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ORIGINAL RESEARCH

A randomized study of food pantry environment-level change following the SuperShelf intervention

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Abstract

The charitable food system is rapidly evolving. Interventions that target the food pantry environment and use behavioral economics are in high demand, but can be difficult to implement in a low-resource setting. This is an analysis of secondary, environment-level outcomes in a food pantry intervention (SuperShelf); the study evaluates whether the intervention resulted in measurable changes to the food pantry environment and improved diet quality of the food available to clients, compared with a control group of food pantries. Eleven food pantries were randomized to an intervention ($n = 5$) or control ($n = 6$) condition and completed baseline and one-year follow-up measures between 2018 and 2020. The intervention addressed healthy food supply and the appeal of healthy foods using behavioral economics. Assessments included manager surveys, intervention fidelity, food inventory, and food supply tracked over 5 days. Measures included change in intervention fidelity (range 0–100) with four subcomponents; Healthy Eating Index scores (HEI-2015, range 0–100) with 13 subcomponents; and Food Assortment Scoring Tool scores (FAST, range 0–100). Descriptive analyses and *t*-tests examined pre–post changes within and between intervention arms. Average fidelity scores increased from baseline to follow-up in the intervention group compared with the control group ($p < .001$), as did FAST scores ($p = .02$). Average HEI-2015 Total scores increased in the intervention group by 6.3 points and by 1.6 points in the control group, but the difference in change between groups was not statistically significant ($p = .56$). The intervention was implemented with high fidelity at five sites, with some evidence of change in the nutritional quality of the food available on the shelf to clients.

Keywords

Food insecurity, Food pantry environment, Behavioral economics intervention, Intervention fidelity, Charitable food system

Implications

Practice: SuperShelf is a feasible model for food pantry intervention that could be expanded to choice-based food pantries outside of Minnesota.

Policy: Policies that strengthen the procurement of healthy food in the charitable food system (e.g., The Emergency Food Assistance Program) can support food pantries in implementing nutrition-focused changes.

Research: Additional research is needed to understand secular trends in the nutritional quality of food in the charitable food system, and to evaluate multilevel interventions that measurably improve it.

INTRODUCTION

Food pantries comprise an integral part of the food assistance safety net for those experiencing food insecurity [1,2]. Clients who rely on the charitable food system often do so frequently and for long periods of time [3–6]. Clients often get a large portion of their food from the pantry; a statewide survey conducted in Minnesota found that more than half of clients received the majority of their food from the food pantry in the past 6 months, including a substantial portion of their total fruits and vegetables [7]. The nutritional quality of food received at the food pantry is generally higher than food that clients consume from other sources [5,6,8,9], making it an especially important source of food for low-income visitors who may have an elevated risk of diet-related chronic diseases, like diabetes and hypertension [10–12].

Food pantries emerged about 50 years ago as part of an informal charitable food system that aimed to distribute food, usually pre-packed, to those facing short-term emergencies. Food pantries have since proliferated and have come to work in tandem with federal nutrition programs in mitigating food insecurity [1]. More recently, food pantries have also been called upon as partners in distributing government-supported commodity foods [13], and in addressing other health and social needs of clients [14]. The role of food pantries in the community was especially pronounced in the early months of the COVID-19 pandemic, when usage of food pantries increased by an estimated 55% [15].

In the last decade, a growing body of research has begun to measure the quality of food in the charitable food sector and evaluate interventions to improve it [3,16–22]. Most interventions have focused on nutrition education and cooking classes for clients

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[12,18]. Alternately, some interventions in food pantries have targeted the food pantry environment, for example, by encouraging healthier food sourcing or targeting client behavior. In particular, food pantries have begun making environment changes using behavioral economics to nudge certain food selections [3,17,23–26]. Behavioral economics uses strategies such as choice architecture to shape human decisions [27]; in the public health context, behavioral economic strategies are used to make a healthy choice the easiest choice [28]. As such, they aim to change individual behavior while minimizing time and resource burdens on the individual.

Understanding how well environmental and nudging strategies can be implemented is critical in food pantries, where the capacity of staff and volunteers is often stretched and budgets are limited [1]. Data also suggest that food pantry staff and volunteers harbor some skepticism that clients want healthy foods at all, or know how to cook them [29–31]. Data from food pantry clients contradict these perceptions [32–35]. A statewide survey of over 5,000 Minnesota clients demonstrated a consistent preference for healthy, staple foods like meat, fruits and vegetables, and dairy, and suggested that their challenge was consistently accessing these foods at the pantry. The overwhelming majority of clients said that they would like to provide their household with more fruits and vegetables, and that someone in their household knew how to prepare many fruits and vegetables [7].

The misalignment of staff and volunteers' orientation and clients' realities yields a potential "buy-in" challenge for interventions in the charitable food sector that could limit the successful implementation of changes within the sector. Indeed, in a pilot evaluation of a community-led food pantry intervention, SuperShelf, such implementation challenges were apparent. SuperShelf relies on a skilled consultant to work with food pantries over a period of several months on a "transformation" process to improve both the supply of healthy food available to clients, as well as the appeal of those foods as clients are making their selections. The 2019 SuperShelf pilot evaluation transformed two intervention sites, but only one with high fidelity to the planned intervention process; the nutritional quality of client food selection improved significantly only in the food pantry with high intervention fidelity [3]. The SuperShelf intervention has since undergone further development and consultant training. A rigorous evaluation was conducted to examine client-level outcomes in an expanded study with 16 sites randomized to an intervention or control condition. The aim of the current study is to explore secondary, environment-level outcomes in the intervention, specifically, how well the SuperShelf intervention was implemented in a group-randomized study, and whether the intervention resulted in changes in measures of the food pantry nutritional quality compared with a control group of pantries.

METHODS

Overall study design

The study was a group-randomized intervention evaluation in 16 food pantries in Minnesota [36]. Pantries were selected to participate through an application process that occurred in two waves and drew 62 unique applicants. To participate, pantries were required to have "full client-choice," in which food was displayed on the shelf and clients were able to physically select or decline food from all different food groups. They were also required to have a worker who could devote 4–6 h per month to implementing intervention activities. Applications were reviewed by a team of community and research partners and were ranked, based on their responses, on capacity to implement the intervention, whether data collection and study timeline goals were feasible at the site, and whether the pantry could be reasonably matched to another pantry prior to randomization—for example, a single food pantry that served only college students was not selected to participate.

In total, 16 food pantries were selected to participate. Baseline data were collected over two waves of eight food pantries (February–May 2018 and February–June 2019). Follow-up data were intended to be collected at each site after 1 year. However, due to the COVID-19 pandemic, in March 2020, food pantries were closed for indoor visits and began distributing prepacked food bags outdoors. At this time, in-person data collection measures were terminated, before follow-up data were collected in five Wave 2 pantries. Therefore, 11 sites completed baseline and follow-up data. The primary outcome of the larger evaluation study (and the outcome on which the sample size was based) was change in food pantry client diet quality from baseline to follow-up; results of that analysis are forthcoming.

Randomization

Within each wave, the selected food pantries were matched prior to randomization. Three factors were used in matching: (1) Rural-Urban Commuting Area (RUCA) Codes [37] which measure area population density and urbanization, which range from 1 (for more dense, more urban areas) to 10 (for less dense, less urban areas); (2) regional food bank areas, which reflect different primary food sourcing agencies for the pantry; and (3) the interventionist who would be assigned to work with each food pantry, which was based on University of Minnesota-Extension SNAP-Ed educator region. Each food pantry was matched with the pantry with the same or closest RUCA code. If more than one pair could be formed with the same RUCA code, food bank region and then interventionist were used as additional factors. Randomization was conducted by the project manager using a virtual coinflip generator (available at www.random.org) to flip four coins at once in each

wave, with one of each food pantry in each pair designated as heads, the other designated as tails, and the coinflip outcome representing selection to the intervention group. Control food pantries received no intervention during the data collection period (baseline and 1-year follow-up), but were supported in completing intervention activities in their food pantry following the study data collection (i.e., delayed intervention).

Intervention

SuperShelf is a collaborative community-led intervention developed by a core team of representatives from a food shelf, a food bank, an integrated healthcare system, a university research team, and the university's Extension services [38]. The aim of SuperShelf is to transform food shelves by creating welcoming environments for communities to access appealing, healthy foods. Transformations (the intervention) focused on two major phases of change. In the first phase, which focused on the supply side, the aim was to operationally embed strategies at the food pantry to increase consistent access to healthy and culturally appropriate foods and meet intervention-defined stocking standards. In the second phase, the aim was to improve the shopping experience for clients and use behavioral economics to make the healthiest choice the easiest choice. Specifically, the food pantry was arranged into food groups, much like a grocery store, with a focus on increasing the visual prominence and appeal of healthy foods and decreasing that of less healthy foods. The intervention approach was guided by a set of values identified by the core team, meant to promote client-centeredness (good food, respect for all, collaborative partnership, evidence-based practices, and systemic thinking).

Trained SuperShelf consultants, who were most commonly SNAP-Ed educators at the University of Minnesota-Extension, worked with each food pantry over a period of months during each transformation. In the first phase, consultants worked with pantry staff, particularly those responsible for ordering food, along with their food bank representatives, to increase the quantity and variety of healthy food available to clients. Using historical ordering data, consultants examined the mix of existing food sources at the pantry, their purchasing priorities, their donation patterns, and the utilization of The Emergency Food Assistance Program (TEFAP) foods. They suggested tradeoffs in ordering to minimize spending on less healthy food and increase spending on healthy and culturally appropriate items while staying within budget. They also suggested ways to maximize free and low-cost healthy food sources such as TEFAP and retail rescue, leverage donation streams through messaging, and seek out new sources of healthy foods (e.g., from community gardens, local farmers, and produce distributions). Sourcing fruits and vegetables in all forms, including canned, frozen, dried, and fresh, was encouraged. A set of stocking standards developed with input from charitable food staff [39] served as the benchmark for pantries to maintain a consistent supply of healthy staple foods on the shelf (not just in backstock).

In the second phase, the intervention used behavioral economics to increase the prominence and appeal of healthy foods and improve the overall shopping environment. Consultants worked with pantry staff to reorganize foods into major food group categories on the shelf and in a particular order, much like in a grocery store, with fruits and vegetables always first, followed by grains, proteins, dairy, cooking, and baking items. Last in the shopping order were processed food categories such as snacks, beverages, canned and boxed meals, and desserts. Consultants also addressed pantry layout to further prioritize healthy foods and increase ease of shopping.

Next, consultants examined how food was offered to clients and how much of each type of food they were allowed to take. It is customary for food pantries to set limits on most food items and offer some specific foods by default. These practices may be more prescriptive than necessary. For example, at the first SuperShelf food pantry, the practice had previously been to offer each household one pancake mix, one syrup, and one baking flour per visit without substitutions, which served as an unintentional nudge to take these specific products even if they would not otherwise have been selected. The food pantry was then arranged to promote healthy foods (e.g., by putting fruits and vegetables first, by putting whole grains at eye level, by arranging them in attractive displays, and bundling them with other foods to make a meal). The approach also de-emphasized less healthy foods such as baking mix and syrup by grouping them in larger categories. For example, all baking items, condiments, and spices were grouped together and clients could make their selections within those options. Finally, SuperShelf branded signs were placed around the food pantry to label food groups. Overall, these practices promoted healthy items, eliminated less healthy defaults and made shopping more akin to a grocery store experience.

Data collection and measures

Pantry characteristics

Food pantry manager surveys at baseline and follow-up assessed pantry characteristics, including monthly households served, monthly pounds of food distributed, number of full-time employees, number of freezers, and number of coolers. At baseline, one food pantry did not report the number of monthly households served or monthly pounds of food distributed, so these data were drawn from their site's

application. Food pantry urban/rural status was assigned based on Rural-Urban Commuting Area (RUCA) code classifications [37] 1–4 (more urban) versus 5–10 (more rural). If a different manager completed the survey at follow-up from baseline, the food pantry was considered to have a change in managers.

Intervention fidelity

The intervention fidelity tool assessed the degree to which components of the intervention were implemented as intended. Fidelity was measured at both intervention and control sites at baseline and follow-up. Measurement at control sites was intended to capture secular changes occurring in the broader charitable food sector. Fidelity was measured using a walkthrough checklist to assess features of the pantry environment. The tool was developed in the study pilot [3] and was slightly modified for the current study by assigning more points for culturally appropriate foods and fewer points for aesthetics and use of space. The assessment was completed by the study's Community Outreach Coordinator or another study staff. The range of the intervention assessment tool was 0–100 based on the sum of four scores representing core intervention components: (1) aesthetics/use of space (28 points), (2) unhealthy food de-emphasis (21 points), (3) healthy food prominence and appeal (22 points), and (4) stocking standards (29 points). Component scores were coded so that higher scores represent higher fidelity.

Pantry inventory

Inventory was assessed at baseline and follow-up in intervention and control food pantries. The data collection team took a "snapshot" of all food that was available for clients to choose at their visit in the same week as other study measures were collected. Inventory measures did not include backstock. Assessments were completed when the pantry was closed to clients but stocked as it would be for client shopping. For all products, data collectors recorded the item name, brand, net product weight, exact count of the product, and special nutritional notes on the label (e.g., reduced sodium, reduced fat). Data were obtained from package labels or, for unlabeled items like produce, items were weighed on a scale with the container weight (e.g., bin, cart) subtracted.

Next, data were entered into the Nutrition Data System for Research (NDSR) [40], a computer-based software application maintained by the Nutrition Coordinating Center at the University of Minnesota. NDSR assigns values for 174 nutrient, nutrient ratios, and other food components, and includes over 18,000 foods and over 160,000 food variants. In the current study, foods were searched in NDSR by their exact profile (brand, preparation, form, etc.), with a generic version or a substitute with similar nutrient profile selected if an exact match could not be found. For processed or prepared foods, if an acceptable substitute could not be found, the food product would be assembled as a recipe of individual ingredients using the nutrition facts label and ingredients list. All foods from the pantry were able to be coded in NDSR using this method.

Healthy Eating Index-2015 scores

The Healthy Eating Index (HEI) is an assessment tool developed and evaluated by the National Cancer Institute (NCI) and the U.S. Department of Agriculture (USDA) [41,42]. Its most recent version, HEI-2015, measures the extent to which a set of foods aligns with the 2015–2020 Dietary Guidelines for Americans [43], HEI-2015 scores are comprised of a Total score with a maximum of 100 and 13 subcomponent scores, each with a range of 0–5 or 0–10 [41]. Subcomponents include nine adequacy components (Total Fruits, Whole Fruits, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, and Fatty Acids) and four moderation components (Refined Grains, Sodium, Added Sugars, and Saturated Fats). Scores are generated by deriving ratios of dietary constituents to energy (or, in the case of fatty acids, the ratio of poly- and monounsaturated fatty acids to saturated fatty acids) [41]. For all subcomponents, higher scores represent higher diet quality.

FAST scores

The Food Assortment Scoring Tool (FAST) was designed to be used by food pantry staff and volunteers to track the diet quality of food within the pantry [44]. Food pantries were instructed to sort and weigh all food that was moved onto the shelves and available for clients into 1 of the 13 FAST categories. The FAST data collection occurred over a period of 5 consecutive days that the food pantry was open to clients during the baseline and follow-up evaluation weeks. FAST scores were generated though an Excel Macro-Enabled Workbook, which access user forms, data, and calculation worksheets. Pantry users simply entered the date, occasion and 13 food category weights each day, from which FAST scores were automatically calculated and saved. Food pantry staff and volunteers received a webinar training on the use of this workbook, as well as tools for sorting and weighing foods into the correct categories.

Unlike the HEI, FAST is calculated without requiring uncommon software or detailed nutrition information for each product. FAST scores are generated after sorting and weighing food into categories by multiplying each category's gross weight share by a previously established healthfulness parameter, and summing the categories for a total score (range

Table 1 | Characteristics of intervention and control food pantries participating in the SuperShelf evaluation

	Intervention (n = 5)		Control (n = 6)	
	Pre	Post	Pre	Post
Monthly household served, mean (min–max)	346 (120–888)	447 (120–900)	530 (300–1100)	672 (280–1350)
Monthly pounds of food distributed, mean (min–max)	31,488 (7,653–76,889)	38,135 (8,973–13,165)	29,388 (9,000–47,000)	35,398 (14,500–53,500)
Monthly pounds distributed per household, mean (min–max)	89 (51–148)	81 (50–110)	59 (30–85)	56 (38–72)
Full-time employees, median (min–max)	1 (0–1)	1 (0–2)	1 (0–3)	2 (0–3)
Number of freezers, median (min–max)	3 (2–7)	3 (1–4)	3 (2–12)	3 (2–14)
Number of coolers, median (min–max)	4 (2–5)	3 (1–5)	2.5 (1–10)	3 (2–11)
Change in food pantry manager from pre to post				
Yes, *N* (%)	NA	2 (40.0%)	NA	2 (33.3%)
No, *N* (%)	NA	3 (60.0%)	NA	4 (66.7%)
Food pantry RUCA[a] Code				
Urban (RUCA Code 1–4), *N* (%)	3 (60%)	3 (60%)	3 (50%)	3 (50%)
Rural (RUCA Code 5–10), *N* (%)	2 (40%)	2 (40%)	3 (50%)	3 (50%)

[a]Rural Urban Community Area Code.

0–100). The healthfulness parameters were developed using out-of-sample forecasts with data from a Minnesota food bank [45]. FAST implementation in Minnesota food pantries has been previously tested, and the correlation between FAST and HEI-2010 scores has been shown to be 0.80 for availability measures at a single time point [44].

Analysis

Statistical analyses were performed in SAS v.9.4 (SAS Institute Inc., Cary, NC). Descriptive statistics (mean or median and standard deviation for continuous variables, frequency and percent for categorical variables) were calculated by intervention arm for baseline and follow-up. To calculate HEI scores, NDSR Intake Properties Totals (file 04) and Serving Count Totals (file 09) output files were used along with the publicly available NCC SAS code and guide for the NCI's "simple HEI scoring algorithm" [46,47] to calculate HEI-2015 total and component scores for pantry inventory. Paired *t*-tests were used to test for statistical significance in change from baseline to follow-up within intervention arms. Two-sample *t*-tests were used for differences in change between intervention arms. The larger evaluation study was powered to detect changes in individual food pantry client behavior rather than site-level environment change, thus statistical analyses should be interpreted noting the small sample size for these site-level variables. p values were considered statistically significant if $p < .05$.

RESULTS

There were no harms or unintended consequences observed in the study.

Pantry characteristics

Table 1 presents characteristics from 11 food pantries (5 intervention, 6 control) at baseline and follow-up. At baseline, intervention food pantries on average served fewer households per month than control food pantries (342 households per month compared with 530 households), but distributed more food on average (31,487 total monthly pounds compared with 29,387 total pounds). The number of households served and total monthly pounds of food distributed increased moderately from baseline to follow-up in both intervention arms. At baseline, food pantries in both arms had a median of 1 full-time employee; this stayed the same at follow-up for intervention food pantries and increased to 2 at follow-up for control sites. Food pantries in both arms had a median of 3 freezers, which did not change from baseline to follow-up. The median number of freezers was 4 at baseline in the intervention pantries and 3 at follow-up; it was 2.5 at baseline in the control group and 3 at follow-up. During the study period, two intervention and two control pantries had changes in their managers. Three pantries in each of the intervention and control groups were located areas with RUCA codes 1–4, and the remaining pantries were located in areas with RUCA codes 5–10.

Fidelity scores

Average total and subcomponent fidelity scores at baseline and follow-up are presented in Table 2 by intervention arm. Average total fidelity scores in the intervention group increased from baseline to follow-up from 57.9 to 91.1 compared with the control group where fidelity scores decreased from 56.9 to 53.2. The difference between intervention arms was statistically significant ($p < .001$). For three fidelity components (aesthetics/use of space, healthy food promotion, and unhealthy food de-emphasis), the intervention group had an increase in scores and the control group had a decrease in scores that was statistically significant between arms. For the stocking standards subcomponent, scores increased in both in the intervention and control group, with no statistically significant difference ($p = .59$).

Changes in fidelity for individual food pantries are presented in Fig. 1. In the intervention group, each total score and subcomponent score increased from baseline to follow-up, except for the site with the highest stocking standards score at baseline, which decreased two points at follow-up. Changes in total and subcomponent scores in the control group were mixed.

Food pantry HEI-2015 scores

Average total HEI-2015 and subcomponent scores at baseline and follow-up are presented in Table 2 by intervention arm. Average total HEI-2015 scores increased in the intervention group by 6.3 points and in the control group they increased 1.7 points, but this difference was not statistically significant ($p = .56$). Changes in HEI-2015 subcomponents are presented in a radar plot in Fig. 2 by intervention arm. In the intervention food pantries, no changes were statistically significant, but changes from baseline to follow-up were positive for the Greens and Beans, Added Sugars, Saturated Fats, Total Vegetables, Whole Grains, Whole Fruits, Total Fruits, and Refined Grains subcomponents. In the control food pantries, change from baseline to follow-up was statistically significant and positive for the Refined Grains subcomponent ($p < .001$), but was not statistically significant between the intervention and control groups. In the control food pantries, changes from baseline to follow-up were positive but not statistically significant for the Saturated Fats, Whole Grains, Whole Fruits, Total Fruits, Sodium, and Refined Grains subcomponents.

FAST scores

Average FAST scores at baseline and follow-up are presented in Table 2 by intervention arm. FAST scores increased in the intervention group from 59.6

Table 2 | Change in intervention fidelity scores, Healthy Eating Index-2015 (HEI-2015) scores, and Food Assortment Scoring Tool (FAST) scores in the SuperShelf intervention

	Intervention (n = 5)			Control (n = 6)			
	Pre	Post		Pre	Post		
	Mean(SD)	Mean (SD)	*p*-value for pre-post change	*Mean (SD)*	*Mean (SD)*	*p*-value for pre-post change	*p*-value for difference in mean change
Total fidelity score (0–100)	57.9 (5.3)	91.1 (4.4)	<.001	56.9 (11.6)	53.1 (11.2)	.36	<0.001
Aesthetics/use of space (0–28)	13.3 (2.0)	25.9 (1.4)	<.001	13.8 (1.3)	12.0 (2.4)	.15	<0.001
Healthy food promotion (0–21)	11.4 (2.5)	18.6 (0.9)	.003	12.3 (2.2)	11.2 (4.0)	.48	0.002
Unhealthy food de-emphasis (0–22)	11.2 (1.8)	19.8 (1.8)	<.001	15.5 (4.2)	11.3 (4.1)	.19	0.003
Stocking standards (0–29)	22.0 (3.0)	26.8 (1.8)	.06	15.3 (6.7)	18.7 (5.7)	.12	0.59
Total HEI-2015 (0–100)	67.2 (3.5)	73.5 (5.0)	.07	63.2 (4.9)	64.8 (15.1)	.81	0.56
Total vegetables (0–5)	4.2 (0.8)	4.3 (1.0)	.94	4.1 (1.4)	3.7 (1.7)	.72	0.74
Greens and beans (0–5)	4.7 (0.5)	4.9 (0.2)	.41	4.6 (1.1)	4.3 (1.4)	.74	0.57
Total fruits (0–5)	1.9 (0.6)	2.7 (1.2)	.22	1.6 (0.9)	2.3 (1.5)	.25	0.88
Whole fruits (0–5)	3.0 (0.9)	4.1 (0.6)	.08	2.8 (1.4)	3.4 (1.4)	.43	0.57
Whole grains (0–10)	7.4 (2.2)	9.7 (0.5)	.08	4.6 (1.9)	4.0 (2.4)	.62	0.10
Dairy (0–10)	3.0 (1.4)	2.3 (1.0)	.25	2.9 (1.6)	4.1 (3.1)	.51	0.33
Total protein foods (0–5)	5.0 (0)	5.0 (0)	Not estimated[a]	5.0 (0)	4.0 (1.7)	.21	0.21
Seafood and plant proteins (0–5)	5.0 (0)	5.0 (0)	Not estimated[a]	5.0 (0)	4.5 (1.3)	.36	0.36
Fatty acids (0–10)	8.5 (1.5)	7.6 (3.4)	.51	8.4 (2.1)	5.8 (4.7)	.26	0.53
Sodium (0–10)	3.8 (2.6)	2.8 (2.6)	.63	4.5 (3.3)	5.6 (3.9)	.45	0.38
Refined grains (0–10)	3.4 (3.2)	6.7 (2.2)	.07	1.3 (1.7)	7.7 (1.5)	<.001	0.07
Added sugars (0–10)	8.8 (0.6)	9.0 (1.1)	.64	9.1 (1.3)	9.8 (0.4)	.14	0.30
Saturated fats (0–10)	8.5 (1.4)	9.4 (0.7)	.34	9.2 (1.3)	5.7 (4.6)	.16	0.12
FAST score (0–100)	59.6 (2.1)	63.6 (2.3)	.08	62.6 (5.4)	60.4 (2.5)	.16	0.02

[a]All food pantries scored the maximum score on these subcomponents at pre and post so a *p*-value for change could not be estimated.

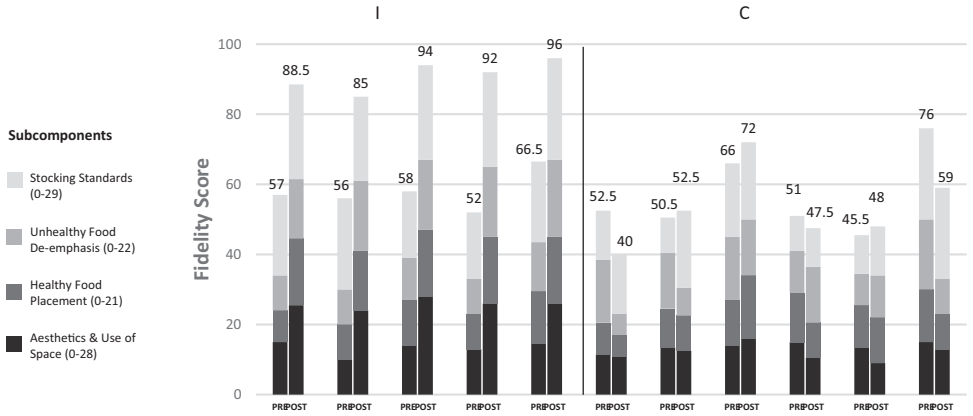

Fig. 1 | Baseline (pre) to follow-up (post) change in fidelity total and subcomponent scores in 11 Minnesota food pantries randomized to intervention (I) and control (C) conditions in the SuperShelf evaluation.

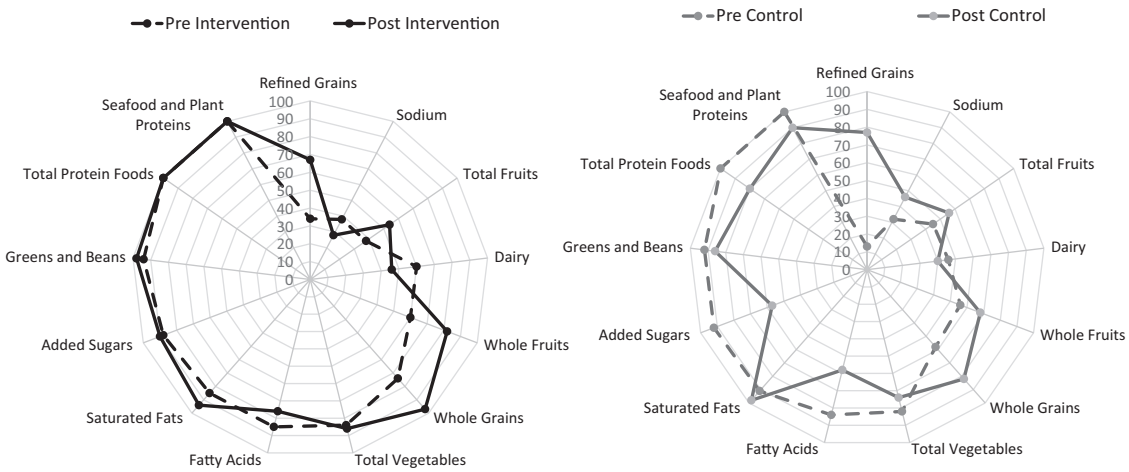

Fig. 2 | Radar plot depicting baseline (pre) and follow-up (post) percent of the maximum possible score for each Healthy Eating Index-2015 subcomponent in intervention ($n = 5$) and control ($n = 6$) food pantries, based on food pantry inventory measures in the SuperShelf evaluation.

to 63.3 compared with the control group, whereas average FAST scores declined from 62.6 to 60.4. The difference between intervention arms was statistically significant ($p < .02$).

DISCUSSION

In the current study, the SuperShelf intervention was successfully implemented in food pantries randomized to the intervention group, as measured by change in fidelity scores and compared with a control group. Increases in aesthetics/use of space, healthy food promotion, unhealthy food de-emphasis, and stocking standards were consistently observed in the food pantries with baseline and follow-up assessments. This was an improvement from the previous pilot study, where one out of two sites transforming encountered implementation challenges [3]. As the pilot study was conducted, SuperShelf methods were formalized through investment in a Community Outreach Coordinator and multiple trainings to build capacity among consultants. SuperShelf was also programmatically integrated into University of Minnesota-Extension SNAP-Ed [48]. SuperShelf transformations have now become widespread in Minnesota; between and 2013 and 2020, 40 food pantries completed transformations using Supershelf methods [49]. Although COVID-19 temporarily disrupted the momentum of the work, food pantry staff sustained their interest, and transformations are currently underway in nearly a dozen food pantries.

Although the intervention was implemented as intended and HEI-2015 scores of the food inventory increased moderately in the intervention arm, there were no statistically significant increases in HEI-2015 scores above the control group. When considering changes in HEI subcomponent scores, results are broadly congruent with the intervention activities; the largest improvements were in subcomponents that were emphasized in the intervention, including Fruits and Vegetables, and Whole and Refined Grains; by contrast, Sodium, Dairy, and Fatty Acid Ratio subcomponent scores decreased in the intervention arm, and these

subcomponents were not specifically emphasized in the intervention.

FAST scores, which measure nutritional quality in the food that moves through the pantry over 5 days, demonstrated improvement compared with the control group. Intervention changes in HEI-2015 scores and FAST scores were similar in magnitude, but FAST scores had notably smaller standard deviations. The inventory measure on which the HEI score was based had two major limitations compared with the FAST measure. First, the inventory measure was a "snapshot" measure of all food on the shelf available to clients on a single day at baseline and follow-up. Although food pantries were instructed to stock their pantry as it would be at the beginning of a day when clients visited, inventory will naturally vary day to day, depending on factors such as how recently a pantry received food from a food bank or gleaned food from local donors. It is possible that inventory measures reflect unusually high or low amounts of certain food groups (e.g., less perishable food if a typical grocery delivery was delayed). In contrast, the FAST measured all food stocked on the shelf over a period of 5 days, which decreases the likelihood that data reflect an unusual assortment of food. Second, inventory at a food pantry may be a measure with considerable lag compared with the FAST. Nonperishables may remain on the shelf for extended periods of time—perhaps *especially* if they are not appealing or promoted by the pantry—and so inventory may be a relatively poor reflection what is being currently stocked by staff or selected by clients. The FAST, in contrast, may be a better indicator of the food that is currently in high demand at the pantry. As has been discussed in previous studies, multifaceted nutritional quality assessments can be useful in the unique context of the food pantry [22].

Secular changes in food pantry organizational practices were evident in the current study; across the intervention arms, food pantries served more households and distributed more total pounds of food in the follow-up period compared with baseline. This trend is consistent with other data suggesting that food pantry use has steadily increased each year in Minnesota [50]. Secular changes in food sourcing may also account for some of the changes in nutritional quality observed in both intervention arms. Additional research is needed to understand how the nutritional quality of food pantry sources is changing over time, and whether changes are concentrated in food sourced from food banks, donations, or federal commodity foods, such as The Emergency Food Assistance Program (TEFAP) [51].

Efforts to improve the charitable food system food supply have been gaining momentum across the United States [14,52–54]. For example, guidelines for healthy food in the charitable food system were recently created by an expert panel [52], and systems for charitable food agencies to rank foods based on these guidelines are being widely adopted and evaluated [21,25]. Guidelines for donations from retailers and distributors have also recently emerged as an additional tool for pantries [54]. The SuperShelf intervention aligns well with these other emerging tools to maximize the availability of healthy food in this sector, and could be tested as multilevel interventions in future evaluations. Elements of the SuperShelf approach that might particularly enhance nutrition guideline toolkits include its focus on client-centered practices, the individualized technical assistance provided by consultants during implementation, and the focus on aesthetic changes, which may motivate food pantry decision-makers to make changes.

Rapid changes transformed the charitable food system in the midst of the COVID-19 pandemic, and questions remain about how interventions like SuperShelf might be adopted or adapted in the post-pandemic era. For example, through the American Rescue Plan Act, increased USDA investment in TEFAP will provide an enhanced stream of nutritious food to the system from local and regional farmers in the coming years, including fresh fruits and vegetables [13]; interventions like SuperShelf that promote new food sourcing are needed to effectively distribute these foods and maximize the effectiveness of federal investments. On the other hand, the COVID-19 pandemic yielded potential setbacks in implementing transformational changes in this sector. For example, choice-based food shopping experiences were scaled back, as nearly all food pantries offered prepacked bags to mitigate risk, and pantries struggled to cope with increased demand and supply chain challenges [55]. It remains to be seen how food pantries will operate following this prolonged period of uncertainty.

Several limitations of this study should be acknowledged. This was an analysis of secondary, environment-level outcomes in a group-randomized study that was terminated early due to the COVID-19 pandemic. Power to detect changes between arms was limited by the small number of food pantries in each arm. It is also possible that high baseline scores on some fidelity and HEI subcomponents yielded a ceiling effect so that it was not possible to observe positive changes in scores. In particular, HEI subcomponents Seafood and Plant Protein, Total Protein, and Greens and Beans were above 90% of the maximum possible score at baseline; along with natural day-to-day variation of inventory and stocking within food pantries, it may have been especially difficult to capture improvements in these subcomponents and, therefore, in Total HEI scores.

Overall, the study results demonstrated that the SuperShelf was implemented with measurable changes to aesthetics/use of space, healthy food promotion, unhealthy food de-emphasis, and meeting stocking standards for healthy food. There was evidence of modest improvement in some indicators of nutritional quality. Although improvements in inventory were mostly not statistically significant compared with the control group, this may be explained by the rapid secular changes in the broader charitable food sector, the small number of pantries in each arm of the study, and limitations associated with the inventory measure. The components of SuperShelf align with other client-centered and nutrition-focused initiatives that are being rapidly adopted across the United States; additional research is warranted to explore layers of interventions in this setting, particularly those that address food systems-level changes. Additional planned analyses will look at whether, beyond being well-implemented, client experiences using the food pantry and dietary behaviors changed as a result of these successful changes in food pantries.

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Compliance with Ethical Standards

Conflict of Interest: None declared.

Primary Data: Findings reported have not been previously published and this manuscript is not being simultaneously submitted elsewhere. Data have not been previously reported elsewhere. The authors have full control of all primary data and agree to allow the Journal to review data if requested.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Transparency statements

- The study was pre-registered at https://clinicaltrials.gov/ct2/show/NCT03421106.
- The analysis plan was not formally pre-registered.
- De-identified data from this study are not available in a public archive. De-identified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author.
- Analytic code used to conduct the analyses presented in this study are not available in a public archive.
- They may be available by emailing the corresponding author.
- Some of the materials used to conduct the study are presented in a public archive: www.supershelfmn.org.

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