



Does a grill menu redesign influence sales, nutrients purchased, and consumer acceptance in a worksite cafeteria?

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ABSTRACT

Worksite cafeterias are compelling venues to improve diet quality through environmental changes.

We conducted a pre-post study to evaluate how a cafeteria-initiated grill menu redesign influenced sales, revenue, and nutrient content of foods purchased. Secondly, we evaluated consumer opinions about menu changes to inform practices for worksite environment interventions. Monthly sales data (2012–2015) were used to compute gross sales and revenue of entrées and side dishes pre-post menu changes. Alternative protein sources replaced red meat; nutrient composition and nutrients purchased were compared using Food Pro software. Consumer responses were queried using online surveys; open-ended responses were analyzed using NVivo. Differences in sales and nutrient content pre-post menu redesign were tested with Wilcoxon Rank Sum tests. Gross sales of entrées (61 vs. 222 servings/month; $p = 0.01$) and side dishes (120 vs. 365 servings/month; $p = 0.001$) increased more than three-fold post-menu changes. Revenue from entrées (312 vs. 1144 USD/month; $p = 0.01$) and side dishes (238 vs. 914 USD/month; $p = 0.001$) also increased; per entrée, consumers purchased significantly more unsaturated fat (5 g), and less saturated fat (3 g) and sodium (100 mg). For side dishes, they purchased fewer calories (48 kcal) and unsaturated fat (2.9 g), but more fiber (1.8 g), and sodium (260 mg). Four themes emerged from consumer responses: the importance of 1) variety, novelty, choice; 2) cost, affordability, value; 3) health; and 4) food quality, taste. Menu redesign can improve nutrient content, while also increasing sales and revenue. Multi-dimensional assessment of the nutritional, consumer, and retailer implications is desirable practice for enacting similar environmental changes.

1. Introduction

The food environment is an important driver of food decisions (Story et al., 2008). Worksite cafeterias are promising environments to promote eating behavior change by providing varied opportunities throughout the day for both meals and snacks to diverse groups of people who spend many hours a day in that space (Almeida et al., 2014). Within graduate universities, worksite cafeterias reach an unusual cross-section of the population, by serving notable numbers of young adults (ages 20–35) (Allman-Farinelli et al., 2016), faculty, and staff with varied educational and socioeconomic backgrounds and food preferences.

Changing the food environment in a location that caters to differing groups of consumers faces unique challenges. For example, young

adulthood has been characterized by more frequent meal skipping, snacking, preference for larger portion sizes, high fast-food and sugar-sweetened-beverage consumption, and low fruit and vegetable intake (Allman-Farinelli et al., 2016). In contrast, adults tend to improve dietary habits as they age, but disparities related to socioeconomic status persist, and lower income adults often have poorer dietary quality (Kanjilal et al., 2006). The differences in food preferences, eating patterns, and disposable income between these groups challenge worksite cafeterias interested in redesigning their menus to improve the healthfulness of offerings. Thus, it is critical that stakeholders evaluate whether redesigned environments can provide foods that are both acceptable and nutrient-dense to diverse groups of customers.

Despite these challenges, evidence suggests that altering workplace food choices influences dietary intake (Roy et al., 2015; Story et al.,

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2008). For example, greater availability and variety of healthful foods in a worksite intervention improved dietary quality (Jeffery et al., 1994), and workplace health promotion campaigns influenced dietary intake (Engbers et al., 2005). While worksite dietary interventions can modestly improve dietary intake (Geaney et al., 2013), better accounting for the heterogeneity in the groups of consumers served, and stronger alignment between public health practitioners, consumers, and retailers prior to implementing worksite interventions may enhance the strength of interventions. Additional research incorporating multi-dimensional assessment is needed to develop evidence-based best practices for worksite interventions (Engbers et al., 2005). Furthermore, objective assessments of environmental changes on sales, nutritional composition, and customer satisfaction is insufficiently studied (Ni Mhurchu et al., 2010), hindering larger scale adoption of environmental interventions.

Enacting environmental change challenges food retailers because the effects on sales and profitability are not always clear. Changing pricing, meal formulations, or food availability could result in greater food waste, preparation time, and labor costs, and ultimately, reduced sales and profitability (Glanz et al., 2007). However, food retailers seem willing to partner with public health practitioners to improve the health profile of their offerings provided sufficient consumer demand (Glanz et al., 2007). Some evidence shows that consumers are demanding and paying for healthier options (Hudson Institute, 2013), but it is not clear how robust this trend is in cafeteria settings. As such, public health advocates developing healthier cafeterias must consider whether such changes will align with other drivers of consumption, and determine if profitability can be maintained along health promotion efforts (Story et al., 2008).

Therefore, using a quasi-experimental pre-post design, we aimed to contrast the sales, revenue, and nutrient composition of grill items purchased during the periods of usual (pre) versus enhanced (post) offerings in a university worksite cafeteria. A secondary aim was to evaluate consumer opinions about the menu changes. The overarching goal was to comprehensively analyze the effect of a menu redesign in one section of the cafeteria to identify challenges and opportunities for larger health-promoting environmental change in worksite cafeterias.

2. Material and methods

2.1. Quasi-experimental study design

This study examined all purchases of grill entrées and sides (approximately 1–3% of total cafeteria revenue) from the Harvard T.H. Chan School of Public Health cafeteria (Sebastian's Café) between Fall 2012 and Winter 2015; this included Fall 2014 when Sebastian's Café revitalized their grill menu, thus facilitating a quasi-experimental pre-post design (Harris et al., 2006). The cafeteria is accessed by graduate students (~20%), faculty (~50%), university employees (~30%), and visitors of the Harvard-Longwood Medical Area. New items were introduced with the goal of replacing red meat with other protein sources to improve both individual and planetary health, and to create more upscale and appealing offerings; no other notable changes were made during this period, and other stations including the salad bar, heart-healthy entrees, and pizza bar remained operational. Menu changes were not community-initiated, but rather supported by the administration.

Entrees and side dishes prior to menu changes and after the October 2014 menu redesign are detailed in Table 1. Sebastian's Café continued to intermittently offer some usual entrées and sides – particularly french fries – during Fall 2014. While usual entrées and side dishes were sold as combination meals, enhanced entrees and sides were sold individually, which increased the total price of purchasing an entrée and side dish. All data were collected from three fall semesters (2012–2014) and Winter 2015. We contrasted monthly sales and nutrients purchased from the usual menu from Fall 2012–Fall 2014 to the enhanced menu

from Fall 2014–Winter 2015. This study does not constitute human subjects research and was therefore exempt from Institutional Review Board review.

2.2. Data collection and analysis

2.2.1. Sales

Monthly sales data recorded by Sebastian's management between Fall 2012 and Winter 2015 were used to compute gross sales and revenue from individual grill items during each academic semester. For each item, we computed the average servings sold per month, the price/serving, gross monthly revenue from that item, and the nutrient content per serving. We then examined the average quantity sold, monthly revenue, and nutrient content for all entrees and all side dishes.

2.2.2. Nutrients

FoodPro software was used to estimate nutrient composition (ESHA, 2017) using recipes and portion sizes provided by the cafeteria. We calculated the composition of key nutrients from individual servings of entrées and sides (total energy (kcal), saturated fat (g), unsaturated fat (g), sodium (mg), and fiber (g)), to evaluate whether changes to the menu influenced: 1) the average nutrient composition of the items available and 2) the average nutrients purchased from the grill items, calculated from sales data as described below. Average nutrients purchased were evaluated across comparable grill categories to evaluate the combined effect of changing sales and changing nutrient composition on the overall nutritional composition of grill purchases. Nutrients selected were based on their associations with overall diet quality (McCullough et al., 2002) and based on the general nutrient composition of the foods evaluated. Trans-fat was not evaluated because cooking oils were trans-fat free during the study.

2.2.3. Statistical analysis

We calculated total nutrients purchased by multiplying total energy and nutrient content of each item by the number of servings sold and then summing total energy and nutrients purchased for all items. The average nutrients purchased per month during the period were calculated by dividing total energy or nutrient content by the number of months during which purchases were made. Finally, the average nutrient content purchased was computed by dividing average nutrients purchased by the average number of servings sold during the time period.

Wilcoxon Rank Sum tests were used to determine whether sales, revenue, and nutrients purchased of five classes of entrees and side dishes differed before and after the grill menu was redesigned. We examined the purchases of meat- and fish-based burgers, turkey burgers, meatless burgers, french fries, and other sides (Table 1). Analyses were conducted using SAS 9.4.

2.2.4. Consumer satisfaction

Consumer responses to menu changes were queried via email survey sent to the university community listserv by Sebastian's Café in Winter 2015. Participants were asked “Do you like the recent changes to the grill menu?,” to which they could respond: ‘yes,’ ‘no,’ ‘haven't noticed,’. They had the option to leave additional comments. An inductive approach was used to code free response comments using NVivo 11 software (QSR International Pty Ltd., 2012). The lead author initially identified thematic nodes, and consensus and refinement of those themes was established with the senior author; no discrepancies in coding were apparent. Quotations were selected based on their representativeness within each node.

Table 1
Entrées and side dishes served before and after menu redesign in a worksite cafeteria.

	Category	Before menu redesign	After menu redesign
Entrees	Meat and fish-based burgers	Hamburgers on a white bun Cheeseburgers on a white bun	Salmon burger on a whole wheat bun
	Turkey burgers	Turkey burger on a white bun	Turkey burger with guacamole on a whole wheat bun
	Meatless burgers	Garden burger on a white bun	Sweet potato and black bean burger on a whole wheat bun Beet and kale burger on a whole wheat bun
Side dishes	French fries	French fries	Sweet potato fries
	Other sides	Onion rings	Asparagus with hoisin sauce Crispy green beans

3. Results

3.1. Changes in sales and revenue before and after the menu redesign

Prior to the menu redesign (2012–2014), the cafeteria sold an average of 32,179 items/month and \$107,669 in total revenue; in the 5-months following the menu redesign, average sales were 29,711 items/month and \$102,703 monthly revenue (data not shown).

Similarly, the grill sold an average of 545 items/month and \$2228 in revenue prior to the menu redesign, and an average of 533 items/month and \$2105 in revenue following the menu redesign (data not shown). Prior to the new menu and the elimination of red meat, average gross sales of beef and turkey burgers decreased by 32% and 24%, respectively between Fall 2012 and Fall 2013 (Fig. 1; Panel A). Average gross sales from usual meatless burgers also declined between Fall 2012 and Fall 2013 by 77%. Gross sales of onion rings remained around 50 servings/month between Fall 2012 and 2014 (Fig. 1, Panel B) while gross sales of french fries progressively declined from about 200 to < 50 servings by Winter 2015. Overall, the new menu corresponded with higher gross sales of all grill items (1290 servings/month) compared to previous years (374 servings/month).

3.2. Changes in nutrient composition before and after the menu redesign

On average, the usual entrées provided 410 kcal, 7 g saturated fat, 10 g unsaturated fat, 700 mg sodium, and 4 g fiber (Table 2). The average enhanced entrée provided fewer calories (377 kcal), saturated fats (3 g), and sodium (686 mg), and more unsaturated fat (11 g) and fiber (5 g). The average nutrient composition of usual side dishes was 310 kcal, 1.9 g saturated fat, 19.8 g unsaturated fat, 147 mg sodium, and 2.2 g fiber. Enhanced side dishes generally provided nearly 70 fewer calories, comparable saturated fat, 7 g less unsaturated fat (due to reduction of deep fried foods), over 300 mg more sodium, and twice the amount of fiber.

3.3. Changes in revenue, price, and nutrients sold before and after the menu redesign

The price for a meat- or fish-based burger or combo meal (i.e. burger with french fries) was \$5.17 on average before the changes to the menu, and \$4.84 after the menu redesign (Table 3). The mean price of both turkey burgers (\$4.83) and meatless burgers (\$4.51) was lower before the menu changes compared to after (\$5.20 and \$5.51, respectively), although differences were only significant for turkey burgers. The price of french fries (\$1.95) and other side dishes (\$2.21) was also significantly lower before the menu changes compared to after (\$2.19 and \$2.96, respectively).

The sales and revenue from all entrées and side dishes, except meatless burgers, increased significantly following menu redesign (Table 3). The average energy content/serving of entrées purchased post-menu redesign was similar (430 vs. 431 kcal, $p = 0.32$). The calories/serving purchased from meat-based burgers (i.e. burgers made with animal flesh) increased after the menu change ($p \leq 0.001$), while

calories/serving purchased from meatless burgers decreased 14% ($p = 0.0005$). Average entrées post-menu redesign provided fewer grams of saturated fat, less sodium, and more unsaturated fat (including increased omega-3 fat). The mean calories/serving purchased from side dishes following the menu redesign was also lower (334 vs. 382 kcal, $p = 0.01$). The average calories/serving purchased from french fries and sweet potato fries increased post-menu redesign whereas fewer calories were purchased from onion rings and other side dishes. Average side dishes purchased also contained more sodium, and fiber, and fewer grams of unsaturated fat.

3.4. Customer responses to the redesigned menu

Customer satisfaction in response to the new menu was mixed. Among respondents ($n = 381$), the majority (71%) did not notice the changes, while 18% liked, and 11% disliked the changes. Qualitative analysis of 49 comments (13% of all respondents) revealed four themes: the importance of 1) variety, novelty, and choice; 2) cost, affordability, and value; 3) health; and 4) food quality and taste (Table 4). For the first theme, respondents commented on disliking the loss of variety in menu options despite enjoying the enhanced menu items initially, and criticized the loss of meat options and the daily offering of only three types of burgers. Eventual loss of novelty was also noticed. A second theme suggested frustration with cost, affordability, and value. Respondents reported that the enhanced burgers were overpriced, given the portion size and lack of included accompaniments. Consumers lamented the loss of “combos” versus having to purchase items separately without a commensurate adjustment to total price. Some suggested that higher prices could be reasonable if consumers knew they were paying for a worthy “premium” option.

A third theme emerged on health-related issues, highlighting an insufficient focus on health, the lack of vegan, vegetarian, and Halal options, and the presence of contradictory health messages. Comments within the taste and food quality theme mentioned the poor taste of the meatless burgers and issues with the freshness and quality of pre-made food being warmed under a heat lamp. Summarizing all comments, consumers generally liked the enhanced grill items, but would prefer greater variety of tasty and healthy options, and affordable combination meals.

4. Discussion

In October 2014, a university cafeteria redesigned their grill menu by phasing out red meat and other usual grill items for an enhanced menu, with the intention to provide nutritionally superior dishes aligned with consumer demand for affordable, tasty options. Evaluation of these changes on total purchases, sales, revenue, nutritional composition, and customer satisfaction revealed a complex landscape with respect to changing worksite cafeteria environments.

Notably, menu changes did not adversely influence sales, and in some cases, favorably impacted sales. The number of servings sold and average monthly revenue after the menu changes increased nearly 4-fold, partly attributable to increased prices for these items. Conversely,

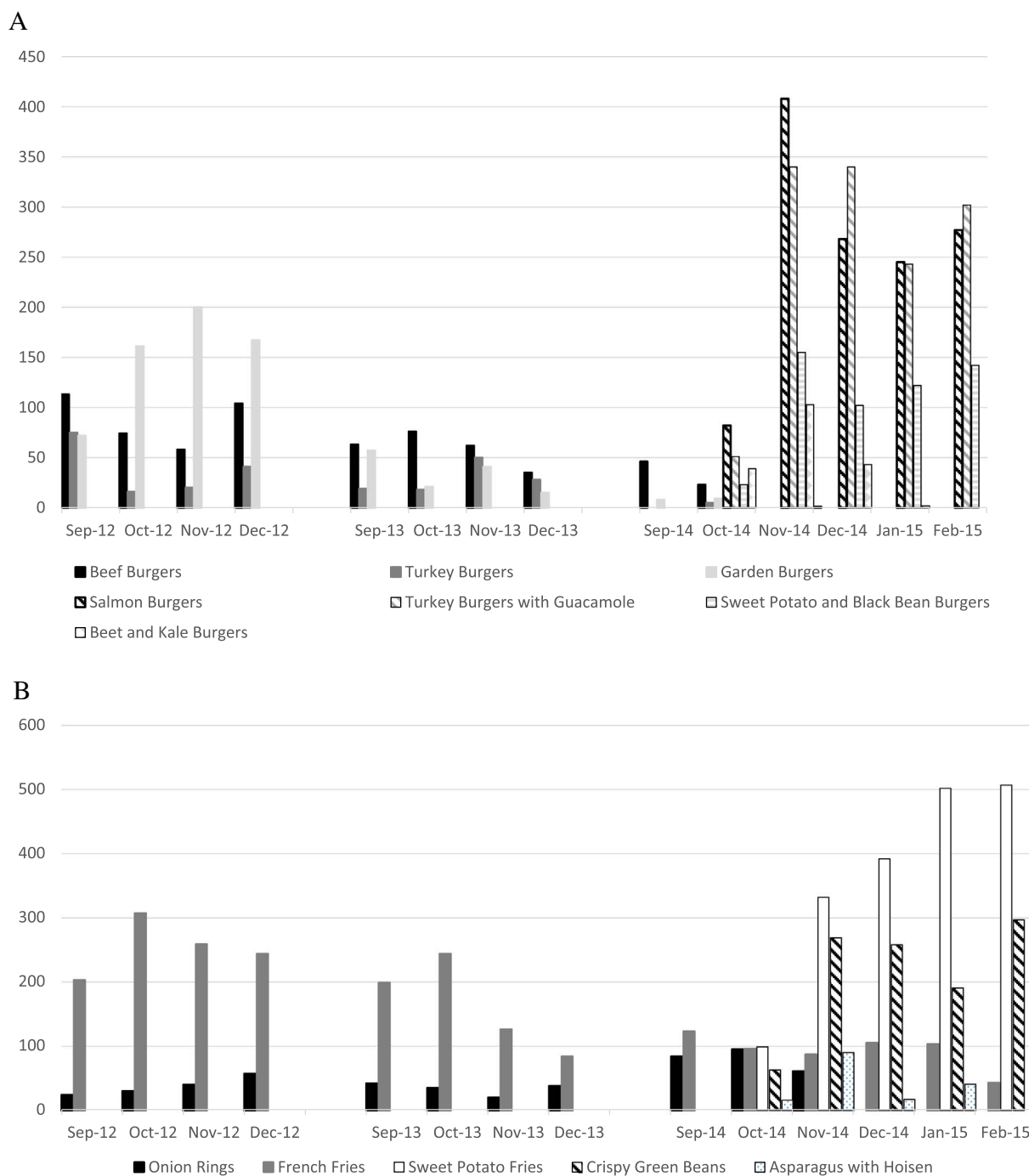


Fig. 1. Gross sales of usual and enhanced grill entrées and sides in a worksite cafeteria setting 2012–2015. Solid bars reflect usual grill entrées or side dishes whereas hatched bars reflect the enhanced entrées or side dishes.

This figure depicts the gross sales of usual (i.e. beef, turkey, and garden burgers) and enhanced (salmon, turkey, kale and beet, and sweet potato and bean burgers) grill entrées (Panel A) and usual (i.e. french fries and onion rings) and enhanced (i.e. sweet potato fries, crispy green beans, and asparagus) side dishes (Panel B) sold between Fall 2012 and Winter 2015. Enhanced items were introduced to the menu in October 2014.

the improvements in the nutritional profile of foods purchased were more equivocal. Although the average nutritional composition of the enhanced dishes was generally healthier, the composition of foods purchased was less clear, especially for sodium. Because the enhanced side dishes provided 350 mg more sodium on average, the total sodium purchased per month was > 3 times higher following the menu redesign. Much as the low-fat diet movement led to the development of products higher in sugars and starches to promote taste acceptance (Layman, 2014), shifting individuals to more nutrient-dense patterns may lead to higher sodium content to promote taste acceptance

(Kremer et al., 2009; Sharafi et al., 2013).

Our results are consistent with existing nutrition interventions within worksite cafeteria settings that have successfully promoted nutrient-dense foods. For example, within the same setting as our study, a price and educational intervention to promote healthful foods resulted in a modest, but sustained increase in healthful food purchases (Michels et al., 2008). Similarly, a color-coded labeling and choice-architecture intervention within a hospital cafeteria improved sales of healthy items and decreased sales of less healthy items (Levy et al., 2012; Thorndike et al., 2012). Finally, a large cluster controlled trial in workplace

Table 2
Nutrient composition per serving from worksite cafeteria grill entrées Fall 2012 (usual) to Winter 2015 (enhanced).

Item	Calories (kcal)	Saturated fat (g)	Unsaturated fat (g)	Sodium (mg)	Fiber (g)
<i>Usual items</i>					
Hamburger	416	6.8	13	496	3.8
Cheeseburger	550	16.4	13	1069	3.8
Turkey burger	303	3.7	9.1	357	1.2
Garden burger	372	0.8	6	876	7.8
Average nutrient composition for usual entrées ^a	410	6.93	10.3	700	4.15
Onion rings	196	1.5	15.3	186	0.4
French fries	424	2.2	24.2	108	4
Average nutrient composition for usual sides ^a	310	1.85	19.8	147	2.2
<i>Enhanced items</i>					
Salmon burger	549	7.4	24.6	874	3.6
Turkey burger with guacamole	374	2.8	10.7	617	3.5
Beet and kale burger	240	0.69	5.35	579	4.5
Sweet potato and black bean burger	345	0.05	5.05	675	8.9
Average nutrient composition for enhanced entrées ^a	377	2.74	11.4	686	5.13
Sweet potato fries	444	3.4	27	360	8
Asparagus with hoisin sauce	116	0.45	2.5	554	3.8
Crispy green beans	166	1	8.3	570	2.1
Average nutrient composition for enhanced sides ^a	242	1.62	12.6	495	4.63

^a The mean nutrient composition of all usual or enhanced entrées and sides irrespective of quantity sold.

settings found that a nutrition education and environmental intervention positively influenced saturated fat and salt intakes and nutrition knowledge in the treated group (Geaney et al., 2016).

Despite these successes, ongoing self-regulation can be depleting, leaving people vulnerable to failures of self-control (Heshmat, 2015). Because a person's ability to regularly refuse less healthy, but tasty foods diminishes with frequent temptation, having these foods readily available hinders individual and public health efforts to improve diet quality (Salmon et al., 2016). Thus, modifying the options available to consumers may improve diet quality more than nutrition education by requiring consumers to exert less restraint. Within school settings,

efforts to improve the nutritional profile of menu offerings have led to favorable changes in food purchases (Cluss et al., 2014), and some evidence suggests that both stealth approaches disguising healthier options (Myrdal Miller et al., 2014) and food reformulations (Combet et al., 2014) could improve nutrient intake. Additionally, explicitly labeling menu items with nutritional information has been shown to improve nutritional intake (Roberto et al., 2010).

Although the favorable sales data and survey results observed in the present study suggest that consumers are willing to accept healthier foods, consumer comments highlight some refinements worth considering for similar environmental change efforts. For example, many

Table 3
Average sales, revenue, and nutrients purchased of entrees and sides sold before and after menu redesign in a worksite cafeteria.^{a,b}

		Meat- and salmon burgers	Turkey burgers	Meatless burgers	French fries and sweet potato fries	Onion rings and other sides	All entrees	All sides
Servings sold/month	Pre	70 (25)	30 (22)	83 (74)	199 (74)	41 (19)	61 (32)	120 (36)
	Post	261 (108)	256 (119)	148 (68)	453 (160)	276 (96)	222 (94)	365 (106)
	p-Value	0.002	0.002	0.24	0.03	0.001	0.01	0.001
Revenue/month (USD)	Pre	363 (133)	142 (107)	430 (442)	384 (137)	92.2 (47.3)	312 (172)	238 (67.5)
	Post	1277 (552)	1334 (619)	821 (394)	1000 (366)	827 (313)	1144 (498)	914 (284)
	p-Value	0.004	0.002	0.19	0.01	0.001	0.01	0.001
Price (USD/serving)	Pre	5.17	4.84	4.51	1.95	2.21	4.84	2.08
	Post	4.84	5.20	5.51	2.19	2.96	5.19	2.58
	p-Value	0.05	0.001	0.16	0.004	0.002	0.01	0.003
Calories (kcal/serving)	Pre	527 (15.5)	303 (0)	372 (0)	424 (0)	196 (0)	431 (36.7)	382 (24.0)
	Post	549 (0.47)	373 (2.84)	319 (24.2)	439 (3.10)	165 (8.04)	430 (6.1)	334 (24.3)
	p-Value	0.001	0.0005	0.0005	0.0005	0.0005	0.32	0.01
Saturated fat (g/serving)	Pre	14.8 (1.11)	3.7 (0)	0.80 (0)	2.2 (0)	1.5 (0)	7.6 (2.8)	2.1 (0.07)
	Post	7.8 (0.84)	2.8 (0.04)	0.23 (0.19)	3.1 (0.19)	1.0 (0.12)	4.2 (0.46)	2.3 (0.23)
	p-Value	0.001	0.0005	0.0005	0.0005	0.0005	0.004	0.16
Unsaturated fat (g/serving)	Pre	13.0 (0)	9.10 (0)	6.0 (0)	24.2 (0)	15.3 (0)	9.7 (1.3)	22.5 (0.94)
	Post	24.1 (1.14)	10.7 (0.06)	5.2 (0.12)	26.4 (0.43)	8.6 (1.69)	14.7 (0.38)	19.6 (1.5)
	p-Value	0.0005	0.0005	0.0005	0.0005	0.0005	0.003	0.004
Sodium (mg/serving)	Pre	972 (66.2)	357 (0)	876 (0)	108 (0)	186 (0)	832 (93.8)	122 (8.2)
	Post	881 (16.7)	612 (10.4)	656 (17.3)	302 (39.1)	515 (90.9)	731 (14.6)	382 (52.2)
	p-Value	0.004	0.0005	0.0005	0.0005	0.0005	0.04	0.003
Fiber (g/serving)	Pre	3.8 (0)	1.2 (0)	7.8 (0)	4.0 (0)	0.40 (0)	4.9 (1.0)	3.3 (0.38)
	Post	3.6 (0.02)	3.5 (0.09)	7.8 (1.10)	7.1 (0.62)	2.1 (0.42)	4.5 (0.13)	5.1 (0.83)
	p-Value	0.0005	0.0005	0.49	0.0005	0.0005	0.95	0.003

^a Shown as mean (SD). Sales data were used to compute the servings sold, gross revenue, and nutritional composition of grill entrees and side dishes sold before (September 2012–September 2014, excluding summer) and after (October 2014–February 2015) menu redesign, which took place in October 2014.

^b Differences in sales and nutrient content pre- and post-menu redesign were computed for each category. Meat and salmon burgers included all beef burgers and salmon burgers, turkey burgers included the original turkey burger and the enhanced turkey burger with guacamole, and meatless burgers included the original meatless burgers and the enhanced sweet potato and black bean burgers, and beet and kale burgers. Following the menu design, some of the original items continued to be sold in the cafeteria in some months, which were incorporated into these analyses.

Table 4
Emergent themes and representative quotes from a consumer opinion survey after grill menu redesign in a worksite cafeteria.

Theme	Specific remarks	Representative quotes
Variety	Loss of variety	“More variety. Sick of the burger bar by day 2” “Every day burger station gets boring. Not enough variety. Would be nicer to have another meal option instead some days a week. Love the salmon burger but would still like more variety.”
	Loss of novelty	“Yes they are new, but now they are old.” “It has been the same menu for the main dishes everyday for a while (alternative between chicken and fish with minor differences in ingredients). What changes???”
Cost	High cost	“But I don't like how these items are priced. 5–6 dollars for a single burger (beef/turkey/salmon) with no sides and sometimes almost no toppings is outrageous.”
	Lack of value	“Now that the burger/sweet potato fries/fried green beans are no longer part of a single meal, they are over 6 dollars, when the old entrées were around \$5.30 and gave much more food. So now it's just more limited options and less food for a higher price.”
	Price for premium	“It would be one thing if everything was organic, locally sourced, free trade, or some other ‘premium’ characteristic that I was willing to pay for, but as far as I know this is the not the case, so I don't know what I'm paying for when I pay 7–8 dollars and change for a burger and fries.”
Health	Insufficient focus on health	“I think there are a lot of mixed messages. You can't get a burger because that is unhealthy, yet you'll pile on a huge serving of french fries.”
	Lack of healthy options	“I have avoid the Sebastian cafe in the past few months because it does not provide healthy and tasty warm food.”
	Contradictory health messages	“I understand we want to be healthy at this school, but there are plenty of healthy options already and if you're going to go down that route, why still serve chocolate cake?”
Taste	Poor taste of meatless burgers	“The grill items are dry and unappetizing. The changes have really impacted my desire to come here for lunch.”
	Low quality of pre-made food	“The food is overpriced and not made to order so the sandwiches sit under a heat lamp for so long that it is not fresh when consumed. When food is pre-made it is not customizable.”

consumers lamented a perceived loss of variety. It is well-established that variety reduces habituation and promotes satisfaction (Epstein et al., 2009a, 2009b), supporting the theme that emerged from the surveys and from similar studies (Miroso et al., 2016). Further, marketing research suggests that dining decisions are influenced by the perceived variety of options available – even if certain options are never selected (Kahn, 1995). In a university food setting, choice reduction negatively impacted customer satisfaction (Miroso et al., 2016). Thus, it may be important to provide a variety of healthy options to consumers to ensure ongoing satisfaction. Strategies to promote healthy foods should be transparent to consumers and include multiple food offerings, as consumers want unambiguous nutrition messages, fairness in choice, societal implications, and health information in interventions (Bos et al., 2013).

Although the environmental impact of food choices was not explicitly stated, the comment accentuating the “premium” value of foods that are ‘organic, locally sourced, or free trade’ underscores an opportunity to engage consumers around food choice as a larger social issue (Perry and Grace, 2015). The influence of food choice on social welfare may be particularly relevant to younger populations (Vilme et al., 2015), and even more so among individuals affiliated with universities, especially in the public health field. However, it is important to note that there is limited awareness of the environmental impact of food choice across other sectors (de Boer et al., 2016). Nevertheless, research among European consumers notes that consumers in worksite food-service settings value many dimensions including information transparency, value, variety, naturalness, nutrition, portion size, taste, origin, animal welfare, environmental impact, fair trade, and organic options (Price et al., 2016).

Sociologic theory posits that cultural shifts in norms and attitudes about the importance of sustainable food can be an important driver of individual eating behavior (Delormier et al., 2009). Eating is inherently social, so as the social landscape changes, population eating patterns and preferences are also shaped (Delormier et al., 2009). There has been an attitude shift toward environmental sustainability observed on some US college campuses (Emanuel and Adams, 2011; Hekler et al., 2010), and as societal attitudes toward sustainable food evolve, consumer preferences and demand for tasty, sustainable, healthful foods may increase, providing profitable retail opportunities in cafeteria settings. While consumers report that discounting healthy foods would incentivize their purchase (Steenhuis et al., 2011), our results imply that discounts may be less crucial for some if food choices are perceived

as healthier, upscale, or sustainable, which warrants further investigation.

Some limitations of the present study must be addressed, including the uncontrolled pre-post design, which could be biased by other time trends we could not control for. However, given the reluctance of many businesses to redesign their menu, promising preliminary analysis from a pre-post study may allay concerns about lost revenue. Our results may not be generalizable as the cafeteria had relatively healthy offerings initially, and the school of public health community may have been more health conscious than the general population. Similarly, response rate for the customer satisfaction survey was not collected, and it may be possible that responders differed from non-responders; nevertheless, customer responses complemented the objective sales data and provided further context. We were unable to examine net profitability because we lacked information on food or labor costs of preparing the new items. However, because total grill revenue increased 4-fold, profitability was likely improved or maintained. Finally, because the cafeteria menu continued to evolve, we were only able to observe changes over a 5-month period, and it is possible that trends would change over time. However, the relatively consistent observed trends and the slowly changing norms around increasing intake of healthful, sustainable foods suggest that these trends may continue.

Some strengths of this analysis also warrant mention. The interrupted time-series design of this quasi-experimental study reduces some of the concerns related to confounding and regression to the mean (Harris et al., 2006). Few studies have examined how environmental changes to promote healthful diets influence multiple stakeholders as well as the concomitant changes in the nutrient composition of foods purchased. We were able to examine how menu redesign influenced purchasing behavior in comparison to the same time period in previous years. The mixed-methods approach provided more comprehensive insight into important drivers of creating sustainable, health-promoting worksite food environments.

5. Conclusions

In conclusion, improving the health profile of menu offerings in a worksite cafeteria increased sales and revenue, and had a generally favorable impact on total calorie reduction and higher quality nutrients purchased by customers. Worksite cafeterias aiming to improve the healthfulness of their menus may benefit by conducting nutritional analysis to ensure that nutrient composition of new offerings is indeed

better, and that the taste and price are acceptable, before fully introducing them to the menu. Taste-testing and market analysis may facilitate similar menu redesigns, and inform retailers whether projected increases in healthier food purchases will allow lower price points for consumers while still sustaining profitability for retailers. Because reducing choice while increasing prices can result in customer dissatisfaction, it is critical to maintain variety and value of healthy options to ensure long-term customer satisfaction. Ongoing monitoring may facilitate evaluation of long-term effects on sales, consumer attitudes, and nutrients purchased. This should include in-person customer satisfaction surveys to increase response rates and to enhance understanding of varied groups of consumers. Finally, researchers interested in conducting larger worksite interventions should focus on presenting stakeholders with revenue, sales, and consumer satisfaction data to enhance cooperation with retailers and consumers.

Transparency document

The [Transparency document](#) associated with this article can be found, in online version.

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Ethics approval and consent to participate

This study does not constitute human subjects research and was therefore exempt from Institutional Review Board review.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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Authors' contributions

MV was involved with all facets of the study and responsible for the acquisition of data, analysis and interpretation, and drafting and revising the manuscript. VM was involved in the acquisition of data, analysis, and critical revision of the manuscript. DS was involved in the conception and design, acquisition of data, statistical analysis, and critical revision of the manuscript. WW was involved in the conception and design of the study, acquisition and interpretation of data, and critical revision of the manuscript. JM supervised the study from its conception, was involved with all facets of the study (e.g. conception

and design, acquisition of data, analysis, and critical revision of the manuscript), and takes final responsibility for its contents.

References

- Allman-Farinelli, M., Partridge, S.R., Roy, R., 2016. Weight-related dietary behaviors in young adults. *Curr. Obes. Rep.* 5, 23–29.
- Almeida, F.A., Wall, S.S., You, W., et al., 2014. The association between worksite physical environment and employee nutrition, and physical activity behavior and weight status. *J. Occup. Environ. Med./American College of Occupational and Environmental Medicine* 56, 779–784.
- de Boer, J., de Witt, A., Aiking, H., 2016. Help the climate, change your diet: a cross-sectional study on how to involve consumers in a transition to a low-carbon society. *Appetite* 98, 19–27.
- Bos, C., Van der Lans, I.A., Van Rijnsoever, F.J., Van Trijp, H.C., 2013. Understanding consumer acceptance of intervention strategies for healthy food choices: a qualitative study. *BMC Public Health* 13, 1073.
- Cluss, P.A., Fee, L., Culyba, R.J., Bhat, K.B., Owen, K., 2014. Effect of food service nutrition improvements on elementary school cafeteria lunch purchase patterns. *J. Sch. Health* 84, 355–362.
- Combet, E., Jarlot, A., Aidoo, K.E., Lean, M.E., 2014. Development of a nutritionally balanced pizza as a functional meal designed to meet published dietary guidelines. *Public Health Nutr.* 17, 2577–2586.
- Delormier, T., Frohlich, K.L., Potvin, L., 2009. Food and eating as social practice – understanding eating patterns as social phenomena and implications for public health. *Sociol. Health Illn.* 31, 215–228.
- Emanuel, R., Adams, J.N., 2011. College students' perceptions of campus sustainability. *Int. J. Sustain. High. Educ.* 12, 79–92.
- Engbers, L.H., van Poppel, M.N., Chin, A.P.M.J., van Mechelen, W., 2005. Worksite health promotion programs with environmental changes: a systematic review. *Am. J. Prev. Med.* 29, 61–70.
- Epstein, L.H., Robinson, J.L., Temple, J.L., Roemmich, J.N., Marusewski, A.L., Nadbrzuch, R.L., 2009a. Variety influences habituation of motivated behavior for food and energy intake in children. *Am. J. Clin. Nutr.* 89, 746–754.
- Epstein, L.H., Temple, J.L., Roemmich, J.N., Bouton, M.E., 2009b. Habituation as a determinant of human food intake. *Psychol. Rev.* 116, 384–407.
- ESHA, 2017. The Food Processor Nutrition Analysis Software, Portland, OR.
- Geaney, F., Kelly, C., Greiner, B.A., Harrington, J.M., Perry, I.J., Beirne, P., 2013. The effectiveness of workplace dietary modification interventions: a systematic review. *Prev. Med.* 57, 438–447.
- Geaney, F., Kelly, C., Di Marrazzo, J.S., et al., 2016. The effect of complex workplace dietary interventions on employees' dietary intakes, nutrition knowledge and health status: a cluster controlled trial. *Prev. Med.* 89, 76–83.
- Glanz, K., Resnicow, K., Seymour, J., et al., 2007. How major restaurant chains plan their menus: the role of profit, demand, and health. *Am. J. Prev. Med.* 32, 383–388.
- Harris, A.D., McGregor, J.C., Perencevich, E.N., et al., 2006. The use and interpretation of quasi-experimental studies in medical informatics. *J. Am. Med. Inform. Assoc.* 13, 16–23.
- Hekler, E.B., Gardner, C.D., Robinson, T.N., 2010. Effects of a college course about food and society on students' eating behaviors. *Am. J. Prev. Med.* 38, 543–547.
- Heshmat, S., 2015. Behavioral economics of self-control failure. *Yale J. Biol. Med.* 88, 333–337.
- Hudson Institute, 2013. Lower-calorie foods: it's just good business. In: Obesity Solutions Initiative. Hudson Institute, Washington DC.
- Jeffery, R.W., French, S.A., Raether, C., Baxter, J.E., 1994. An environmental intervention to increase fruit and salad purchases in a cafeteria. *Prev. Med.* 23, 788–792.
- Kahn, B.E., 1995. Consumer variety-seeking among goods and services: an integrative review. *J. Retail. Consum. Serv.* 2, 139–148.
- Kanjilal, S., Gregg, E.W., Cheng, Y.J., et al., 2006. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US adults, 1971–2002. *Arch. Intern. Med.* 166, 2348–2355.
- Kremer, S., Mojet, J., Shimojo, R., 2009. Salt reduction in foods using naturally brewed soy sauce. *J. Food Sci.* 74, S255–62.
- Layman, D.K., 2014. Eating patterns, diet quality and energy balance: a perspective about applications and future directions for the food industry. *Physiol. Behav.* 134, 126–130.
- Levy, D.E., Riis, J., Sonnenberg, L.M., Barraclough, S.J., Thorndike, A.N., 2012. Food choices of minority and low-income employees: a cafeteria intervention. *Am. J. Prev. Med.* 43, 240–248.
- McCullough, M.L., Feskanich, D., Stampfer, M.J., et al., 2002. Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. *Am. J. Clin. Nutr.* 76, 1261–1271.
- Michels, K.B., Bloom, B.R., Riccardi, P., Rosner, B.A., Willett, W.C., 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.
- Mirosa, M., Loh, J., Spence, H., 2016. The possibilities of reducing food choice to improve the performance of college foodservices. *J. Acad. Nutr. Diet.* 116 (7), 1163–1171.
- Myrdal Miller, A., Mills, K., Wong, T., et al., 2014. Flavor-enhancing properties of mushrooms in meat-based dishes in which sodium has been reduced and meat has been partially substituted with mushrooms. *J. Food Sci.* 79, S1795–804.
- Ni Mhurchu, C., Aston, L.M., Jebb, S.A., 2010. Effects of worksite health promotion interventions on employee diets: a systematic review. *BMC Public Health* 10, 62.
- Perry, B.D., Grace, D.C., 2015. How growing complexity of consumer choices and drivers of consumption behaviour affect demand for animal source foods. *EcoHealth* 12,

- 703–712.
- Price, S., Hartwell, H., Hemingway, A., Chapleo, C., 2016. Workplace foodservice; perception of quality and trust. *Appetite* 97, 169–175.
- Roberto, C.A., Larsen, P.D., Agnew, H., Baik, J., Brownell, K.D., 2010. Evaluating the impact of menu labeling on food choices and intake. *Am. J. Public Health* 100, 312–318.
- Roy, R., Kelly, B., Rangan, A., Allman-Farinelli, M., 2015. Food environment interventions to improve the dietary behavior of young adults in tertiary education settings: a systematic literature review. *J. Acad. Nutr. Diet.* 115, 1647–1681 (e1).
- Salmon, S.J., Adriaanse, M.A., Fennis, B.M., De Vet, E., De Ridder, D.T.D., 2016. Depletion sensitivity predicts unhealthy snack purchases. *Appetite* 96, 25–31.
- Sharafi, M., Hayes, J.E., Duffy, V.B., 2013. Masking vegetable bitterness to improve palatability depends on vegetable type and taste phenotype. *Chemosens. Percept.* 6, 8–19.
- Steenhuis, I.H., Waterlander, W.E., de Mul, A., 2011. Consumer food choices: the role of price and pricing strategies. *Public Health Nutr.* 14, 2220–2226.
- Story, M., Kaphingst, K.M., Robinson-O'Brien, R., Glanz, K., 2008. Creating healthy food and eating environments: policy and environmental approaches. *Annu. Rev. Public Health* 29, 253–272.
- Thorndike, A.N., Sonnenberg, L., Riis, J., Barraclough, S., Levy, D.E., 2012. A 2-phase labeling and choice architecture intervention to improve healthy food and beverage choices. *Am. J. Public Health* 102, 527–533.
- Vilme, H., Lopez, I.A., Walters, L., et al., 2015. Perspectives of stakeholders on implementing a farm-to-university program at an HBCU. *Am. J. Health Behav.* 39, 529–539.