized into tertiles using student enrolment statistics as a proxy for institution size. Institutions with $\leq 15\,000$, 15 001–29 999 and $\geq 30\,000$ students were categorized as small-sized, medium-sized and large-sized institutions, respectively. Ranges, means and standard deviations for construct scores were calculated. ANOVA with *post hoc* Tukey's *B* and *T* tests were used to determine whether significant differences occurred between mean scores of on-campus and off-campus dining venues, and between institutions, geographic regions, institution sizes and data collection periods (i.e. 2009 *v.* 2011). To permit comparisons of all restaurant-type facilities both on and off campus including on-campus snack bar/cafés and all off-campus restaurants, only the NEMS-R constructs were considered. The percentages of dining establishments with healthy foods, facilitators and barriers were calculated and compared using χ^2 tests. Significance was set at $P < 0.05$.

Results

About half of the fifteen post-secondary institutions participating in the present study were from the Northeast region of the USA ($n = 8$), one-third were from the Midwest and the remaining two were in the Southeast. There were no significant differences in results between the two data collection periods, so all data were combined. Similarly, no differences were detected by institution or region.

Table 2 describes the characteristics of participating institutions and the number of dining establishments assessed. Small-sized institutions were located in significantly smaller communities than medium-sized and large-sized institutions as indicated by the differences in community population density; however, there were no differences in community median income or percentage of students living on campus.

A total of sixty-eight campus dining venues were assessed. There were no differences by institution size in the number of campus dining venues evaluated; however, small-sized institutions evaluated significantly more fast-food restaurants (50%), whereas large-sized institutions had significantly more sit-down restaurants (47%). In general, dining halls had significantly higher (more healthful) scores than campus snack bars/cafés on all campus dining environment constructs except Facilitators of Healthy Eating (Table 3). There were few differences between dining hall scores by institution size, although medium-sized institutions had significantly higher (more) Healthy Side Dishes/Salad Bar scores than small-sized institutions. Student unions at large-sized institutions were less healthy, with significantly lower scores than smaller institutions in the categories of Total NEMS-CD, Healthy Side Dishes and Healthy Beverages. There were no differences in snack bars/cafés by institution size.

A total of 175 restaurants with a fairly equal representation across types were evaluated. There were no significant differences in NEMS-R total score or sub-scores by institution size for the restaurants; therefore Table 4 compares differences between the types of restaurants, including on-campus snack bars/cafés. For this analysis, only constructs common to both the NEMS-R and NEMS-CD were used to allow comparability. Overall, the various dining venues were similar. There were no significant differences in healthfulness among restaurant types as indicated by the lack of differences in scores for Total NEMS-R, Healthy Entrées and Barriers to Healthy Eating. However, NEMS-R sub-scores indicated that on-campus ‘restaurants’ or snack bars/cafés had more Healthy Side Dishes, and fast-food restaurants had more Facilitators of Healthy Eating. Both fast-food and on-campus restaurants offered more monetary incentives to buy meal deals (increased quantity for limited price) as indicated by the significantly lower Price scores.

Table 5 shows the detailed percentages of healthy food items offered, facilitators of and barriers to healthy eating, and pricing factors available at each type of dining venue. There were no significant differences among venues for the presence of healthy salads (available at 21–41% of venues), 100% juices, nutrition information or healthy entrées identified on the menu, signs showing healthy menu options, whether unhealthy eating or overeating was encouraged, or whether customers were charged to share entrées. Significantly more dining halls offered

Table 2 Institution demographics and distribution of dining venues evaluated; fifteen US post-secondary institutions, 2009–2011

Institution characteristic	Small institutions, ≤15 000 students (n 5)			Medium institutions, 15 001–29 999 students (n 5)			Large institutions, ≥30 000 students (n 5)			All institutions combined		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Student enrolment*	7451	5423	293–11 995	21 210	6685	15 204–29 306	42 933	6629	34 392–52 112	23 865	16 196	293–52 112
Community population density†‡	557 ^a	332	40–913	2912 ^{a,b}	1899	604–5871	4731 ^b	2820	1981–9287	2734	2542	40–9287
Community median annual income (\$US)	34 618	11 078	21 858–51 697	36 510	3991	30 856–41 821	40 569	11 798	24 958–53 340	37 236	9273	21 858–53 340
% of students living on campus	55	22	30–89	29	13	19–45	36	28	16–84	40	23	16–89
Dining venues evaluated	n	%		n	%		n	%		n	%	
Restaurant type§												
Sit down	7	29.1		8	21.6		53	46.5		68	38.9	
Fast casual	5	20.8		20	54.1		36	31.6		61	34.9	
Fast food	12	50.0		9	24.3		25	21.9		46	26.2	
On-campus venues												
Dining halls	6	40.0		8	30.8		15	40.0		29	33.0	
Student union	4	26.7		4	15.4		12	25.5		20	22.7	
Snack bars/cafés	5	33.3		14	53.8		20	42.5		39	44.3	

a,b,c Mean values within a row with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey’s B post hoc test (P < 0.05).
 *Student enrolment data collected with NEMS (Nutrition Environment Measures Survey) data.
 †Community population density is the population of the city within which the institution is located/city area in square miles according to 2010 census data.
 ‡ANOVA main effects indicate significant differences by institution size (P = 0.019).
 §Pearson χ^2 determined a significant difference in the distribution of restaurants assessed by institution size: P = 0.002; $\chi^2 = 16.75$, df = 4.

Table 3 Comparison of campus dining environment construct scores by on-campus dining venues and institution size; fifteen US post-secondary institutions, 2009–2011

	By institution size									
	All institutions combined			Small institutions, ≤15 000 students		Medium institutions, 15 001–29 999 students		Large institutions, ≥30 000 students		
	Mean	SD	<i>P</i> value*	Mean	SD	Mean	SD	Mean	SD	<i>P</i> value†
Total score										
Dining halls	42.31 ^a	10.02		47.50	16.47	46.13	6.75	38.20	6.57	NS
Student union	24.90 ^b	15.92		32.00 ^a	20.80	38.00 ^a	15.66	18.17 ^b	11.09	0.05
Snack bars/café	22.51 ^b	9.49	<0.000	22.60	12.05	20.05	9.39	23.90	9.17	NS
Healthy Entrées sub-score‡										
Dining halls	4.00 ^a	2.71		4.17	2.86	4.25	2.71	3.80	2.83	NS
Student union	2.85 ^{a,b}	2.96		4.25	3.86	4.50	3.70	1.83	2.13	NS
Snack bars/café	2.18 ^b	2.37	0.022	2.00	3.08	2.07	2.34	2.30	2.34	NS
Healthy Side Dishes/Salad Bar sub-score§										
Dining halls	19.03 ^a	4.68		17.00 ^a	5.37	22.50 ^b	3.34	18.00 ^{a,b}	4.26	0.037
Student union	8.85 ^b	8.38		14.00 ^a	9.27	16.25 ^a	8.66	4.67 ^b	5.35	0.013
Snack bars/café	7.44 ^b	5.26	<0.000	8.60	9.48	7.43	4.96	7.15	4.38	NS
Healthy Beverages sub-score										
Dining halls	14.24 ^a	3.10		15.67	3.78	13.50	3.51	14.07	2.60	NS
Student union	11.15 ^b	5.16		14.25 ^a	2.50	17.50 ^a	0.58	8.00 ^b	3.91	<0.001
Snack bars/café	10.44 ^b	5.16	0.002	12.60	2.79	9.79	5.48	10.35	4.12	NS
Facilitators of Healthy Eating sub-score¶										
Dining halls	7.90	6.29		12.00	8.53	8.75	7.98	5.80	3.01	NS
Student union	6.05	6.13		3.25	3.95	3.75	4.79	7.75	6.81	NS
Snack bars/café	4.46	5.71	NS		1.14	3.29	5.38	6.15	6.15	NS
Barriers to Healthy Eating sub-score**										
Dining halls	-3.21 ^a	2.26		-1.50	1.64	-3.38	1.06	-3.80	2.65	NS
Student union	-2.55 ^{a,b}	3.41		-0.75	1.50	-1.50	3.00	-3.50	3.80	NS
Snack bars/café	-1.54 ^b	2.27	0.031	-0.60	1.34	-2.14	3.21	-1.35	1.53	NS
Price sub-score††										
Dining halls	0.34 ^a	1.11		0.17	1.84	0.50	0.95	0.33	0.90	NS
Student union	-1.45 ^b	2.24		-3.00	2.45	-2.50	3.00	-0.58	1.56	NS
Snack bars/café	-0.46 ^{a,b}	1.90	0.003	-1.00	1.41	0.07	1.90	-0.70	2.00	NS

^{a,b}Mean values within a column (for all institutions combined) or within a row (for by institution size) with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey's *B post hoc* test ($P < 0.05$).

*ANOVA main effects significance level comparing campus dining environment total score by dining venues.

†ANOVA main effects significance level comparing campus dining environment sub-scores for each venue by institution size.

‡Healthy entrées (main dishes, main dish salads and low-fat/fat-free dressings; possible range = 0–12).

§Healthy sides dishes/salad bar (non-fried vegetables, no-sugar added fruit, vegetarian, wholegrain items, baked chips, salad bar; possible range = 0–35).

||Healthy beverages (low-fat and non-fat milk and alternatives, 100% fruit juice, diet and low-calorie soda; possible range = 0–18).

¶Facilitators of healthy eating (nutrition information, healthy signs, reduced portions; possible range = 0–30).

**Barriers to healthy eating (unhealthy signs, large portions, all-you-can-eat; possible range = -15 to 0).

††Price (dining hall contracts, salad bar by weight, combo meals, portion and healthy meal pricing; possible range = -14 to 5).

Table 4 Comparison of restaurant dining environment construct scores by restaurant type; fifteen US post-secondary institutions, 2009–2011

	Restaurant type												P value†			
	All restaurants combined (n 214)			Sit down (n 68)			Fast casual (n 61)			Fast food (n 46)				On-campus (n 39)*		
	Mean	SD		Mean	SD		Mean	SD		Mean	SD			Mean	SD	
Total score	14.40	9.31		12.37	9.06		14.13	9.10		15.85	10.85		16.67	7.46		NS
Healthy Entrées sub-score‡	2.43	2.39		2.21	2.15		2.59	2.54		2.89	2.58		2.03	2.38		NS
Healthy Side Dishes sub-score§	4.49	3.52		4.19 ^a	3.16		4.08 ^a	3.24		3.85 ^a	3.67		6.38 ^b	3.84		0.002
Healthy Beverages sub-score	5.37	2.43		5.12 ^a	2.20		4.92 ^a	2.33		5.67 ^a	2.63		6.15 ^b	2.57		0.05
Facilitators of Healthy Eating sub-score¶	4.83	5.62		3.50 ^a	4.58		4.51 ^a	4.77		7.54 ^b	7.08		4.46 ^a	5.71		0.002
Barriers to Healthy Eating sub-score**	-1.92	2.90		-2.29	3.40		-1.28	2.35		-2.54	3.10		-1.54	2.27		NS
Price sub-score††	-0.90	1.76		-0.35 ^a	1.60		-0.69 ^a	1.77		-1.57 ^b	1.76		-1.38 ^b	1.80		<0.001

^{a,b}Mean values within a row with unlike superscript letters were significantly different as determined by pairwise comparisons using Tukey's *B* post hoc tests ($P < 0.05$).
^{*}On-campus restaurants are the snack bars/café's; from the campus dining environment survey only the restaurant dining environment constructs were used for this analysis to permit comparisons across restaurant types.
[†]ANOVA main effects significance level comparing scores by restaurant type.
[‡]Healthy entrées (main dishes, main dish salads and low-fat/fat-free dressings; possible range = 0–9).
[§]Healthy sides (non-fried vegetables, no-sugar added fruit, vegetarian, whole-wheat bread, baked chips; possible range = 0–15).
^{||}Healthy beverages (low-fat and non-fat milk, 100% fruit juice, diet and low-calorie soda; possible range = 0–9).
[¶]Facilitators of healthy eating (nutrition information, healthy signs, reduced portions; possible range = 0–30).
^{**}Barriers to healthy eating (unhealthy signs, large portions, all-you-can-eat; possible range = -15 to 0).
^{††}Price (combo meals, portion and healthy meal pricing; possible range = -9 to 3).

more healthy food items than other dining venues. More than 90% of dining halls offered low-fat and non-fat milk and whole-wheat bread (*v.* 50% of student unions, the second most likely to offer whole-wheat bread). In addition, more than 80% had vegetarian options, a salad bar and no-sugar added fruit (*v.* 62% of campus snack bars, the second most likely to serve no-sugar added fruit). More than 70% of dining halls had healthy entrées, non-fried vegetables (followed by 60% of sit-down restaurants), special requests encouraged and signs encouraging healthy eating, but also 'all-you-can-eat' pricing. Student unions had the highest percentage of locations offering baked chips (55%) and point-of-purchase information that encouraged healthy eating (45%). Fast-food restaurants had a significantly higher percentage of nutrition information available at the point of purchase, but also encouraged large portions (44%) and combo pricing (57%); student unions were a close second with 55% having combo pricing.

Discussion

The on-campus dining environment is unique in that it has multiple competing goals related to feeding students. Some of these include responding to young adult's food preferences, food service cost-effectiveness and efficiency, and students' health considerations^(40,41). Dining halls provided the greatest variety of healthy entrées, side dishes and beverages, but also had the most barriers to healthy eating (i.e. 'all-you-can-eat' pricing) as compared with student unions and snack bars. Facilitators of healthy eating, such as point-of-purchase education, could be improved to counter these barriers. Although facilitators of healthy eating did not differ significantly among the on-campus dining venues, they do help students make more healthful decisions^(15–18,42,43).

Based on the current findings, a variety of dining options are available for students on and near campus with no substantive differences in healthful choices among restaurant types. There were no significant differences in main dish salads, 100% juice, nutrition information or signs for healthy menu options, and whether unhealthy eating or overeating was encouraged. Total NEMS-R scores for all restaurant types were only a fraction of the total maximum points (66), implying that unhealthy dining environments were prevalent.

A comparison of the findings reported here with those for the original implementation of NEMS-R in Atlanta, GA⁽²⁸⁾ revealed that a higher percentage of the present sample of restaurants offers no-sugar added fruit, healthy entrée salads and entrées, but similar trends were evident in the offering of non-fried vegetables, baked chips and diet soda. In addition, more restaurants in the present sample facilitate healthy eating by identifying healthy entrées and providing nutrition information and reduced

Table 5 Availability of dining environment constructs by dining venue; fifteen US post-secondary institutions, 2009–2011

Dining environment construct	Dining venue						P value†
	Sit down (n 68)	Fast casual (n 61)	Fast food (n 46)	On- campus (n 39)*	Dining hall (n 29)	Student union (n 20)	
	% Available						
Healthy entrées							
Main dish	29.4	36.1	46.5	23.1	72.4	45.0	<0.001
Main dish salad	38.2	41.9	37.0	30.8	20.7	30.0	NS
Healthy sides/salad bar							
Non-fried vegetables	60.3	32.8	26.1	33.4	72.4	35.0	<0.001
No sugar-added fruit	20.6	28.2	26.1	61.5	82.8	45.0	<0.001
Vegetarian options	35.3	24.6	26.1	20.5	82.8	15.0	<0.001
Baked chips	4.4	16.4	19.6	38.5	13.8	55.0	<0.001
Whole-wheat bread	19.1	36.1	30.4	59.0	93.1	50.0	<0.001
Low-fat and non-fat milk	17.6	27.9	41.3	56.4	96.6	60.0	<0.001
100% fruit juice	52.9	42.6	50.0	59.0	72.4	60.0	NS
Diet soda	100	93.4	97.8	89.7	100	90.0	NS
Salad bar				10.3	86.2	35.0	<0.001
Facilitators of healthy eating							
Nutrition information available at POP	7.4	9.8	28.3	10.3	34.5	15.0	0.002
Nutrition information or healthy entrées identified on menu	17.6	14.8	34.8	15.4	24.1	10.0	NS
Reduced-size portions offered	36.8	34.4	23.9	2.6	6.9	30.0	<0.001
Special requests encouraged	7.4	3.3	13.0	7.7	31.0	20.0	0.002
Signs show healthy menu options	4.4	14.8	19.6	20.5	24.1	20.0	NS
Signs encourage healthy eating	0	9.8	17.4	25.6	31.0	45.0	<0.001
Barriers to healthy eating							
Signs encouraging unhealthy	17.6	9.8	15.2	25.6	13.8	25.0	NS
Signs encouraging overeating	16.2	11.5	23.9	10.3	3.4	25.0	NS
Large portion sizes	14.7	11.5	43.5	12.8	6.9	30.0	<0.001
All-you-can-eat	11.8	6.6	2.2	2.6	79.3	5.0	<0.001
Special requests discouraged	16.2	3.3	2.2	0	3.4	0	<0.002
Price							
Combo meals	20.6	19.7	56.5	35.9	–	55.0	<0.001
Charge to share entrée	4.4	4.9	0	2.6	–	0.0	NS
Reduced portion costs less	13.2	3.3	6.5	2.6	–	20.0	0.019
Healthy entrées costs more	0	1.6	2.2	10.3	–	5.0	0.034

POP, point of purchase.

*On-campus restaurants are the snack bars/cafés.

†Pearson χ^2 statistic used to assess significance in distribution between each dining venue for each construct.

portion sizes. However, more restaurants in the present sample also provided more barriers to healthful eating by offering larger portion sizes. A higher percentage of sit-down restaurants in the current survey encouraged unhealthy eating or overeating and none encouraged healthful eating. The changes in fast-food restaurants are noteworthy; this current sample displays more healthful offerings and signage encouraging healthy eating. Compared with the original NEMS-R implementation, twice as many fast-food restaurants offered whole-wheat bread and 100% fruit juice; three times as many encouraged healthy eating; and 50% fewer encouraged unhealthy eating. Although 59% of fast-food restaurants had combo pricing, this percentage is lower than previously reported. Some of these positive findings may result because nutrition information has become more widely available since the original NEMS-R research and/or due to the differences between Atlanta neighbourhoods and communities and post-secondary institutions. Despite these improvements, additional changes could help consumers choose healthier

meals when eating out. Restaurant owners need to be encouraged to provide healthful foods and nutrition information. Although legislative efforts have forced large, franchised operations to provide healthy offerings and nutrition information, this environmental support has not been required of smaller and independent restaurants^(44–46).

On-campus dining venues offer more healthy options than off-campus venues; however, there were some differences in the healthfulness of the on-campus dining environment according to institution size. Bigger was not necessarily better, possibly indicating differences in how resources are allocated to dining services. In the present study, large-sized institutions' student union/food courts had significantly lower scores and similar trends for dining halls on a number of the dining environment constructs. A wider sample of comparison data for campus environments is necessary. The newly developed NEMS-CD modified from the NEMS-R, along with the campus food environment assessment⁽²²⁾, can be added to the instruments designed to evaluate the college

nutrition environment^(47,48). It is imperative that evaluation of the campus food environment across varied post-secondary institutions continues given the environment's influence on young adults' weight^(12-14,21) and dietary intake^(14,49,50). Perception of the food environment is related to intake⁽⁵¹⁾ and point-of-purchase information presents an opportunity to positively influence students' food selections^(15-17,42). Pricing strategies to improve student behaviours and health outcomes can be effective and should be considered. For example, reducing the price of fruit and salad by half resulted in a threefold increase in purchases⁽¹⁹⁾, and a 20% price reduction coupled with a promotional campaign resulted in modest increases in the purchase of health-promoting foods and a slight decrease in the selection of less-healthy foods⁽²⁰⁾.

Acknowledging that campus food environments support healthful food behaviours that can help prevent obesity is critical to achieving sustainable improvements. Environmental and policy changes take time to implement and come with challenges⁽⁵²⁾. The likelihood for effective, sustained changes is increased when community-based participatory approaches are used⁽¹¹⁾ and key stakeholders – students, health advocates, campus staff, local store and restaurant owners, local food producers – are involved throughout the process. Resistance to change may be addressed effectively by making gradual and modest changes in healthy food offerings, providing locally produced foods (www.FarmtoCollege.org) and adding facilitators, such as point-of-purchase education and pricing strategies that promote intake of healthier food items^(15-17,42,52). Changes like these may be welcomed by stakeholders and could improve profitability^(40,41).

To our knowledge, the present study is the first evaluation of campus dining venues with high IRR comparing a number of institutions. The use of CBPR and the stakeholders at each institution facilitated the selection of the most appropriate establishments evaluated given limited time and resources. This is a new instrument that others can use to evaluate their campus dining venues. The modified tools and training materials are available at <http://www.med.upenn.edu/nems/materials.shtml>. These data provide baseline benchmarks that other campuses can use as a comparison. In addition, these data point to improvements that need to be made to improve the dining environment which can provide environmental supports needed to avoid unwanted weight gain.

Despite the strengths of the present study, it is important to also consider its limitations. The study is limited to a small percentage of the many post-secondary institutions in the USA. Although the NEMS-R is a validated measure of the healthfulness of restaurants, it is limited because it is not a comprehensive evaluation of restaurant offerings and is dependent on knowing the nutrient content of foods offered. As a result, many venues may be offering healthful/nutrient-dense foods, but if nutrition information is not provided the NEMS-R score will be

lower than it actually is. NEMS-R and the NEMS-CD are useful for a detailed nutrient-based analysis but also generate extensive data to manage⁽⁵³⁾. The NEMS-CD also needs to be validated to ensure it accurately reflects the nutrition/food environment of a post-secondary institution campus. A more parsimonious tool might enhance appeal and utility for use by those wishing evaluate their campus food environment. Researchers who recently developed tools to evaluate public schools^(54,55) found a checklist approach to evaluating foods for healthfulness to be less time-consuming and labour-intensive than the inventory method used in NEMS-R.

Future research

Not all students eat in dining halls and most also supplement their meal plan by purchasing food and snacks at local convenience and grocery stores. Thus, conducting an evaluation of the broader consumer retail food environment would round out the understanding of the full campus food environment⁽²²⁾.

Validation of NEMS-CD for the campus dining environment is needed and could be accomplished via a comparative study with the Healthy Eating Index⁽⁵⁶⁾ or one of the newly created campus/NEMS tools^(47,48,57).

Conclusions

Most on-campus dining venues and nearby restaurants can improve their dining environments by increasing healthy food and drink options and facilitators of healthy eating and by decreasing barriers that promote obesity. Large-sized institutions in particular might have additional challenges to overcome to improve their campus dining environments. These findings should provide motivation for other campuses to evaluate the quality of their dining environments as the importance of environmental supports for obesity prevention becomes more evident.

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References

- Burke JD, Reilly RA, Morrell JS *et al.* (2009) The University of New Hampshire's Young Adult Health Risk Screening Initiative. *J Am Diet Assoc* **109**, 1751–1758.
- Racette SB, Deusinger SS, Strube MJ *et al.* (2008) Changes in weight and health behaviors from freshman through senior year of college. *J Nutr Educ Behav* **40**, 39–42.
- Strong KA, Parks SL, Anderson E *et al.* (2008) Weight gain prevention: identifying theory-based targets for health behavior change in young adults. *J Am Diet Assoc* **108**, 1708–1715.
- American College Health Association (2011) *American College Health Association-National College Health Assessment II: Reference Group Executive Summary Fall 2010*. Linticum, MD: American College Health Association.
- Adams T & Rini A (2007) Predicting 1-year change in body mass index among college students. *J Am Coll Health* **55**, 361–365.
- American College Health Association (2007) American College Health Association National College Health Assessment Spring 2006 Reference Group data report (abridged). *J Am Coll Health* **55**, 195–206.
- Kindblom JM, Lorentzon M, Hellqvist A *et al.* (2009) BMI changes during childhood and adolescence as predictors of amount of adult subcutaneous and visceral adipose tissue in men: the GOOD Study. *Diabetes* **58**, 867–874.
- Mokdad AH, Marks JS, Stroup DF *et al.* (2004) Actual causes of death in the United States, 2000. *JAMA* **291**, 1238–1245.
- Greaney ML, Less FD, White AA *et al.* (2009) College students' barriers and enablers for healthful weight management: a qualitative study. *J Nutr Educ Behav* **41**, 281–286.
- Horacek TM & Betts NM (1998) Students cluster into 4 groups according to the factors influencing their dietary intake. *J Am Diet Assoc* **98**, 1464–1467.
- Green LW & Kreuter M (2005) *Health Program Planning: An Educational and Ecological Approach*, 4th ed. New York: McGraw-Hill.
- Kapinos KA & Yakusheva O (2011) Environmental influences on young adult weight gain: evidence from a natural experiment. *J Adolesc Health* **48**, 52–58.
- Pliner P & Saunders T (2008) Vulnerability to freshman weight gain as a function of dietary restraint and residence. *Physiol Behav* **93**, 76–82.
- Brunt AR & Rhee YS (2008) Obesity and lifestyle in US college students related to living arrangements. *Appetite* **51**, 615–621.
- Driskell JA, Schake MC & Detter HA (2008) Using nutrition labeling as a potential tool for changing eating habits of university dining hall patrons. *J Am Diet Assoc* **108**, 2071–2076.
- Chu YH, Frongillo EA, Jones SJ *et al.* (2009) Improving patrons' meal selections through the use of point-of-selection nutrition labels. *Am J Public Health* **99**, 2001–2005.
- Freedman MR (2011) Point-of-selection nutrition information influences choice of portion size in all-you-can-eat university dining hall. *J Foodserv Bus Res* **14**, 86–98.
- Peterson S, Duncan DP, Null DB *et al.* (2010) Positive changes in perceptions and selections of healthful foods by college students after a short-term point-of-selection intervention at a dining hall. *J Am Coll Health* **58**, 425–431.
- French SA & Wechsler H (2004) School-based research and initiatives: fruit and vegetable environment, policy, and pricing workshop. *Prev Med* **39**, Suppl. 2, S101–107.
- Michels KB, Bloom BR, Riccardi P *et al.* (2008) A study of the importance of education and cost incentives on individual food choices at the Harvard School of Public Health cafeteria. *J Am Coll Nutr* **27**, 6–11.
- Giskes K, van Lenthe F, Avendano-Pabon M *et al.* (2011) A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments? *Obes Rev* **12**, e95–e106.
- Horacek TM, Erdman MB, Reznar ME *et al.* (2012) Evaluation of the food store environment on and near the campus of 15 post-secondary institutions. *Am J Health Promot* (In the Press).
- Byrd-Bredbenner C, Johnson M, Quick V *et al.* (2012) Sweet and salty. An assessment of the snacks and beverages sold in vending machines on US post-secondary institution campuses. *Appetite* **58**, 1143–1151.
- McKinnon RA, Reedy J, Morrisette MA *et al.* (2009) Measures of the food environment: a compilation of the literature, 1990–2007. *Am J Prev Med* **36**, 4 Suppl., S124–S133.
- Ohri-Vachaspati P & Leviton L (2010) Measuring food environments: a guide to available instruments. *Am J Health Promot* **24**, 410–426.
- National Cancer Institute (2012) Risk Factor Monitoring and Methods. Instruments. <https://riskfactor.cancer.gov/mfe/instruments> (accessed March 2012).
- Horacek TM, White AA, Greene GW *et al.* (2012) Sneakers and spokes: an assessment of the walkability and bikeability of US post-secondary institutions. *J Environ Health* **74**, 8–15.
- Saelens BE, Glanz K, Sallis JF *et al.* (2007) Nutrition Environment Measures Study in restaurants (NEMS-R): development and evaluation. *Am J Prev Med* **32**, 73–281.
- Glanz K, Sallis JF, Saelens BE *et al.* (2007) Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. *Am J Prev Med* **32**, 282–289.
- Oldenburg B, Sallis JF, Harris D *et al.* (2002) Checklist of Health Promotion Environments at Worksites (CHEW): development and measurement characteristics. *Am J Health Promot* **16**, 288–299.
- Beydoun MA, Powell LM & Wang Y (2008) The association of fast food, fruit and vegetable prices with dietary intakes among US adults: is there modification by family income? *Soc Sci Med* **66**, 2218–2229.
- Erdman MB (2009) *An Assessment of the Eating and Food Environment of Syracuse University Students*. Syracuse, NY: Syracuse University, College for Human Development.
- Sperber B (2002) Fast casual ahead. *Brandweek* **43**, 16–20.
- US Department of Agriculture (2008) Dietary Guidelines for Americans 2005: Executive Summary. <http://www.health.gov/dietaryguidelines/dga2005/document/html/executivesummary.htm> (accessed May 2009).
- Craig WJ (2009) Health effects of vegan diets. *Am J Clin Nutr* **87**, issue 5, S1627–S1633.
- Newby PK, Maras J, Bakun P *et al.* (2007) Intake of whole grains, refined grains, and cereal fiber measured with 7-d diet records and associations with risk factors for chronic disease. *Am J Clin Nutr* **86**, 1745–1753.
- Rose N, Hosig K, Davy B *et al.* (2007) Whole-grain intake is associated with body mass index in college students. *J Nutr Educ Behav* **39**, 90–94.
- US Department of Agriculture, ChooseMyPlate.gov (2010) Grain Foods. <http://www.choosemyplate.gov/food-groups/grains.html> (accessed December 2011).
- Honeycutt S, Davis E, Clawson M *et al.* (2010) Training for and dissemination of the Nutrition Environment Measures Surveys (NEMS). *Prev Chronic Dis* **7**, A126.

40. Anonymous (2011) Technomic: College students calling for healthier choices and greater say in shaping campus dining programs. *Food & Beverage Close-Up*, 17 August. <http://www.highbeam.com/doc/1G1-264426169.html> (accessed December 2011).
41. Anonymous (2009) Technomic finds that convenience and cost drive college students' dining choices. *The Free Library*, 20 July. <http://www.thefreelibrary.com/Technomic+Finds+That+Convenience+and+Cost+Drive+College+Students'+...-a0204031165> (accessed December 2011).
42. Buscher LA, Martin KA & Crocker S (2001) Point-of-purchase messages framed in terms of cost, convenience, taste, and energy improve healthful snack selection in a college foodservice setting. *J Am Diet Assoc* **101**, 909–913.
43. Kolodinsky J, Green J, Michahelles M *et al.* (2008) The use of nutritional labels by college students in a food-court setting. *J Am Coll Health* **57**, 297–302.
44. Vadiveloo MK, Dixon LB & Elbel B (2011) Consumer purchasing patterns in response to calorie labeling legislation in New York City. *Int J Behav Nutr Phys Act* **27**, 51.
45. Becker N (2010) Grassroots efforts behind restaurant menu labeling legislation. *J Am Diet Assoc* **110**, 1633.
46. Roberto CA, Schwartz MB & Brownell KD (2009) Rationale and evidence for menu-labeling legislation. *Am J Prev Med* **37**, 546–551.
47. Freedman MR (2010) Development, evaluation, and validation of environmental assessment tools to evaluate the college nutrition environment. *J Am Coll Health* **58**, 565–568.
48. Minaker LM, Raine KD & Cash SB (2009) Measuring the food service environment: development and implementation of assessment tools. *Can J Public Health* **100**, 421–425.
49. Pei-Lin H (2004) Factors influencing students' decisions to choose healthy or unhealthy snacks at the University of Newcastle, Australia. *J Nurs Res* **12**, 83–91.
50. Chapman GE, Melton CL & Hammond GK (1998) College and university students' breakfast consumption patterns: behaviours, beliefs, motivations and personal and environmental influences. *Can J Diet Pract Res* **59**, 176–182.
51. Inglis V, Ball K & Crawford D (2008) Socioeconomic variations in women's diets: what is the role of perceptions of the local food environment? *J Epidemiol Community Health* **62**, 191–197.
52. Story M, Nannery MS & Schwartz MB (2009) Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. *Milbank Q* **87**, 71–100.
53. Lytle LA (2009) Measuring the food environment: state of the science. *Am J Prev Med* **36**, 4 Suppl., S134–144.
54. Hearst MO, Lytle LA, Pasch KE *et al.* (2009) Inventory versus checklist approach to assess middle school a la carte food availability. *J Sch Health* **79**, 593–598.
55. Krukowski RA, Philyaw Perez AG, Bursac Z *et al.* (2011) Development and evaluation of the school cafeteria nutrition assessment measures. *J Sch Health* **81**, 431–436.
56. Reedy J, Krebs-Smith SM & Bosire C (2010) Evaluating the food environment: application of the Healthy Eating Index-2005. *Am J Prev Med* **38**, 465–471.
57. Lesser LI, Hunnes DE, Reyes P *et al.* (2012) Assessment of food offerings and marketing strategies in the food-service venues at California Children's Hospitals. *Acad Pediatr* **12**, 62–67.