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Evaluating a school-based fruit and vegetable co-op in low-income children: A quasi-experimental study

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ABSTRACT

The purpose of this study was to evaluate the effectiveness of a new school-based food co-op program, Brighter Bites (BB), to increase fruit and vegetable intake, and home nutrition environment among low-income 1st graders and their parents. This was a non-randomized controlled comparative effectiveness trial (2013–2015). Six schools received BB ($n = 407$ parent-child dyads); six comparison schools implemented a coordinated school health program ($n = 310$ parent-child dyads) in Houston, Texas, 2013–2015. Brighter Bites (BB) is a 16-week school-based food co-op comprising weekly distribution of fresh produce (50 servings); nutrition education in schools and for parents; and weekly recipe tastings. Measurements included parent-reported home nutrition environment surveys, and food frequency questionnaires for parent and child. Intervention effects were examined using multivariate analyses. At baseline, the sample was 71% Hispanic, 24% African American; 43% of 1st graders were overweight/obese. Children receiving BB had significant increases in intake of fruit servings ($P = 0.046$), vegetable servings ($P = 0.049$), and decreased intake of added sugars ($P = 0.014$). Among parents, there were significant increases in fruit consumed ($P = 0.032$); vegetable intake increased baseline to midpoint but not post-intervention. Among BB families, there were significant improvements in the home environment including understanding and usage of nutrition facts labels to make food purchases ($P < 0.05$), frequency of cooking ($P = 0.007$), rules and practices regarding eating family meals ($P = 0.022$), serving fruits ($P = 0.005$) and vegetables ($P = 0.028$) at meals, and limiting portion sizes ($P = 0.016$).
In conclusion, a school-based food co-op model shows promising results in improving dietary habits and home nutrition environment among low-income families.

1. Introduction

Most children in the United States (U.S.) do not meet the recommended intakes of healthy foods including fruits, vegetables and whole grains, putting them at risk for chronic diseases later in life. Recent reports from the Centers for Disease Control and Prevention (CDC) using the National Health and Nutrition Examination Survey (NHANES) data between 2003 and 2010 indicate a 12% per year increase in intake of fruit among children ages 6 to 11 years, and among those from low-income families; however, there were no increases in intake of vegetables or whole grain foods (Kim et al., 2014). Also, 30% of the intake of vegetables was from fried potatoes or potato chips, and none of the socio-demographic groups met the recommended intakes for fruits or vegetables (Kim et al., 2014).

Experts have identified home and the school as important settings to improve dietary habits among children (Story et al., 2008a). Specifically among school settings, federal policies and programs such as the Healthy Hunger Free Act of 2010 (United States Department of Agriculture, Food and Nutrition Service, 2016) require schools participating in the National School Lunch Program and School Breakfast Program to increase the amounts and variety of fruits and vegetables (F&V) on their menus. However, studies comparing pre and post implementation of the new nutrition standards show an increased plate waste post-implementation, despite the school meals being more nutritious in offering a wider selection of F&V (Ishdorj et al., 2015; Smith and Cunningham-Sabo, 2014). These studies suggest a lack of preference and demand for F&V among children, underscoring the need for innovative nutrition education models. The social-ecological model posits several individual, environmental, community level, and cultural factors influence what people eat (Story et al., 2008b). The school and home environment, including peer, parent, and teacher interactions influence

Abbreviations: CATCH, Coordinated Approach To Child Health.

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dietary habits among children (Story et al., 2008b). Given that over 50 million children attend school in the U.S. every day, these are important settings to engage families and create opportunities for healthy eating among children. Brighter Bites is a 16-week school-based intervention that uses a food co-op model to increase access to fresh F&V using reclaimed produce aggregated at local food banks combined with nutrition education for low-income children and their families. We present the results of a study to determine the effectiveness of Brighter Bites in improving intake of F&V and parental food practices, rules and mealtime environment among 1st grade children and their parents in Houston, Texas.

2. Methods

2.1. Study design

This was a quasi-experimental non-randomized controlled school-based study conducted in Houston, Texas.

2.2. Setting

Public or charter schools were eligible to participate if they enrolled 1st grade children and >75% of the children in the school were enrolled in the free/reduced lunch program.

2.3. Study population

Families were recruited into the study as parent-child dyads in which the "parent" was the adult family member primarily responsible for caregiving. Enrollment in the study was limited to one parent-child dyad per family. While all 1st grade children and their families were invited to participate in Brighter Bites, only those consenting to participate were measured. A convenience sample of nine elementary schools were recruited over two school years. In year 1 (2013–2014 school year), 1st grade parent-child dyads across six elementary schools (three receiving Brighter Bites; three comparison schools) were recruited. In year 2 (2014–2015 school year), the three schools that were in the comparison group in year 1 crossed over to the intervention group to receive Brighter Bites, three new schools were recruited to be in the comparison group, and a new cohort of 1st grade children and their parents was recruited across these six schools. Data were collected pre-intervention (baseline), at the intervention's midpoint (8-weeks follow up), and post-intervention (16-weeks follow up). At baseline, a total of 717 parent-child dyads consented to participate in the study ($n = 407$ intervention, $n = 310$ control) (Fig. 1).

This study was approved by the Institutional Review Board of the University of Texas Health Science Center in Houston. All study documents were in English and in Spanish.

3. Brighter Bites intervention description

Brighter Bites (Sharma et al., 2015) is a 16-week school-based program, grounded in the Social Cognitive Theory (Bandura, 1986) and the Theory of Planned Behavior (Ajzen, 1991), combining access to F&V and nutrition education among low-income children and their families. It includes: 1) weekly distribution of 50–60 servings (~30 lb) of fresh, donated produce procured from the local food banks sent home to the families eight weeks in fall and eight weeks in spring; 2) weekly healthy recipe tastings during pick up time, featuring produce provided that week; 3) health education in schools and for parents. Schools were trained in the Coordinated Approach To Child Health (CATCH) program, an evidence-based coordinated school health program with proven obesity prevention effects in children (Hoelscher et al., 2010). Parent-child nutrition education includes a set of two bilingual handbooks and weekly recipe cards sent home with the parents. The weekly recipe cards featured produce in the bags. Fig. 2 outlines the program components and logic model.

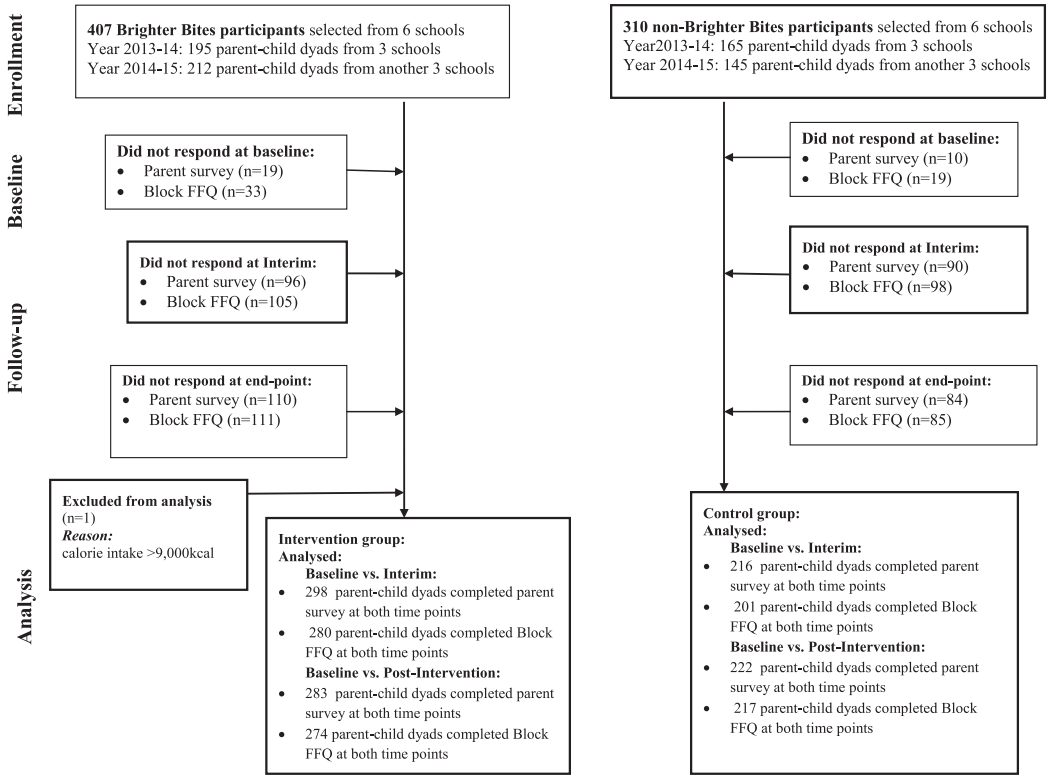
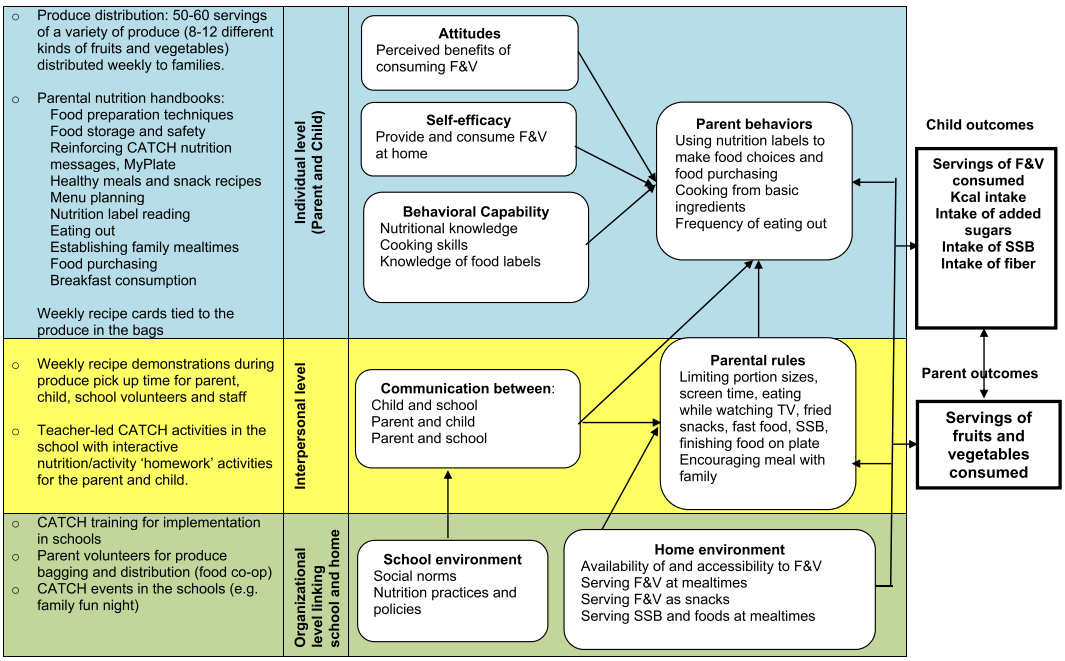


Fig. 1. Study flow, Brighter Bites study, Houston, Texas, 2013–2015.



F&V = fruits and vegetables; CATCH = Coordinated Approach to Child Health; SSB = sugar-sweetened beverages

Fig. 2. Brighter Bites intervention logic model, Houston, Texas 2013–2015.

4. Intervention implementation

Brighter Bites is a 501c3 non-profit organization based in Houston, Texas and fosters a community-academic partnership with the University of Texas School of Public Health. For this study, participating families opted into the program at the start of the school year. The food bank delivered weekly pallets of produce to the schools. Since the program uses a co-op model, participating parents were invited to participate in produce bagging and distribution. Produce pick-up was conducted at the end of the school day so that participating parents could pick up their child, the produce bags and taste the healthy recipe at the same time. A Brighter Bites coordinator had a roster of the participating families to document attendance. Distributions were conducted for 8 weeks each in the fall and spring semesters in each school.

All intervention schools implemented Brighter Bites and all comparison schools implemented CATCH only. All participating schools were trained in CATCH prior to the baseline assessment. A CATCH-only comparison school model was implemented to reflect a 'real-life' scenario since most schools in Texas implement health education as part of their curriculum.

4.1. Data collection measures

Outcome evaluation was conducted at baseline (T0), midpoint (T1) and post-intervention (T2). Process evaluation measured program attendance, dose, reach and fidelity.

5. Outcome measures

5.1. Child anthropometrics

Trained project staff used a calibrated digital scale and stadiometer to measure weight and height using standard procedures. Body Mass Index (BMI) percentiles were computed to determine weight status at baseline (CDC Vital Health and Statistics, 2007–2010). All measurements were conducted during regular school hours.

5.2. Child dietary intake

Child dietary intake was measured using the parent-reported Block Kids Food validated food frequency questionnaire (FFQ) (Hunsberger et al., 2015) to assess children's intake by food group, with outcomes measured in number of servings. The focus of this tool is on intake of fruit and fruit juices, vegetables, potatoes (including French fries), whole grains, meat/poultry/fish, dairy, legumes, saturated fat, and "added sugars" (in sweetened cereals, soft drinks, and sweets). A secondary analysis produces estimates for intake of sugary beverages (both kcal and frequency). Individual portion sizes were also assessed. Parents self-completed the questionnaire and returned to project staff, who immediately assessed the FFQ for completeness and followed up with the parent in case further clarification was needed.

5.3. Parent intake of fruits and vegetables

The validated 10-item Fruits and Vegetables Screener by the National Institutes of Health was administered to parents to determine the total number of servings of F&V consumed daily (Thompson et al., 2002).

5.4. Parental food practices, rules and home mealtime environment

Parents completed a self-report questionnaire using validated items on frequency of cooking from scratch at home, eating out, using nutrition facts labels, serving F&V at mealtimes and snacks, serving sugary cereals and sugary drinks at meals (Penkilo et al., 2008; Baranowski et al., 2000; Edmundson et al., 1996). Finally, parental rules regarding limiting portion sizes, screen time, fried foods, fast food and/or sugary beverages, as well as eating family dinners, and requiring that children finish the food on their plate were assessed (Ding et al., 2012).

5.5. Parent and child demographics

Demographics were reported at baseline by parents including age, gender and race/ethnicity for both parent and child, language spoken

at home, parent's country of birth, employment status, and education level.

6. Process measures

To evaluate program fidelity, Brighter Bites staff reported weekly the amount and type of produce distributed to calculate the number of F&V servings distributed using USDA 2010 Dietary Guidelines (U.S. Department of Agriculture, 2010). Cost of the produce to serve per family per week was computed with data obtained from the local food bank. Data on perceived program effectiveness were collected using parent surveys administered at the end of each 8 weeks of programming. To assess CATCH implementation, a self-administered web-based survey was conducted among teachers during the school year.

7. Statistical analysis

All analyses were performed using STATA software, version 13.1. Means, standard deviations (SD) and frequencies were computed for all demographic data and other variables of interest. Differences between the two groups at baseline were tested by X^2 test and *t*-test. At baseline, parents completed 688 (96%) parent surveys and 665 (93%) Block FFQ's. Of those who completed the baseline surveys, a total of 514 parents (75%) completed parent surveys and 481 parents (72.3%) completed food frequency questionnaires at the midpoint (8 weeks follow-up). At post-intervention, the response rate was 73.4% for parent surveys and 74% for the Block FFQs, respectively. This was the final sample size used for analysis in the current study (i.e. complete parent-child dyads). In order to address potential non-respondent bias, baseline characteristics of respondents and non-respondents were compared and odd ratios (OR) were calculated. Retention at the two follow-ups did not differ between intervention and comparison groups. Intervention effects from baseline to each time point (T1 and T2) were tested to examine within group changes at each time period (T0 vs. T1, T0 vs. T2). Repeated measures mixed models were applied and group-by-time interaction terms were tested for between group changes over time. Socio-demographic variables were included in the models only if the coefficients were changed by >10%.

8. Results

8.1. Parent-child characteristics (Table 1)

Participant characteristics at baseline are shown in Table 1. Responding parents were primarily mothers (90.1%), Hispanic (71.2%) or African American (23.6%), employed (48.4%), and the average age was 34.3 years (SD = 7.4); 27.9% spoke English only and 53.9% were bilingual in English and Spanish; 46.7% were born outside of U.S. The mean child age was 6.2 years (SD = 0.38), 51.9% were girls, and 42.7% were overweight or obese. At baseline, a greater proportion of the parents in the intervention group were African American as compared to those in the comparison group (26.9% vs. 19.3%; $P = 0.009$). Otherwise, there were no statistically significant differences in characteristics between the two groups.

8.2. Child dietary intake (Table 2)

Brighter Bites had a statistically significant impact on the child's F&V consumption (Table 2). At post-intervention, as compared to those in the comparison group, children receiving Brighter Bites demonstrated a significant increase in cups of fruits (+0.12 cups/1000 kcal/day, $P = 0.046$) and vegetables consumed (+0.11 cups/1000 kcal/day, $P = 0.049$). Concurrently, our results showed a significant decrease pre-to-post intervention in the amount of added sugars consumed among children receiving Brighter Bites (−0.66 tsp/1000 kcal/day, $P = 0.014$). Similarly, there was an increase in child's fiber intake from baseline to midpoint (+0.84 g/1000 kcal/day, $P = 0.034$), but not post-intervention among those receiving Brighter Bites. Finally, the results showed a decrease in caloric intake among those in the intervention group; however, these changes were not statistically significant.

Table 1
Baseline characteristics of participants, Brighter Bites study, Houston, Texas 2013–2015.

Characteristics	Total	Intervention group	Comparison group	*P*-values[a]
	mean (SD[b])	←	→	*t-Test*
Child's age	6.15(0.38)	6.14(0.37)	6.17(0.39)	0.286
Parent's age	34.28(7.40)	34.51(7.65)	33.99(7.08)	0.371
Number of people live in your household	5.02(3.67)	5.14(4.75)	4.86(1.52)	0.329
Number of children younger than 18 years in your household?	3.19(6.80)	3.17(6.51)	3.23(7.16)	0.92
Child's gender	*n(%)*	←	→	*Chi-sq. test*
Boy	322(48.1)	177(47.6)	145(48.7)	0.782
Girl	348(51.9)	195(52.4)	153(51.3)	
Parent's gender				
Male	71(10.5)	45(11.9)	26(8.6)	0.163
Female	607(89.5)	332(88.1)	275(91.4)	
Respondents' relationship to child				
Mother	610(90.1)	335(88.9)	275(91.7)	0.070
Father	54(8.0)	37(9.8)	17(5.7)	
Others (guardian)	13(1.9)	5(1.3)	8(2.7)	
Parent's race/ethnicity				
Hispanic	486(71.2)	267(69.7)	219(73.0)	**0.009**
Black or African American	161(23.6)	103(26.9)	58(19.3)	
White	24(3.5)	7(1.8)	17(5.7)	
Other[c]	12(1.8)	6(1.6)	6(2.0)	
Language spoken at home				
English only	179(27.8)	103(29.1)	76(26.2)	0.642
Bilingual	347(53.9)	184(52.0)	163(56.2)	
Spanish other	96(14.9)	53(15.0)	43(14.8)	
Another languages	22(3.4)	14(4.0)	8(2.8)	
Parent's Country of Birth				
U.S.	342(53.3)	185(52.4)	157(54.3)	0.628
Other Countries	300(46.7)	168(47.6)	132(45.7)	
Parent's employment status				
Employed (full/part time)	311(49.0)	160(45.9)	151(52.8)	0.231
Self-employed	33(9.5)	33(9.5)	18(6.3)	
Homemaker	113(32.4)	113(32.4)	88(30.8)	
Unemployed	43(12.3)	43(12.3)	29(10.1)	
Parent's highest education level				
Never attended school or only kindergarten	8(1.3)	5(1.4)	3(1.1)	0.272
Grades 1 through 8	57(8.9)	34(9.6)	23(8.0)	
Grades 9 through 11	101(15.8)	45(12.8)	56(19.6)	
Grade 12 or GED	181(28.3)	101(28.6)	80(28.0)	
College 1 year to 3 years	190(29.7)	112(31.7)	78(27.3)	
College 4 years or more	102(16.0)	56(15.9)	46(16.1)	
Child BMI percentile				
Normal weight (<85%ile)	386(57.3)	221(58.2)	165(56.1)	0.846
Overweight (85 to <95%ile)	116(17.2)	65(17.1)	51(17.4)	
Obese (≥95%ile)	172(25.5)	94(24.7)	78(26.5)	

Boldface indicates statistical significance at $P \le 0.05$.
[a] χ^2 tests and t tests were used to determine significant differences for categorical and continuous variables respectively.
[b] Standard deviation.
[c] Asian, Native Hawaiian, Pacific Islander, American Indian or Alaska Native, more than one race, other.

8.3. Parent dietary intake (Table 2)

Results from the parent F&V screener showed a significant increase in the servings of fruits consumed from baseline to midpoint (+0.25 servings/day, $P = 0.032$) and post-intervention (+0.25 servings/day, $P = 0.013$) among parents in the Brighter Bites group, as compared

Table 2
Changes in child and parent dietary intake, Brighter Bites study, Houston, Texas 2013–2015.

Measures	Intervention group				Comparison group				
Food group/nutrient intakes	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Net changes (delta) in intervention group[d]e (95% CI[c]) *P*-value
Child dietary intake									
Fruits[e] (cup/1000 kcal per day)	1.26 (0.82)	1.40 (0.76)	1.38 (0.76)	**T0 to T1:** 0.13(0.03,0.22), ***P* = 0.010** **T0 to T2:** 0.13(0.04,0.23), ***P* = 0.006**	1.24 (0.67)	1.23 (0.62)	1.23 (0.63)	**T0 to T1:** −0.004(−0.12,0.11), *P* = 0.947 **T0 to T2:** −0.01(−0.12,0.10), *P* = 0.801	**T0 to T1:** 0.13(−0.02,0.28), *P* = 0.086 **T0 to T2:** 0.15(0.003,0.30) ***P* = 0.046**
Vegetables[f] (cup/1000 kcal per day)	0.56 (0.33)	0.68 (0.37)	0.67 (0.34)	**T0 to T1:** 0.11(0.07,0.15), ***P* < 0.001** **T0 to T2:** 0.09(0.05,0.14), ***P* < 0.001**	0.55 (0.32)	0.55 (0.38)	0.59 (0.28)	**T0 to T1:** 0.005(−0.04,0.05), *P* = 0.835 **T0 to T2:** 0.03(−0.01,0.08), *P* = 0.164	**T0 to T1:** 0.11(0.05,0.17), ***P* = 0.001** **T0 to T2:** 0.06(0.0002,0.12), ***P* = 0.049**
Added sugar[g] (tsp/1000 kcal per day)	5.30 (2.80)	4.66 (2.09)	4.64 (2.00)	**T0 to T1:** −0.59(−0.89,−0.29), ***P* < 0.001** **T0 to T2:** −0.63(−0.94,−0.33), ***P* < 0.001**	5.25 (2.66)	4.85 (2.08)	5.17 (2.43)	**T0 to T1:** −0.42(−0.77,−0.06), ***P* = 0.022** **T0 to T2:** −0.06(−0.40,0.29), *P* = 0.748	**T0 to T1:** −0.17(−0.64,0.29), *P* = 0.463 **T0 to T2:** −0.58(−1.04,−0.11), ***P* = 0.014**
Estimated percent of daily kilocalories from sugar beverages (%)	2.85 (4.34)	2.04 (2.67)	1.90 (2.43)	**T0 to T1:** −0.72(−1.16,−0.29), ***P* = 0.001** **T0 to T2:** −0.88(−1.32,−0.44), ***P* < 0.001**	2.69 (3.76)	2.25 (2.71)	2.38 (3.13)	**T0 to T1:** −0.49(−1.01,0.02), *P* = 0.062 **T0 to T2:** −0.33(−0.83,0.18), *P* = 0.204	**T0 to T1:** −0.23(−0.91,0.45), *P* = 0.502 **T0 to T2:** −0.55(−1.22,0.12), *P* = 0.106
Total fiber (grams per 1000 kcal/day)	10.03 (3.18)	10.87 (3.25)	10.92 (3.15)	**T0 to T1:** 0.75(0.40,1.10), ***P* < 0.001** **T0 to T2:** 0.82(0.47,1.18), ***P* < 0.001**	10.15 (3.23)	10.28 (2.82)	10.43 (2.77)	**T0 to T1:** 0.16(−0.26,0.57), *P* = 0.457 **T0 to T2:** 0.29(−0.12,0.69), *P* = 0.164	**T0 to T1:** 0.59(0.05,1.14), ***P* = 0.034*** **T0 to T2:** 0.54(−0.003,1.08), *P* = 0.051
Total fat (grams per 1000 kcal/day)	39.38 (6.64)	38.39 (6.32)	38.15 (6.34)	**T0 to T1:** −0.91(−1.69,−0.12), ***P* = 0.024** **T0 to T2:** −1.22(−2.02,−0.43), ***P* = 0.003**	39.24 (5.94)	39.36 (5.69)	38.86 (5.32)	**T0 to T1:** 0.15(−0.78,1.08), *P* = 0.748 **T0 to T2:** −0.41(−1.32,0.49), *P* = 0.370	**T0 to T1:** −1.06(−2.27,0.16), *P* = 0.089 **T0 to T2:** −0.81(−2.01,0.39), *P* = 0.188
Average daily kilocalories (kcal per day)	1103.95 (630.43)	1055.45 (510.89)	1074.69 (581.29)	**T0 to T1:** −25.80(−92.44,40.83), *P* = 0.448 **T0 to T2:** −17.36(−84.41,49.70), *P* = 0.612	1020.07 (464.79)	1009.35 (466.08)	1058.49 (521.65)	**T0 to T1:** −11.37(−89.51,66.78), *P* = 0.776 **T0 to T2:** 45.14(−31.32,121.60), *P* = 0.247	**T0 to T1:** −14.44(−117.13,88.26), *P* = 0.783 **T0 to T2:** −62.50(−164.19,39.20), *P* = 0.228
Whole grains (ounce/1000 kcal/day)	0.47 (0.33)	0.53 (0.36)	0.54 (0.34)	**T0 to T1:** 0.05(0.006,0.10), ***P* = 0.027** **T0 to T2:** 0.07(0.03,0.12), ***P* = 0.001**	0.46 (0.35)	0.50 (0.41)	0.48 (0.30)	**T0 to T1:** 0.04(−0.01,0.09), *P* = 0.130 **T0 to T2:** 0.02(−0.03,0.07), *P* = 0.428	**T0 to T1:** 0.01(−0.06,0.08), *P* = 0.766 **T0 to T2:** 0.05(−0.02,0.12), *P* = 0.129
Parent fruit and vegetable intake									
Fruit group[h]	1.87 (2.52)	2.12 (2.47)	2.12 (2.64)	**T0 to T1:** 0.25(−0.05,0.55), *P* = 0.096 **T0 to T2:** 0.30(−0.009,0.60), *P* = 0.057	1.75 (2.43)	1.52 (2.02)	1.48 (1.70)	**T0 to T1:** −0.25(−0.60,0.10), *P* = 0.162 **T0 to T2:** −0.29(−0.64,0.06), *P* = 0.103	**T0 to T1:** 0.51(0.04,0.97), ***P* = 0.032** **T0 to T2:** 0.58(0.12,1.05), ***P* = 0.013**
Vegetable group[i]	1.46 (3.29)	1.76 (3.35)	1.55 (2.47)	**T0 to T1:** 0.25(0.02,0.48), ***P* = 0.031** **T0 to T2:** 0.05(−0.18,0.28), *P* = 0.677	1.25 (1.53)	1.09 (1.45)	1.29 (1.83)	**T0 to T1:** −0.12(−0.39,0.15), *P* = 0.369 **T0 toT2:** 0.04(0.23,0.31), *P* = 0.778	**T0 to T1:** 0.38(0.02,0.73), ***P* = 0.038** **T0 to T2:** 0.01(−0.34,0.36), *P* = 0.951
Fruit and vegetable group[j]	3.33 (5.11)	3.86 (4.96)	3.67 (4.13)	**T0 to T1:** 0.50(0.08,0.92), ***P* = 0.020** **T0 to T2:** 0.37(−0.06,0.80), *P* =	3.01 (3.14)	2.60 (2.72)	2.78 (2.89)	**T0 to T1:** −0.41(−0.90,0.09), *P* = 0.110 **T0 to T2:** −0.27(−0.76,0.22), *P*	**T0 to T1:** 0.90(0.25,1.55), ***P* = 0.007** **T0 to T2:** 0.64(−0.007,1.29), *P* =

Table 2 (*continued*)

Measures	Intervention group				Comparison group				
Food group/nutrient intakes	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Net changes (delta) in intervention group[d]e (95% CI[c]) *P*-value
				0.089				= 0.277	0.053

T0 vs. T1: $n = 481$ parent child dyads for child block FFQ (intervention:control = 280:201), $n = 514$ parent child dyads for parent survey (intervention:control = 298:216);
T0 vs. T2: $n = 491$ parent child dyads for child block FFQ (intervention:control = 274:217), $n = 505$ parent child dyads for parent survey (intervention:control = 283:222).
Boldface indicates statistical significance at $P \leq 0.05$.

[a] Standard deviation.
[b] Contrasts and linear hypothesis tests after estimation.
[c] Confidence Interval.
[d] Adjusted coefficients were calculated using mixed-effect linear regression models that adjusted for ethnicity.
[e] Fruit density including fruits and fruit juice.
[f] Vegetable density including all vegetables except potatoes and legumes.
[g] Sugar/syrup added to foods/beverages during processing/preparation.
[h] Total daily number of MyPyramid servings for fruits which includes consumption of 100% juice, fresh, canned, and frozen fruits and excludes fruit drinks like Kool-Aid, lemonade, Hi-C, Tang, and Twister.
[i] Total daily number of MyPyramid servings for vegetables which includes consumption of lettuce salad, raw, cooked, canned and frozen vegetables, tomato sauce, vegetable soups and excludes white potatoes, cooked dried beans, and vegetables in mixtures.
[j] Sum of total daily number of MyPyramid servings for fruits and vegetables.

to those in the comparison group. Similarly, among parents in the Brighter Bites group, there was a significant increase in vegetables consumed (+0.30 servings/day, $P = 0.038$) and in total F&V consumed (+0.53 servings/day, $P = 0.007$) from baseline to midpoint; but not post-intervention.

8.4. Parental food practices, rules and home mealtime environment (Table 3)

Consistent with our dietary findings, we found a significant increase pre-to-post intervention among parents receiving Brighter Bites in understanding the nutrition facts label ($\beta_{adj} = 0.21$, 95% CI 0.07 to 0.35, $P = 0.004$) and using the label to make food purchasing decisions ($\beta_{adj} = 0.23$, 95% CI 0.03 to 0.43, $P = 0.028$) compared to parents in the comparison group. Furthermore, there was a two-fold increase pre-to-post intervention in frequency of cooking from scratch at home among parents receiving Brighter Bites ($OR_{adj} = 2.28$, 95% CI 1.19 to 4.34, $P = 0.013$), a two-fold increase pre-to-post intervention in eating dinner together ($OR_{adj} = 2.19$, 95% CI 1.12 to 4.28, $P = 0.022$), and an increase in home availability of fruits ($\beta_{adj} = 0.34$, 95% CI 0.10 to 0.57, $P = 0.005$) and vegetables ($\beta_{adj} = 0.26$, 95% CI 0.03 to 0.48, $P = 0.028$) during mealtimes compared to families in the comparison group. Finally, we found significant improvements pre-to-post intervention in parental rules regarding limiting portion sizes ($OR_{adj} = 2.02$, 95% CI 1.14 to 3.57, $P = 0.016$) among parents receiving Brighter Bites compared to those in the comparison group.

8.5. Results of process evaluation (Table 4)

The average number of F&V servings in weekly produce bags ranged from 48.6 to 79.9 (mean = 60.1 servings) and 42.0 to 77.0 (mean = 53.6 servings) in the 2013–2014 and 2014–2015 school years, respectively. On average, 4 to 10 parents volunteered per site/week, and parents rotated volunteering throughout the 16 weeks. Cost of produce averaged $2.67 per family/week in 2013–2014 school year and $2.63 per family/week in 2014–2015 school year. >80% of the parents reported receiving the Brighter Bites produce every week for 8 weeks in each of the fall and spring semesters. Moreover, >92% of the parents reported consuming all or most of the fruits and >88% reported eating all or most of the vegetables. Also, >90% and >85% of the parents reported that receiving F&V every week was effective in influencing their family's eating habits, per respective school year.

Teacher survey data ($n = 38$ teachers in 2013–2014 and $n = 30$ teachers 2014–2015) collected at the end of the school year showed that in 2013–2014 68% of teachers in the intervention schools and 68% in the comparison schools, and in 2014–2015 62% of the teachers in the intervention schools and 35% in the comparison schools reportedly taught CATCH lessons or activities (data not shown in tables).

9. Discussion

The purpose of this study was to determine the effectiveness of Brighter Bites, a program that uses a food co-op model, combining access to fresh produce using donated sources with nutrition education in school and for parents. The results of our study supported the primary hypothesis that participation in Brighter Bites would improve intake of F&V among children. At baseline, child intake of fruits was higher (1.24 cups/1000 kcal) compared to intake of vegetables (0.54 cups/1000 kcal). Our study demonstrated an approximate daily increase in a 0.25 cups/1000 kcal/day of F&V which translates to an additional 1.75 cups/1000 kcal per week. The increase in vegetable intake seen in our study is promising because meta-analysis studies (Evans et al., 2012) have concluded that school-based interventions moderately improve fruit intake but have minimal impact on vegetable intake, and there is a need for interventions that specifically address vegetables. However, while the increase in intake of F&V was statistically significant, it was less than two servings per week. While participating families were provided with F&V weekly, it is unclear how much of the produce was consumed by the children. Moreover, while there was ongoing exposure to a variety of produce over the program duration, continuity with regards to one particular fruit or vegetable was not targeted. Prior studies have shown that children need to be exposed to a new food 10–14 times prior to accepting it (Birch and Fisher, 1998). These factors may have negatively impacted child intake of F&V. Thus, longer term follow up along with data regarding child intake of the distributed produce is warranted in future studies.

For parents, our results demonstrated improved intake of fruits. For vegetables, there was a significant increase baseline to midpoint but not post-intervention. These results indicate that Brighter Bites strategies were not sufficient to significantly impact parent normative practices around vegetable consumption, which remains a challenge for behavioral interventions among adults (Thomson and Ravia, 2011). Additional attention should be directed towards strategies that change the social norms and beliefs around vegetable intake, for parents and children. Moreover, systematic reviews of the literature demonstrate that parent-centered interventions in community settings can successfully improve diet, physical activity and weight related outcomes in children,

Table 3
Changes in parental food practices, rules and home mealtime environment, Brighter Bites study, Houston, Texas 2013–2015.

Intervention group					Comparison group				
Survey questions	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Net changes (delta) in intervention group[d] (95% CI[c]) *P*-value
Parental food practices: how often do you?									
Understand the Nutrition Facts Table on food and drink packages?									
Always/often	128(39.3)	140(45.9)	141(49.1)	**T0 to T1:** 0.20(0.11,0.30), ***P* < 0.001**	112(46.1)	96(44.9)	110(49.1)	**T0 to T1:** 0.06(−0.05,0.17), *P* = 0.291	**T0 to T1:** 0.15(0.004,0.19), ***P* = 0.044**
Sometimes	89(27.3)	99(32.5)	105(36.6)		58(23.9)	66(30.8)	69(30.8)		
Never/rarely	109(33.4)	66(21.6)	41(14.3)		73(30.0)	52(24.3)	45(20.1)		
				T0 to T2: 0.33(0.24,0.43), ***P* < 0.001**				**T0 to T2:** 0.12(0.01,0.23), ***P* = 0.027**	**T0 to T2:** 0.21(0.07,0.35) ***P* = 0.004**
Use the Nutrition Facts Table on food and drink help you with your purchase decisions?									
Always	43(13.3)	41(13.4)	50 (17.2)	**T0 to T1:** 0.21(0.08,0.34), ***P* = 0.002**	36(14.7)	29(13.4)	31(13.8)	**T0 to T1:** 0.16(0.003,0.31), ***P* = 0.046**	**T0 to T1:** 0.05(−0.15,0.26), *P* = 0.608
Often[e]	63(19.5)	55(18.0)	64 (22.1)		37(15.1)	46(21.2)	42(18.8)		
Sometimes[e]	74(22.9)	124(40.7)	106(36.6)		76(31.0)	73(33.6)	89(39.7)		
Rarely[e]	96(29.7)	50(16.4)	47(16.2)		56(22.9)	43(19.8)	44(19.6)		
Never	47(14.6)	35(11.5)	23 (7.9)		40(16.3)	26(12.0)	18(8.0)		
				T0 to T2: 0.43(0.29,0.57), ***P* < 0.01**				**T0 to T2:** 0.20(0.05,0.35), ***P* = 0.010**	**T0 to T2:** 0.23(0.03,0.43), ***P* = 0.028**
Cook from scratch at home, using fresh/frozen ingredients food?									
Once per day or more often	149(46.0)	139(45.9)	138(48.4)	**T0 to T1:** −0.08(−0.50,0.35), *P* = 0.717	134(55.1)	102(47.9)	97(44.3)	**T0 to T1:** −0.49(−0.99,0.004), *P* = 0.052	**T0 to T1:** 1.51[f](0.79,2.91), *P* = 0.214
Less than once per day	175(54.0)	164(54.1)	147(51.6)		109(44.9)	111(52.1)	122(55.7)		
				T0 to T2: 0.13(−0.31,0.56), *P* = 0.567				**T0 to T2:** −0.78(−1.28,−0.28), ***P* = 0.002**	**T0 to T2:** 2.35[f](1.27,4.78), ***P* = 0.007**
In the past week, how many times did you eat food from any type of restaurant?									
Everyday	7(2.1)	1(0.3)	0(0.0)	**T0 to T1:** −0.12(−0.20,−0.04), ***P* = 0.005**	3(1.2)	1(0.5)	1(0.5)	**T0 to T1:** −0.13(−0.23,−0.03), ***P* = 0.008**	**T0 to T1:** 0.01(−0.12,0.14), *P* = 0.857
5–6 times	7(2.1)	4(1.3)	1(0.3)		5(2.0)	1(0.5)	2(0.9)		
3–4 times	32(9.8)	29(9.5)	22(7.5)		31(12.6)	23(10.6)	23(10.3)		
1–2 times	209(63.9)	190(62.3)	184(63.2)	**T0 to T2:** −0.18(−0.27,−0.10), ***P* < 0.001**	164(66.7)	138(63.6)	145(64.7)	**T0 to T2:** −0.12(−0.22,−0.03), ***P* = 0.011**	**T0 to T2:** −0.06(−0.19,0.07), *P* = 0.369
None	72(22.0)	81(26.6)	84(28.9)		43(17.5)	54(24.9)	53(23.7)		
Home mealtime environment - during the past 7 days, how many times:									
Were fresh/frozen fruits served as snacks to your child in your home?									
Everyday	58(17.9)	65(21.9)	56(19.6)	**T0 to T1:** 0.24(0.08,0.39), ***P* = 0.003**	41(17.4)	25(11.9)	24(10.9)	**T0 to T1:** −0.12(−0.30,0.06), *P* = 0.186	**T0 to T1:** 0.36(0.12,0.60), ***P* = 0.003**
5–6 times	34(10.5)	43(14.5)	47(16.4)		29(12.3)	33(15.6)	40(18.1)		
3–4 times	99(30.5)	90(30.3)	94(32.9)		74(31.4)	60(28.4)	76(34.4)		
1–2 times	93(28.6)	77(25.9)	76(26.6)		68(28.8)	72(34.1)	62(28.1)		
Never	41(12.6)	22(7.4)	13(4.6)	**T0 to T2:** 0.31(0.16,0.47), ***P* < 0.001**	24(10.2)	21(10.0)	19(8.6)	**T0 to T2:** −0.03(−0.20,0.15), *P* = 0.778	**T0 to T2:** 0.34(0.10,0.57), ***P* = 0.005**
Were fresh/frozen vegetables served to your child at evening meal in your home?									
Everyday	42(12.9)	68(23.1)	52(18.4)	**T0 to T1:** 0.40(0.25,0.55), ***P* < 0.001**	43(18.4)	34(16.0)	32(14.9)	**T0 to T1:** 0.06(−0.12,0.23), *P* = 0.528	**T0 to T1:** 0.35(0.12,0.58), ***P* = 0.003**
5–6 times	40(12.3)	46(15.7)	46(16.3)		32(13.7)	33(15.5)	36(16.7)		
3–4 times	91(27.9)	82(27.9)	83(29.3)		60(25.6)	60(28.2)	72(33.5)		
1–2 times	109(33.4)	74(25.2)	84(29.7)		63(26.9)	70(32.9)	58(27.0)		
Never	44(13.5)	24(8.2)	18(6.4)	**T0 to T2:** 0.37(0.22,0.53), ***P* < 0.001**	36(15.4)	16(7.5)	17(7.9)	**T0 to T2:** 0.11(−0.06,0.29), *P* = 0.204	**T0 to T2:** 0.26(0.03,0.49), ***P* = 0.028**
Were 100% whole-wheat or whole-grain bread or tortillas served to your child at meals in your home?									
5 times or more	95(29.1)	103(34.6)	95(33.6)	**T0 to T1:** 0.09(0.004,0.17), ***P* = 0.040**	71(29.6)	73(34.4)	74(33.8)	**T0 to T1:** 0.05(−0.04,0.15), *P* = 0.283	**T0 to T1:** 0.03(−0.09,0.16), *P* = 0.607
1–4 times	177(54.3)	153(51.3)	160(56.5)		125(52.1)	105(49.5)	119(54.3)		
Never	54(16.6)	42(14.1)	28(9.9)	**T0 to T2:** 0.12(0.03,0.20), ***P* = 0.006**	44(18.3)	34(16.0)	26(11.9)	**T0 to T2:** 0.10(0.002,0.20), ***P* = 0.046**	**T0 to T2:** 0.02(−0.11,0.15), *P* = 0.759
Was sugar sweetened cereal served to your child at breakfast in your home?									
5 times or more	68(20.9)	35(12.2)	35(12.2)	**T0 to T1:** −0.14(−0.21,−0.06), ***P* < 0.001**	40(16.7)	40(17.9)	40(17.9)	**T0 to T1:** −0.03(−0.12,0.05) *P* = 0.464	**T0 to T1:** −0.10(−0.22,0.01), *P* = 0.075
1–4 times	203(62.5)	190(66.4)	190(66.4)		165(68.8)	140(62.8)	140(62.8)		
Never	54(16.6)	61(21.3)	61(21.3)	**T0 to T2:** −0.13(−0.21,−0.06), ***P* = 0.001**	35(14.6)	43(19.3)	43(19.3)	**T0 to T2:** −0.04(−0.13,0.05), *P* = 0.368	**T0 to T2:** −0.09(−0.21,0.02), *P* = 0.110
Were sugar sweetened drinks served at the evening meal in your home?									

thus emphasizing the need for targeting parents as agents of change (Collins et al., 2013).

Our study demonstrated that while there was an increase in F&V intake there was a concurrent decrease in intake of added sugars among

Table 3 (*continued*)

Intervention group					Comparison group				
Survey questions	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Baseline (T0) mean (SD[a])	Midpoint (T1) mean (SD[a])	Post-test (T2) mean (SD[a])	Within group changes[b] (95% CI[c]) *P*-value	Net changes (delta) in intervention group[d] (95% CI[c]) *P*-value
5 times or more	55(16.9)	35(11.8)	25(8.8)	**T0 to T1:** −0.11(−0.18,−0.03), ***P* = 0.004** **T0 to T2:** −0.19(−0.26,−0.12), ***P* < 0.001**	34(14.2)	20(9.4)	21(9.5)	**T0 to T1:** −0.06(−0.14,0.03), *P* = 0.181 **T0 to T2:** −0.009(−0.18,−0.01), ***P* = 0.028**	**T0 to T1:** −0.05(−0.16,−0.06), *P* = 0.398 **T0 to T2:** −0.10(−0.21,0.02), *P* = 0.091
1–4 times	199(61.2)	178(60.1)	164(57.5)		146(60.8)	137(64.0)	136(61.3)		
Never	71(21.9)	83(28.0)	96(33.7)		60(25.0)	57(26.6)	65(29.3)		
Parental rules - do you have the following rules about your child's eating?									
Limit porting sizes?									
Yes	150 (46.7)	139 (48.6)	150 (56.8)	**T0 to T1:** 0.15(−0.21,0.52), *P* = 0.411 **T0 to T2:** 0.66(0.27,1.05), ***P* = 0.001**	120(50.2)	108(52.2)	107(49.1)	**T0 to T1:** 0.13(−0.30,0.55), *P* = 0.561 **T0 to T2:** −0.04(−0.46,0.37), *P* = 0.847	**T0 to T1:** 1.03[f](0.59,1.80), *P* = 0.926 **T0 to T2:** 2.02[f](1.14,3.57), ***P* = 0.016**
Sometimes	86(26.8)	73(25.5)	56(21.2)		57(23.9)	57(27.5)	60(27.5)		
No	85(26.5)	74(25.9)	58(22.0)		62(25.9)	42(20.3)	51(23.4)		
No meals while watching TV/DVDs?									
Yes	111(34.7)	108(37.2)	107(37.9)	**T0 to T1:** 0.16(−0.17,0.49), *P* = 0.345 **T0 to T2:** 0.17(−0.17,0.50), *P* = 0.329	89(36.9)	85(40.7)	87(39.7)	**T0 to T1:** 0.19(−0.19,0.58), *P* = 0.324 **T0 to T2:** 0.08(−0.31,0.46), *P* = 0.695	**T0 to T1:** 0.96[f](0.58,1.61), *P* = 0.890 **T0 to T2:** 1.09[f](0.66,1.82), *P* = 0.728
Sometimes	118(36.9)	107(36.9)	95(33.7)		85(35.3)	74(35.4)	71(32.4)		
No	91(28.4)	75(25.9)	80(28.4)		67(27.8)	50(23.9)	61(27.9)		
No fried snacks (such as potato chips) at home?									
Yes	59(18.3)	73(25.3)	53(18.9)	**T0 to T1:** 0.37(0.04,0.69), ***P* = 0.027** **T0 to T2:** 0.10(−0.23,0.43), *P* = 0.552	43(18.0)	40(19.4)	40(18.2)	**T0 to T1:** 0.17(−0.21,0.55), *P* = 0.369 **T0 to T2:** 0.16(−0.21,0.53), *P* = 0.403	**T0 to T1:** 1.21[f](0.74,2.00), *P* = 0.451 **T0 to T2:** 0.94[f](0.58,1.54), *P* = 0.815
Sometimes	159(49.4)	134(46.4)	144(51.3)		114(47.7)	106(51.5)	116(52.7)		
No	104(32.3)	82(28.4)	84(29.9)		82(34.3)	60(29.1)	64(29.1)		
Must eat dinner with the family?									
Yes	218(67.5)	207(71.9)	196(69.8)	**T0 to T1:** 0.21(−0.21,0.64), *P* = 0.328 **T0 to T2:** 0.20(−0.24,0.63), *P* = 0.377	166(68.6)	143(68.8)	150(67.6)	**T0 to T1:** −0.007(−0.50,0.49), *P* = 0.978 **T0 to T2:** 0.07(−0.41,0.55), *P* = 0.771	**T0 to T1:** 1.25[f](0.65,2.40), *P* = 0.507 **T0 to T2:** 1.13[f](0.59,2.16), *P* = 0.708
Sometimes	69(21.4)	46(16.0)	51(18.2)		46(19.0)	41(19.7)	52(23.4)		
No	36(11.2)	35(12.2)	34(12.1)		30(12.4)	24(11.5)	20(9.0)		
Limit fast food?									
Yes	232(71.6)	232(80.0)	210(74.2)	**T0 to T1:** 0.64(0.19,1.08), ***P* = 0.005** **T0 to T2:** 0.39(−0.04,0.81), *P* = 0.078	167(69.0)	156(74.6)	168(75.7)	**T0 to T1:** 0.53(0.04,1.01), ***P* = 0.035** **T0 to T2:** 0.56(0.08,1.04), ***P* = 0.022**	**T0 to T1:** 1.12[f](0.58,2.16), *P* = 0.735 **T0 to T2:** 0.84[f](0.44,1.59), *P* = 0.588
Sometimes	63(19.4)	40(13.8)	58(20.5)		57(23.6)	47(22.5)	45(20.3)		
No	29(9.0)	18(6.2)	15(5.3)		18(7.4)	6(2.9)	9(4.1)		
No sugary beverages?									
Yes	131(40.4)	147(51.6)	143(50.7)	**T0 to T1:** 0.63(0.28,0.97), ***P* < 0.001** **T0 to T2:** 0.63(0.28,0.97), ***P* < 0.001**	104(43.0)	99(48.1)	104(47.3)	**T0 to T1:** 0.30(−0.90,0.69), *P* = 0.131 **T0 to T2:** 0.12(−0.26,0.51), *P* = 0.536	**T0 to T1:** 1.38[f](0.82,2.33), *P* = 0.221 **T0 to T2:** 1.66[f](0.99,2.78), *P* = 0.055
Sometimes	124(38.3)	96(33.7)	97(34.4)		94(38.8)	82(39.8)	77(35.0)		
No	69(21.3)	42(14.7)	42(14.9)		44(18.2)	25(12.1)	39(17.7)		
Must finish all food on plate?									
Yes	166(51.1)	64(21.9)	60(21.2)	**T0 to T1:** −0.03(−0.42,0.36), *P* = 0.894 **T0 to T2:** −0.16(−0.55,0.24), *P* = 0.440	109(45.4)	52(24.9)	63(28.4)	**T0 to T1:** −0.30(−0.74,0.14), *P* = 0.185 **T0 to T2:** −0.49(−0.92,−0.05), ***P* = 0.029**	**To to T1:** 1.31[f](0.73,2.37), *P* = 0.364 **T0 to T2:** 1.39[f](0.77,2.51), *P* = 0.270
Sometimes	90(27.7)	84(28.8)	85(30.0)		76(31.7)	69(33.0)	73(32.9)		
No	69(21.2)	144(49.3)	138(48.8)		55(22.9)	88(42.1)	86(38.7)		

T0 vs. T1: $n = 514$ parent-child dyads for parent survey (intervention: control = 298:216); T0 vs. T2: $n = 505$ parent-child dyads for parent survey (intervention: control = 283:222). Boldface indicates statistical significance at $P \le 0.05$.

[a] Standard deviation.

[b] Contrasts and linear hypothesis tests after estimation.

[c] Confidence Interval.

[d] Adjusted coefficients were calculated using mixed-effect linear regression models that adjusted for ethnicity.

[e] Often = about three quarters of the time; Sometimes = about half of the time; Rarely = about a quarter of the time;

[f] Adjusted Odds Ratios were calculated using mixed-effect logistic or ordered logistic regression models that adjusted for ethnicity.

Table 4
Brighter Bites program dosage, fidelity and perceived effectiveness, Houston, Texas 2013–2015.

	Year 1 (2013–14)	Year 2 (2014–15)	Mean
Average cost of produce per family per week	$2.67	$2.63	$2.65
Average number of servings of F&V[a] provided per family	60.1	53.6	56.9

Parent process survey evaluation results

	Fall 13′ ($n = 136$)	Spring 14′ ($n = 130$)	Fall 14′ ($n = 135$)	Spring 15′ ($n = 140$)	Average
Attendance per semester[b] (mean weeks ± SD)	7.5 ± 1.5	7.1 ± 1.7	7.0 ± 1.8	7.0 ± 2.0	7.1 ± 1.8
	n(%)				
Overall experience using the fruit.					
My family ate all or most of the fruit every week	110(92.4%)	107(89.9%)	135(95.7%)	124(96.9%)	93.7%
My family ate less than half or none of the fruit	5(4.2%)	4(3.4%)	0(0.0%)	0(0.0%)	1.9%
Overall experience using the vegetables.					
My family ate all or most of the veggies every week	101(87.8%)	92(81.4%)	120(87.0%)	115(92.0%)	87.1%
My family ate less than half or none of the veggies	7(6.1%)	9(8.0%)	6(4.4%)	3(2.4%)	5.2%
% Parents who reported reading nutrition booklet	69(50.7%)	101(77.7%)	79(58.5%)	109(77.9%)	66.2%
% Parents who reported using nutrition booklet	59(43.4%)	67(51.5%)	61(45.2%)	71(50.7%)	47.7%
Effectiveness of the fruit provided to influence child's intake of F&V					
Very effective	69(66.4%)	81(65.3%)	96(72.2%)	99(76.7%)	69.9%
Somewhat effective	8(7.7%)	21(16.9%)	10(7.5%)	7(5.4%)	9.4%
Not effective	3(2.9%)	2(1.6%)	2(1.5%)	3(2.3%)	2.1%
Effectiveness of the vegetables provided to influence child's intake of F&V					
Very effective	52(50.0%)	69(56.6%)	83(63.4%)	88(68.8%)	59.7%
Somewhat effective	13(12.5%)	17(13.9%)	11(8.4%)	12(9.4%)	11.1%
Not effective	2(1.9%)	2(1.6%)	2(1.5%)	3(2.3%)	1.8%
Effectiveness of the nutrition booklet to influence child's F&V intake.					
Very effective	38(40.9%)	46(40.0%)	50(44.6%)	63(52.5%)	44.5%
Somewhat	18(19.4%)	21(18.3%)	19(17.0%)	15(12.5%)	16.8%
Not effective	3(3.2%)	8(7.0%)	5(4.5%)	4(3.3%)	4.5%
Effectiveness of the recipe cards to influence child's F&V intake.					
Very effective	40(40.0%)	44(38.3%)	55(45.8%)	66(55.0%)	44.8%
Somewhat effective	16(16.0%)	26(22.6%)	19(15.8%)	15(12.5%)	16.7%
Not effective	5(5.0%)	5(4.4%)	6(5.0%)	4(3.3%)	4.4%

[a] F&V – fruits and vegetables.
[b] Number of weeks attended per eight weeks cycle.

children. Consumption of added sugars has been proven to increase risk of childhood obesity (Te Morenga et al., 2012). These results are further supported by the changes reflected in the parental food rules observed in our study, with significantly more parents in the Brighter Bites group reportedly limiting sugary beverages for their child during mealtimes at home. Brighter Bites nutrition education also provided information on minimizing consumption of foods with added sugars. These results demonstrate that providing parents with messages to strengthen healthy habits coupled with information on how to reduce unhealthy behaviors can have a positive impact on the child's diet.

In addition to changes in dietary intake among children and parents, our study also demonstrated significant improvements in parental frequency of cooking using basic ingredients and using nutrition facts labels in making food purchasing decisions. Other changes included increased availability of F&V at meals, eating meals together as a family, and limiting portion sizes. Systematic reviews of the literature indicate that parents remain a key mediator of the relationship between the environment and child behaviors related to obesity prevention (Gicevic et al., 2016), and recommend interventions to target parents as agents of change using school/after-school settings to successfully improve child dietary behaviors, which was a major focus of our study among low-income, ethnically diverse, underserved populations (Collins et al., 2013). Moreover, other studies have demonstrated promise in implementing programs targeting healthy eating among parents and children from disadvantaged communities (Burrows et al., 2015). These results, along with those in our study, underscore the importance of combining access with education in the school and for parents to promote healthy behaviors among children.

Our study showed the feasibility and acceptability of implementing a F&V food co-op model in schools. Food co-ops are gaining popularity around the U.S. (Zitcer, 2015) However, there are limited data demonstrating the feasibility and effectiveness of implementing co-ops in low-income communities. Through Brighter Bites, participating families received an average of 56.8 servings per family per week of donated produce from the local food bank. Using a F&V co-op concept is an innovative strategy to engage families around a healthy activity in the schools. The Texas House Bill 4 approved in the 2015 Texas legislative session requires public schools to provide a parent engagement plan to the state "to assist the district in achieving and maintaining high levels of parental involvement" (Texas Education Agency, 2015). Moreover, Brighter Bites purposefully channeled donated produce from the food bank using schools for distribution at no cost to the families. Cost of produce for the food bank was low, $2.65 per family/week, which was primarily associated with produce inventory and delivery cost. By linking the food banks with the schools to distribute F&V, Brighter Bites is able to create new models for food distribution for local food banks. Strengths of the study include retention of all schools participating in the study, a relatively large sample size with a diverse low-income population, and bilingual materials.

10. Limitations

Limitations include a non-randomized design with a convenience sample of schools limiting internal validity. The comparison schools were trained to implement the CATCH program targeting healthy eating and physical activity which could attenuate the findings. However, a CATCH-only comparison model was implemented in our study to reflect a 'real-life' scenario, and to standardize this exposure in the comparison schools. Moreover, participation in Brighter Bites required the ability to pick up produce bags when picking up children at the end of the school

day. This could have resulted in a selection bias of motivated parents who volunteered to participate in the program and the study which could have biased our results away from the null. Currently, a long-term follow up study looking at maintenance of observed effects in the current cohort of families is being planned, along with future studies to implement a cluster-randomized controlled trial design. Other limitations include attrition for our parent survey measures. However, sensitivity analysis demonstrated that non-respondents were not significantly different from respondents. Also, there could be underestimation of dietary intake from the Block FFQ. Finally, the self-report data from the parent surveys could be subject to social desirability bias.

11. Conclusions

Outcomes of the Brighter Bites study add to the accumulating body of literature that engaging parents and schools helps children learn to eat healthy foods such as F&V and establish stronger dietary habits. However, results of our study indicate that longer term follow up is needed to assess behavior change over time.

Conflict of interest statement

Dr. Sharma is on the Executive Board of Brighter Bites non-profit organization, the goal of which is to improve access to fresh fruits and vegetables and nutrition education among underserved communities. The other authors have no conflicts of interest relevant to this article to disclose.

Financial disclosure

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