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THE IMPACT THE SMARTER LUNCHROOM MOVEMENT STRATEGIES HAVE ON SCHOOL CHILDREN'S HEALTHY FOOD SELECTION AND CONSUMPTION: A SYSTEMATIC REVIEW

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ABSTRACT

Purpose/Objectives

In 2009, the Smarter Lunchroom Movement (SLM) strategy was created to provide schools across the United States (US) with evidence-based solutions to encourage healthier eating among children. Results, though, are inconsistent with how well this movement impacts school-aged children's healthy food selection and consumption. Thus, the purpose was to systematically review peer-reviewed literature on the SLM strategies and their impact on school-aged children's (Kindergarten – 8th grade) healthy food selection and consumption.

Methods

A 3-stage process: search, distillation, full-text review was used to identify appropriate articles. In the search phase, peer-reviewed articles were identified from CINAHL, ERIC, PubMed and Scopus databases. In the distillation phase, articles were evaluated using a 9-point inclusion criterion. In the full-text review stage, data extraction and quality of articles were evaluated using the Academy of Nutrition and Dietetics Evaluation Criteria.

Results

In the search phase, 1,669 articles was retrieved. In the distillation phase, articles that did not meet the 9-point inclusion criteria, such as they were conducted outside of the U.S. (n=284) or participants were younger than kindergarten or older than 8th grade (n=589), were removed; thus 38 articles remained for full-text review. In the full-text review phase, 11 articles remained after further data extraction. Results from these studies showed that regardless of the SLM strategy employed, children selected healthier food items. However, SLM strategies that promoted consumption of healthy foods were those that involved children in naming food products, in taste-testing, or in creating marketing materials.

Application To Child Nutrition Professionals

Analysis of published research showed that involving children in the process led to an increased consumption of healthy foods. Thus, school nutrition personnel can implement low-cost methods to involve children in the marketing and promotion of healthy foods within the cafeteria to improve their consumption of healthy foods.

Keywords: Behavioral Economics, Smarter Lunchroom Movement, School-Aged Children, Healthy Food Selection and Consumption

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INTRODUCTION

In 2016, 30.4 million United States (US) children participated in the National School Lunch Program (NSLP) (USDA, 2017). This program was created in 1946 through USDA's Food and Nutrition Service for children who attended non-profit private and public schools to receive low-cost or no-cost lunches based on standard nutritional government guidelines (USDA, 2016). To improve the diets of children, the Healthy, Hunger-Free Kids Act of 2010 authorized funding and set policy for the USDA to increase the variety of vegetables, offer more whole fruits over fruit juice, serve reduced-fat milk, require grains-based products to be whole grain-rich, and establish calorie maximums (USDA, 2013, 2016). To decrease any potential food waste, the "offer vs serve" option was maintained, giving children the option to choose at least three of five food items offered as part of the reimbursable lunch meal (USDA, 2013, 2015). The intention of the reforms was to improve nutrition, yet school districts across the US encountered challenges in implementing them.

The consequential impacts of these requirements have resulted in increased food costs and decreased the number of children purchasing lunch (Government Accountability Office, 2014; Thiagarajah, Getty, Johnson, Case, & Herr, 2015). Additionally, some studies have shown an increased amount of fruit, vegetable, and milk waste (Bontrager Yoder, Foecke, & Schoeller, 2015; Byker, Farris, Marcenelle, Davis, & Serrano, 2014; Cohen, Richardson, Parker, Catalano, & Rimm, 2014; Cravener et al., 2015; Gase, Mccarthy, Robles, & Kuo, 2014; Niaki, Moore, Chen, & Weber Cullen, 2017; Smith & Cunningham-Sabo, 2013). One reason food waste may occur is due to children' inability to express their freedom of choice by having to take these healthier food items (Just & Wansink, 2009a). Therefore, interventions addressing children's behaviors and the school environment should be considered and implemented in combination with policy changes (Hawley, Beckman, & Bishop, 2006; Thomson & Ravia, 2011).

Role of Behavioral Economics

Behavioral economics utilizes theories from psychology and traditional economics to "nudge" one to make a better choice (Bonell, McKee, Fletcher, Wilkinson, & Haines, 2011; Patel & Volpp, 2015; Thorgeirsson & Kawachi, 2013). A "nudge" is a subtle change to the environment that does not impede on the freedom of choice, but instead encourages the selection of the healthier choice by making it the easier choice (Hanks, Just, Smith, & Wansink, 2012; Hanks, Just, & Wansink, 2013b). Since the early 2000s, behavioral economics has gained popularity among various health promotion fields, including nutrition, to translate the scientific evidence into practical and effective behavior-change interventions such as elementary schools' cafeterias (Bickel, Moody, & Higgins, 2016; Contento, 2016; Cornell University, 2015; The Food Trust, 2012; Thorgeirsson & Kawachi, 2013).

Cornell University's Center for Behavioral Economics in Child Nutrition Programs (BEN), created the Smarter Lunchrooms Movement (SLM) in 2009 that is based on six principles within behavioral economics (Cornell University, 2015). This movement strives to provide schools across the US with research-based solutions to encourage healthier eating among children and to maintain school lunch participation and sales (Cornell University, 2015). There are eight main strategies and about 60 sub-strategies that schools may use to nudge children to select healthier foods. Schools can implement one or more of these strategies and sub-strategies to encourage consumption of healthier foods (Cornell University, 2015; D. Just & Price, 2013; Thorgeirsson & Kawachi, 2013). However, results from studies that have used these strategies have been inconsistent in whether these strategies lead to children increasing their selection and consumption of healthy foods. Thus, the purpose of this study was to systematically review peer-reviewed literature on the SLM strategies and their impact on school-aged children's

(Kindergarten – 8th grade) healthy food selection and consumption based on the 2010 Healthy, Hunger-Free Kids Act requirements.

METHODOLOGY

Search Strategy

The review was conducted by two independent researchers using the Preferred Reporting Items for Systematic review and Meta-analysis (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009). Identification of studies followed a three-step process: i) search, ii) distillation, and iii) independent review, as shown in Figure 1. To assess the quality of the identified studies, the researchers used the Quality Criteria Checklist from the Academy of Nutrition and Dietetics (AND) Evidence Analysis Manual (AND, 2016). The AND checklist was chosen as it provides several in-depth questions within several experimental design classifications. Other quality-assessment tools, such as Consolidated Standards for Reporting Trials (CONSORT), Strengthening of Reporting of Observational Studies in Epidemiology (STROBE), and Transparent Reporting of Evaluations with Nonrandomized Designs (TREND), focus on certain research designs and are limited in the complexity and depth of questions to assess a study's quality (Myers, Parrott, Cummins, & Splett, 2011). No IRB approval was acquired due to no humans or animals were involved in this study.

In the first phase or search step, the researchers used four databases: CINAHL, ERIC, PubMed and Scopus databases. The searches were completed for studies that were peer-reviewed, available in English, and published between January 2009 and November 2017. The following keywords were used, in varying combinations, when searching for articles: "behavioral economics," "children (Kindergarten – 8th grade)," "smarter lunchroom," "food choice," and "consumption". Literature searches were combined into Covidence, a software to assist in screening and removing duplicate articles.

Article Screening

The second phase of the systematic review process was the distillation phase. This involved one researcher reading through the titles and abstracts to identify articles that met the following nine inclusion criteria: (1) peer-reviewed studies; (2) research articles published between January 2009-November 2017; (3) articles available in English; (4) studies conducted in the US; (5) participants in studies were children (Kindergarten-8th graders) or schools; (6) studies were experimental; (7) interventions took place in a school cafeteria environment; (8) intervention included a SLM strategy; and (9) outcomes measured food selection and/or food consumption. Studies with titles and abstracts that did not meet the above criteria were excluded by the researchers.

In the third and final screening phase, digital and hard copies of all remaining articles were obtained and the two researchers independently reviewed each of them in their entirety using the 9-point inclusion criteria. If the reviewers disagreed about including an article in the results, a discussion took place until an agreement was obtained. The peer-reviewed articles that satisfied the 9-point inclusion requirements were accepted by the researchers for this systematic review.

Data Extraction

Table 1 was constructed and organized to compare the data extracted from each article included in this systematic review. The data extracted included the first authors' last names, date of publication, experimental design, duration, location of study, target population, intervention groups, SLM main strategy, interventions, evaluation measures, and intervention impacts.

Table 1. ***Data extraction of studies included in systematic review (n=11)***

Authors (Year)	Design/ Duration	Location	Population/ Intervention Groups	Smarter Lunchroom Movement Strategies	Interventions for Treatment Group(s)	Evaluation Measures	Intervention Impacts
Goto et al. (2013)	Observation Pre-post control trial/ 2 weeks	California	1st-6th graders N = 677 children Group 1 (n=247 children) Group 2 (n=153 children) Control (n=277 children)	Move More White milk	Ask for chocolate milk (group 1) Increased quantity of white milk (group 2) No changes in milk displays or having the children ask for milk (control)	Milk selection (observation – 5 days pre-intervention/ 5 days post-intervention)	Selection: White milk selection increased among group 1 when having to ask for chocolate milk compared to control group ($p<0.001$) No change in white milk selection for group 2 compared to control group ($p > 0.05$)
						Milk consumption (counted empty containers/ weighed milk remaining in cartons)	Consumption: No change in white milk consumption for groups 1 and 2 compared to control group ($p=0.5$)
						Milk waste (weighed milk remaining in cartons)	Waste: Milk waste remained the same for groups 1 and 2 compared to control group ($p>0.05$)
Greene et al. (2017)	Observation Pre-post control trial/ 9 weeks (3 week pre-intervention, 6-week intervention)	New York	5th-8th graders N = 7, 752 trays Fruit group (4 schools, 4,139 trays) Control group (3 schools, 3,613 trays)	Focus on Fruit	Interventions: Placement of fruits, Cut fruits, Whole fruits displayed, Fruits labeled with creative names, and Positive fruit facts posted in the cafeteria Control: no changes in cafeteria/information presented about fruits	Fruit selection (observation)	Selection: Increased in treatment schools from pre-post intervention ($p<0.001$) Decreased in control schools ($p<0.001$)
						Fruit consumption (visual estimate and record remaining amount of fruit on tray)	Consumption: Increased in treatment schools from pre- post intervention ($p<0.001$) Decreased in control schools ($p<0.001$)

Table 1. ***Continued***

Gustafson et al. (2017)	Observation Pre-post control trial/ 5 months (1 month pre-intervention, 1 month design, 1 month promotion, follow up period 2 months post-intervention)	Nebraska	K-5th graders N = 435 (children) Treatment groups: 1) Control (n=71) 2) Participation only (n=107) 3) Marketing only (n=109) 4) Participation and marketing (n=148)	Student Involvement: Focus on Vegetables	1) Control: no posters mounted or children participated 2) Participation only: children designed the posters 3) Marketing only: Posters mounted above salad bar 4) Participation and marketing: children designed the posters and then they were mounted above the salad bar	Vegetable selection/consumption/waste (digital photography-based plate waste)	Selection: Promotion period – increase in selection of vegetables among all three intervention groups compared to control group ($p > 0.05$) Consumption: Promotion period - Participation and marketing group increased consumption of vegetables compared to control group ($p < 0.001$) and other conditions ($p < 0.05$) Follow-up period – Participation and marketing group increased vegetable consumption compared to pre-intervention ($p = 0.04$); Marketing only group increased vegetable consumption compared to pre-intervention ($p < 0.01$). No statistical significance comparing participation and marketing group to marketing group only. Waste: Promotion period - Increase in vegetable waste among marketing only and participation and marketing groups compared to pre-intervention ($p<0.05$)
Huynh et al. (2015)	Cross-sectional/ 1 week	26 states across USA	K-6th graders N = 606 schools (137 school districts across 26 states)	Highlight the Salad	Format, placement and location of salad bars	F/V selection (calculating the amount of produce available at the start of lunch period to the amount left over after the lunch period)	Stand-alone fruit and vegetable bars increased F/V selection compared to F/V incorporated into the line ($p < 0.001$) Salad bars that were visible before hot line bar increased F/V selection compared to those salad bars placed after hot line bar ($p = 0.001$) Salad bars that offered more choices increased F/V selected compared to

							salad bars that offered less choices (p = 0.001)

Table 1. ***Continued***

Just & Price (2013)	Pre-post observational/ 1 academic year	Utah	K-8th graders 15 elementary schools (n=29,880 tray observations baseline; 17,534 treatment) District 1 (treatment) District 2 (no treatment)	Focus on Fruits, Vary the Vegetables	Required children to place a F/V on tray, choice of F/V (district 1) No requirement to place F/V on tray (district 2) Children who consumed a serving of F/V were provided a small reward	F/V consumption (visual of how much was consumed) F/V waste (visual of how much was discarded)	Consumption: No difference in consumption of F/V between the districts (p = 0.47) Waste: District 1 increased food waste when required to take a F/V compared to District 2 where there was no requirement (p = 0.000)
Loweenstein et al. (2016)	Pre-post observational/ 18 months (5 week treatment)	Utah	1st-6th graders 40 elementary schools (n=8,000 children, 400,000 trays) 40 Schools were randomized for providing the incentives for 3 weeks (n=22 schools) or 5 weeks (n=18 schools)	Focus on Fruits, Vary the Vegetables	Incentives for children who consumed at least 1 serving of fruit or vegetables	F/V consumption (observed amount of F/V consumed from trays)	Increase in F/V consumption from 3 or 5-week periods compared to baseline (p<0.01) No difference post-intervention follow-up period of 1-2 months for 3 or 5-week incentive period (p>0.10)
Miller et al. (2016)	Pre-post experimental/ 4 weeks (2 weeks baseline, 2 weeks intervention)	Florida	4th&7th graders for control; 5-6th graders for intervention N = 169 Treatment 1 (n=71) Treatment 2 (n=72) Control (n=433)	Boost Reimbursable Meal	Pre-ordering (treatment 1) Pre-ordering with behavioral cues (treatment 2) No pre-ordering or behavioral cues (control group_	F/V and milk selection (observed the number of F/V and milk taken from the tray line)	Increase in selection of F/V and milk in intervention of treatments 1 2 and control groups compared to baseline (p<0.05) Increase in F/V and milk selection in treatment 2 compared to treatment 1 and control groups (p<0.05) Increase in F in treatment 1 compared to control group (p<0.05)

Table 1. ***Continued***

Schwartz et al. (2018)	Longitudinal Observational / 2 years (40 days of data – Time 1 (2010 to 2011) and Time 2 (2012 to 2013), milk promotion tested 6 additional days (2012 to 2013))	New England	K-8th graders 2 schools (n=13,883 trays): School 1 (n=379) School 2 (n=391)	Move More White Milk	School 1: Interventions took place for 6 days and only 1 was tested for milk selection and consumption: 1)marketing – school administrators milk moustache and placed in the cafeteria line 2)multiple locations – milk placed at the beginning and end of the lunch line 3)rewards – children informed stickers were on the bottom of some milk cartons 4)automatic placement – a carton of milk placed on each tray at beginning of line by cafeteria staff School 2: No interventions took place	Milk selection (children who selected milk researcher marked student's grade and sex on each carton) Milk consumption (subtracting weight of a full carton of milk and adjusting for weight of the carton amount consumed)	Selection: Milk selection increased over the 2-year period in both schools 1 and 2 ($p<0.05$) At time 1, children in K-4th and 8th grade selected more milk in both schools 1 and 2 ($p<0.001$). At time 2, children in K-6th selected more milk in both schools 1 and 2 ($p<0.001$) Intervention period: None of the behavioral economic strategies employed in school 1 affected milk selection compared to non-intervention period. Consumption: Milk consumption decreased from time 1 to time 2 ($p<0.001$), except for K and 7th grades in which consumption stayed the same at both schools 5-8th graders consumed more milk than K-4th graders at both time periods at both schools ($p<0.001$)

Table 1. ***Continued***

Snelling et al. (2017)	Pre-post experimental/ 1 academic year	Northwest state	K-5th graders 4 schools (n=5,296 observational trays) Treatment (n=2 schools) Control (n=2 schools)	Vary the Vegetables	Treatment 2 schools: Taste-testing vegetables prior to placing them on the menu. Prepared 1 vegetable the traditional way (steam, unseasoned or raw) and 2 vegetables a novel way: Broccoli – 1)with soy sauce and ginger or 2) with parmesan dip Black beans – 1) chili spiced or 2) pineapple black bean salad Spinach – 1) cooked with garlic or 2) cooked with curry spice For the taste testing, children tried all 3 preparations and indicated which one was their favorite. Control 2 schools: no taste-testing and not informed that a vegetable with a specific preparation technique was being served.	Vegetable consumption (using application V-Project to indicate via observation if children consumed 0-100% of meals) Based on taste testing results: The preparation technique that was most preferred was placed on the cafeteria menu and flyers were posted in the cafeteria to indicate this vegetable and the preparation technique was being served.	Increased consumption of preferred broccoli technique – with soy sauce and ginger at taste-testing schools, 65%, compared to control schools 40% Increased consumption of preferred black bean technique – chili spiced at treatment schools from 32% at follow up 1 to 23% at follow up 2 compared to consumption at control schools with follow up 1 at 16% and follow up 2 at 11%. Increased consumption of preferred spinach technique – with garlic at treatment schools for follow up 1 at 28% and 17% at follow up 2 compared to control schools with follow up at 18% and follow up 2 at 9%.

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Table 1. ***Continued***

Song et al. (2013)	Quasi-experimental pre-post trial/ One academic year	Maryland	2nd-6th graders N = 665 Group 1 (n=332; 8 schools) Group 2 (n=142; 2 schools) Control (n=191; 2 schools)	Lunchroom Atmosphere	Group 1: Nutrition education based on Social Cognitive Theory and cafeteria changes. 8 nutrition education units, 4 lessons within each unit Group 2: Cafeteria changes with no education Control – No cafeteria changes or nutrition education	Self-reported F/V selection, preference & consumption (self-reported student preference and consumption survey)	Self-reported preferences for whole grains, fruits, and vegetables increased among group 1 compared to groups 2 and control ($p<0.05$) Increasing children's fruit and vegetable consumption using nutrition education and active choice principles
Wansink et al. (2013)	Pre-post experimental/ 8 weeks	New York	6th – 8th graders 6 elementary schools N = 2150 children Treatment group (3 schools) Control group (3 schools)	Focus on Fruit	Treatment group: Pre-sliced apples served. 2 schools allowed children to choose the sliced apples. 1 school put the pre-sliced apples on all children' trays regardless if they wanted it or not. Control group: whole apples served	Fruit sales (based on apple amount consumed compared to if children selected these apples) Fruit consumption/waste (observed based on the amount of apple consumed – either number of sliced apples consumed or portion of whole apple consumed)	Sales: Treatment groups increased apple sales on average by 71% compared to control groups ($p<0.01$). Consumption/Waste: 73% of children in the treatment group consumed more than half of the pre-sliced apples compared to baseline ($p=0.03$) Treatment groups decreased food waste by 6% after sliced fruit was introduced, but not significant ($p=0.11$)

Notes: F/V = fruit and vegetable

Critical evaluation of material

The AND's Quality Criteria Checklist guided the evaluation of these studies. These systematic, unbiased methods consisted of two parts: relevance and validity. Relevance determines a study's usefulness to the nutrition profession and is defined by four questions. If responses to all four questions were "yes", the researchers then proceeded to the validation questions, otherwise the article was removed from the systematic review.

For validity, 10 domain questions were used to determine the quality of each article. These 10 questions addressed the following study elements: research question, subject selection, study population, withdrawals, blinding, intervention/exposure, outcomes, analysis, conclusion of support, and likelihood of bias (AND, 2016). A comprehensive description of each criterion is found in the AND's Evidence Analysis Manual (AND, 2016). Each question within the validity portion of the checklist was answered with a 0 = "yes", 1= "no", 2= "unclear", or 3= "not applicable". An article was determined high quality (+) if responses to at least five validity criteria were yes. An article was determined low quality (-) and subsequently removed from further analysis if the responses to at least six criteria were no. An article was determined neutral (Ɵ) if responses to four validity criteria were no or unclear.

After two researchers independently reviewed the articles, they evaluated the quality of the articles based on the Quality Criteria Checklist. Inter-rater reliability using a quadratic weighted Cohen's kappa was used to account for the degree of disagreement among raters (Landis & Koch, 1977). To determine inter-rater reliability, each reviewer's response to each question of the Checklist was entered into SPSS (v24). Cohen kappa results were interpreted as follows: values ≤ 0 indicate no agreement; 0.01–0.20 indicate none to slight agreement; 0.21–0.40 indicate fair agreement; 0.41– 0.60 indicate moderate agreement; 0.61–0.80 indicate substantial agreement; and 0.81–1.00 indicate almost perfect agreement (Landis & Koch, 1977).

RESULTS AND DISCUSSION

Article Selection

A total of 1,669 articles was identified from the first search phase: CINAHL (n=50), ERIC (n=42), PubMed (n=667), and Scopus (n=910) databases. In the second, or distillation phase, 273 articles were found to be duplicates and therefore removed. Then, using the 9-point evaluation criteria checklist, the researchers reviewed the remaining 1,396 articles. A total of 1,358 articles was removed through this stage. Articles removed were not peer-reviewed or unpublished studies (n=4), were not in English (n=2), were conducted outside of the US (n=284), included participants who were younger than kindergarten or older than 8th grade (n=589), were non-experimental (n=54), did not take place in a school cafeteria environment (n=321), took place outside of traditional school hours (n=14), did not use a SLM strategy (n=77), and outcomes were not food selection and/or food consumption (n=13). A total of 38 articles remained and the full-length of the articles were reviewed independently by two researchers. A total of 24 articles was excluded because they were not conducted in the US (n=2), there was no experimental design (n=6), intervention did not occur in a school (n=6), intervention did not use a SLM strategy (n=6), and the participants were not in kindergarten - 8th grade (n=4). During final discussions, articles were further eliminated because their outcomes did not measure food selection and/or food consumption (n=3). Thus, a total of 11 peer-reviewed articles was accepted (See Figure 1, below).

These 11 peer-reviewed articles were evaluated based on the Quality Criteria Checklist among the two researchers. All 11 studies were considered high-quality as more than seven out of the ten validation questions had a response of yes. The most common factors that influenced the validity of these studies were the demonstration of adjustments in statistical analyses for withdrawals, limited explanation of withdrawals, and length of the study duration (i.e. short studies of two weeks). The overall Cohen kappa scores from the two researchers was 0.67, which demonstrates substantial agreement among the pair (Landis & Koch, 1977)

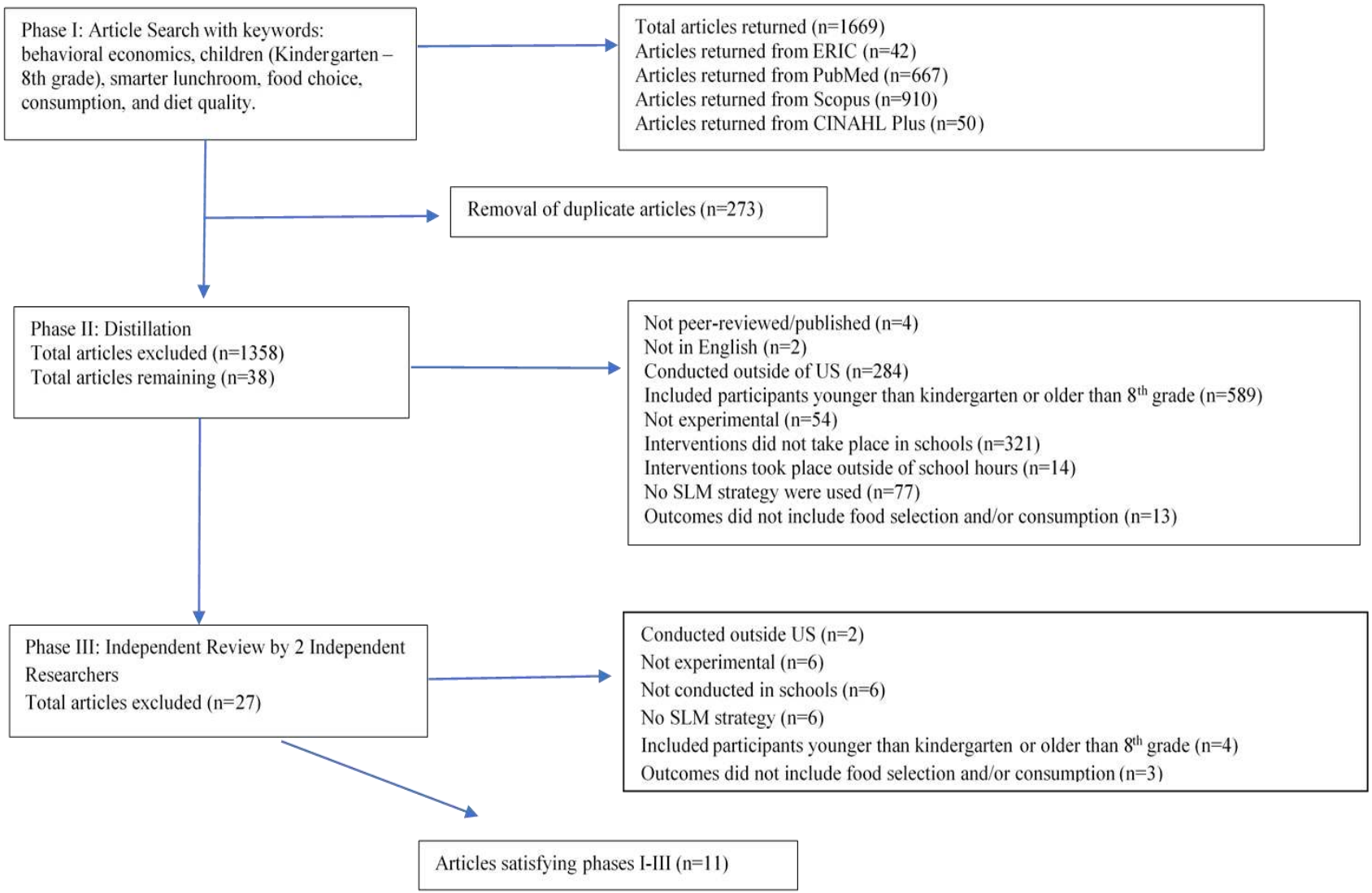

Figure 1. ***Article Extraction Steps***

Table 2. ***Quality of Studies within the Systematic Review (n=11)***

Author (Year)	Quality rating	Research question stated	Clear of selection bias	Comparable study groups	Withdraws discussed	Blinding use	Intervention described	Outcomes defined	Appropriate statistical analyses	Results support conclusions	No potential for funding bias
Goto et al. (2013)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Greene et al. (2017)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Gustafson et al. (2017)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Huynh et al. (2015)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Just & Price (2013)	+	Yes	Yes	Yes	No	Yes	Unclear	Yes	Yes	Yes	Yes
Loewenstein et al. (2016)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Miller et al. (2016)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Schwartz et al. (2018)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Snelling et al. (2017)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Song et al. (2013)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Wansink et al. (2013)	+	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

Note: Quality ratings: (+) = positive

Characteristics of Studies

Eight studies were conducted in elementary schools within certain states: California (Goto et al., 2013); Florida (Miller et al., 2016); Maryland (Song et al., 2015); Nebraska (Gustafson et al., 2017); New York (Greene et al., 2017; Brian Wansink et al., 2013); and Utah (Just & Price, 2013; Loewenstein et al., 2016). Two studies focused on one area, but did not clarify the states (Schwartz et al., 2018; Snelling et al., 2017). One study was conducted in 26 states across the United States (Huynh et al., 2015).

For the research design, nine studies used a pre-post experimental design, (Goto et al., 2013; Greene et al., 2017; Gustafson et al., 2017; Just & Price, 2013; Loewenstein et al., 2016; Miller et al., 2016; Snelling et al., 2017; Song et al., 2015; Wansink et al., 2013) while one study used a cross-sectional research design (Huynh et al., 2015), and another used a longitudinal-observational design (Schwartz et al., 2018). Seven studies included tray observations that ranged from as few as 2,150 trays (Wansink et al., 2013) to as many as 400,000 trays (Loewenstein et al., 2016). Four studies included participants that ranged from 169 (Miller et al., 2016) to 677 (Goto et al., 2013). The duration of the studies lasted from 2 weeks (Miller et al., 2016; Wansink et al., 2013) to 24 months (Schwartz et al., 2018).

Synthesis of Intervention Results

The main objective for these studies was to improve selection and/ or consumption of fruits, vegetables, whole grains, and/or white milk among elementary school children by use of School Lunchroom Movement (SLM) strategies. Studies were based on various SLM strategies such as *Boost Reimbursable Meals* (Miller et al., 2016), *Focus on Fruits* (Greene et al., 2017; Just & Price, 2013; Loewenstein et al., 2016; Wansink et al., 2013), *Highlight the Salad* (Huynh et al., 2015), *Lunchroom Atmosphere* (Song et al., 2015), *Move More White Milk* (Goto et al., 2013; Schwartz et al., 2018), *Student Involvement* (Gustafson et al., 2017) and *Vary the Vegetables* (Just & Price, 2013; Loewenstein et al., 2016; Snelling et al., 2017).

Results from the seven studies that measured selection of fruits, vegetables, whole grains, and/or milk, demonstrated an increase in the selection of these foods compared to the control or other intervention groups. However, depending on the SLM strategy used, results were inconsistent with the consumption of healthy foods. The strategies *Lunchroom Atmosphere* (Song et al., 2015) and *Student Involvement* (Gustafson et al., 2017) resulted in an increased consumption of fruits, vegetables, and/or whole grain consumption possibly due to the involvement among children and the school community (teachers, school administrators, and food service staff).

In the *Lunchroom Atmosphere* strategy, the objective is to change the cafeteria from a non-friendly to friendly environment for school-aged children to improve selection and consumption of healthy foods (Cornell University, 2015). Song and colleagues (2015) showed that children who were exposed to nutrition education and involved in promoting healthy foods consumed more of these healthy foods as compared to the control group of students not involved. The researchers recommended that nutrition education is needed, and that children need to be involved and engaged to change their dietary behaviors. Other studies have also shown that providing nutrition education while exposing children to healthy foods, resulted in an increase in consuming these foods as children have a better understanding of the importance of these foods (Bai, Suriano, & Wunderlich, 2014; Blanchette & Brug, 2005; Cafiero, Bai, & Liou, 2017; Wijesinha-Bettoni, Orito, Löwik, McLean, & Muehlhoff, 2013).

For the *Student Involvement* strategy, the objective is to involve children in the development of foods offered in the cafeteria to encourage them to consume healthy foods (Cornell University, 2015). Gustafson and colleagues (2017) sought to determine which marketing technique(s)

increased participants' consumption of vegetables. Participants were placed in 1 of 4 groups with varying levels of involvement: 1) control; 2) designed materials for the cafeteria; 3) saw the materials in the cafeteria; or 4) designed and posted their materials in the cafeteria. Results showed that participants in Group 4 increased their consumption of vegetables compared to the other groups. The researchers suggested that for behavior change to occur, children need to see that their ideas are being acknowledged by the school, in this case by the school administrators and teachers posting the children' artwork in the cafeteria. By this tactic children are 'nudged' in a positive dietary change behavior with the positive reaction among school personnel, which is the premise of behavioral economics (Bickel et al., 2016; Bonell et al., 2011; Patel & Volpp, 2015; Thorgeirsson & Kawachi, 2013). Other studies found in this systematic review had similar results, especially if they involved children or the school community (principals, food service staff, and/or teachers).

The objectives of *Focus on Fruits* and *Vary the Vegetables* strategies are to increase children's consumption of fruits and vegetables. Snelling and colleagues (2017) conducted a study to determine if children who taste-tested certain vegetables (broccoli, black beans, and spinach) would increase their consumption of these vegetables when they were placed on the school lunch menu. Results showed that children in the taste-testing group consumed more broccoli, black beans, and spinach compared to the control group, even after a follow-up period. This is similar to a literature review results by Thomson and Ravia (2011), in which they reported that a combination of behavior-based interventions, including behavioral economics and social marketing, was needed to sustain fruit and vegetable consumption among low-income adults. Furthermore, the involvement of children and school community resulted in positive behavioral changes among children as their dietary habits are influenced by parents, peers, and teachers (Glanz & Bishop, 2010; Reidy, Deming, & Pares, n.d.; Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011).

On the other hand, those studies that used non-student involvement sub-strategies for *Focus on Fruit, Vary the Vegetables,* and *Move More White Milk* had inconsistent results. Just and Price (2013) found that pre-plating children's plates with fruits and vegetables, did not increase fruit and vegetable consumption when compared to the control group. In fact, the pre-plate option substantially increased the amount of fruits and vegetables waste. For the *Move More White Milk* strategies, Goto and colleagues (2013) used the sub-strategy of increasing the visibility of white milk in the line and having children ask for chocolate milk. Schwartz and colleagues (2018) increased the visibility of the white milk in the line and additionally provided incentives to children who consumed the entire carton of white milk and posted information about the benefits of white milk in the cafeteria. However, none of these strategies appeared to be effective in increasing consumption of white milk.

CONCLUSIONS AND APPLICATION

To the researchers' knowledge, this is the first systematic review addressing the impact of school-based interventions using the SLM strategies on food selection and consumption among children. The theory of behavioral economics is to nudge individuals to choose the healthier option. In the case of Cornell University's Smarter Lunchroom Movement, it is to nudge children to consume healthier foods at school during the lunchroom period via eight main strategies and 60 sub-strategies.

Overall, the SLM strategies were effective with children increasing their selection of fruits, vegetables, whole grains, and/or white milk. There was inconsistency with consumption of fruits, vegetables, and/or white milk, especially with three SLM strategies – *Move More White Milk, Focus on Fruit,* and *Vary the Vegetables*, in which treatment groups either increased, remained

the same, or decreased consumption compared to baseline data, control groups or other treatment groups in the same study. The SLM strategies that appeared to be effective in increasing consumption of fruits and vegetables were *Lunchroom Atmosphere* and *Student Involvement*. Furthermore, the findings from this systematic review indicate that those SLM strategies that involved children and school staff (e.g. teachers, principals, food service), increased the selection and consumption of healthy foods such as fruits, vegetables, whole grains and/or white milk.

The involvement of children included taste-testing vegetables, creating promotional items, and posting information in the cafeteria to encourage consumption of these healthy foods. School staff were also involved by posting facts about healthy foods in the cafeteria, verbally encouraging children to consume these foods, and changing the cafeteria to a 'friendlier' atmosphere. Additionally, one study showed that providing nutrition education to children in combination with a SLM strategy that involved both children and staff increased consumption of healthy foods more so than just the SLM strategy alone. Therefore, it would be important to not only involve children in the promotional process or in tasting foods prior to implementation on the school-menus, but to also educate them on the importance of consuming these foods. Schools are typically provided with no or low-cost, reliable nutrition education materials through government entities such as Food and Nutrition Information Center or the Academy of Nutrition and Dietetics and curriculum guides to assist teachers and school staff to provide basic nutrition information. Nutrition education materials can be provided either in the classroom via integration within the core curriculum (math, science, social studies, reading) or by posting information on the school walls. This eliminates the need to hire registered dietitian nutritionists or other health professionals, if schools are on a limited budget. Moreover, with collaboration of local high schools, community colleges, universities, government resources such as state agencies and health care organizations, nutrition professors and students can assist in creating and providing trustworthy nutrition education to children without burdening teachers and school staff to be trained on providing this information to children. Nutrition extension agents are able to come into schools to provide nutrition information to children for a school-focused integrative approach. Finally, the assistance of all these entities may help develop district wellness policies to ensure these approaches are integrated within schools at all times throughout the academic year.

In the circumstances in which children are unable to be involved in the process, another option may be to offer several healthy choices as opposed to one, so children feel they are not forced to pick one food, but instead believe they are making a conscious choice based on their taste and texture preferences (Aldridge, Dovey, Halford, 2009; Wansink et al., 2013; Wansink, van Ittersum, & Painter, 2006). SLM sub-strategies do encourage schools to offer choices (e.g. pre-cut fruits and vegetables, at least two choices of fruits and vegetables in either raw or cooked form), and display the fruit and vegetable options in colorful, attractive bowls in front of the line as opposed to presentation in a stainless-steel tray line (Cornell University, 2015). These tactics can be employed in the schools without increasing time spent in preparing meals for the day. Because many schools have a pre-determined cycle menu, the element of surprise is eliminated with regards to when food service staff need to cut, chop or slice fruits and vegetables for that day. Additionally, these strategies are considered low-food costs as food service employees could chop, cut, and slice fruits and vegetables using mechanical equipment (e.g. dicers and slices) as opposed to purchasing already pre-cut produce. Hanks (2017) determined that labor and food costs are relatively low in respect to initiation of certain Smarter Lunchroom Strategies such as *Name the Vegetables*, *Move the Fruit*, and *Changing the Lunchroom Atmosphere*. Hanks (2017) determined that schools can save between $225 (*Name the Vegetables*) and $435 (*Lunchroom Atmosphere*) over an academic year in both labor and food costs by implementing these strategies.

The results from our review showed that the strategies that appeared to be least effective were those nudging children to take pre-plated fruits and vegetables, and choosing white milk. This apparent lack of effectiveness might have been due to the limited variety of the foods pre-plated, particularly if these were foods less preferred. Additionally, by offering only white milk, children may have felt that they were forced to take white milk. The two sub-strategies contradict the elements of behavioral economics theory as food choices should originate from the individual's free will, not an imposition. Therefore, it is recommended that schools allow children to choose the fruits and vegetables they would like, work with students to create fun and interesting menu names for fruits and vegetables to entice children to take these items, and to encourage children to try the offered fruits and vegetables. These strategies could also be applied to improve milk consumption by students. Additionally, school teachers, administrators, and staff should be positive role models and consume healthier foods (fruits/vegetables, whole grains, and white milk) in front of the children. Consequently, involving children and staff when encouraging children to consume these healthy foods may be an effective strategy. Other strategies that may promote healthier lifestyles among children include increasing times allocated for lunch and recess.

A limitation of this systematic review was the inability to compare effect sizes due to inconsistent study lengths and methodologies, especially with the use of the SLM strategies. Even though studies used similar strategies (i.e., four studies used the main strategy *Focus on Fruits*), the sub-strategies used varied such as offering pre-cut fruits or taste-testing vegetables, or a combination of sub-strategies was used, thus the reviewers were unable to determine the effectiveness of specific sub-strategies on children's consumption of healthy foods. Additionally, to determine if children selected and consumed healthy foods, plate waste data was based on observational methods, which varied and were not consistent from study to study. Thus, comparing results could not occur.

A second limitation was the focus on children's food selection and consumption as the outcomes of interest. Goto and colleagues (2013) noted that to apply the theory of behavioral economics in a school, when attempting to encourage a child to consume more healthy foods, the physiological, social, cognitive and environmental factors that contribute to a child changing their dietary behavior must be explored. A third limitation was that the studies took place in the United States, primarily in specific districts in certain states and within schools located in low-income school districts where >50% of the children population were receiving school meals at free or reduced costs, thus results cannot be generalizable to all children. While there are limitations, overall, the results from this review may encourage school food service managers and registered dietitian nutritionists to implement these evidence-supported interventions and select the strategy that best fit their school district's needs due to their low or minimal impact on meal preparation, labor, and food cost.

To determine the effectiveness of each SLM strategy, further research is needed. Future studies should focus on evaluating the current strategies to increase the accuracy of the results, while increasing sample sizes to allow for the findings to be generalizable to all children in the United States. Additional research is needed to determine if involving children and staff in SLM strategies are effective in increasing consumption of healthy foods. Further research should be emphasized on the observational strategies employed to ensure they are valid and reliable in order to reach consistent conclusions. The evidence from these 11 articles demonstrates that interventions using SLM strategies can lead to increases in healthier food selection and consumption, but more research is needed to prove the results are conclusive. Overall, the findings from the systematic review imply that school-based interventions using strategies based

on behavioral economics from the SLM can be affordable and effective to improve food choices and consumption among school-age children.

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