JOURNAL OF SCHOOL HEALTH

American School Health Association
Connecting Health & Learning
www.ashaweb.org

RESEARCH ARTICLE

Youth Chef Academy: Pilot Results From a Plant-Based Culinary and Nutrition Literacy Program for Sixth and Seventh Graders

AMY HARLEY, PhD, MPH, RD[a] MELISSA LEMKE, MA[b] RUTA BRAZAUSKAS, PhD[c] NICOLE B. CARNEGIE, PhD[d] LORI BOKOWY, MEd, CHES[e] LISA KINGERY, MS, RD[f]

ABSTRACT

BACKGROUND: National data confirm that youth are not eating recommended amounts of fruits and vegetables (F/V), legumes, and whole grains (WGs). Establishing plant-based eating patterns early in life may positively impact long-term health through tracking of adolescent eating patterns into adulthood and through potential associations between adolescent dietary intake and adult disease risk. The study aim was to examine the effectiveness of Youth Chef Academy (YCA), a classroom-based experiential culinary and nutrition literacy intervention for sixth and seventh graders (11- to 13-year-olds) designed to impact healthy eating.

METHODS: Study used a nonequivalent control group design with 8 schools selected for similarity in: free/reduced-price lunch, race/ethnicity, and student mobility rate (N = 248). Primary outcomes were times per day of F/V, vegetable, and WG consumption. Students completed a survey to assess primary outcomes and other measures at baseline and post-intervention.

RESULTS: Significant increases in times per day of F/V ($p = .022$) and vegetable only ($p = .015$) consumption in the intervention group compared to the control group. Increases in WG consumption showed trended toward significance ($p = .071$). Student engagement and nutrition knowledge showed significant intervention effects.

CONCLUSIONS: YCA positively impacts behavioral and knowledge variables related to healthy eating and increases students' engagement in their classrooms.

Keywords: diet; youth health; school interventions school health; nutrition.

Citation: Harley A, Lemke M, Brazauskas R, Carnegie NB, Bokowy L, Kingery L. Youth Chef Academy: pilot results from a plant-based culinary and nutrition literacy program for sixth and seventh graders. J Sch Health. 2018; 88: 893-902.

Childhood obesity rates have risen sharply in recent decades[1] and is responsible for over $14.1 billion in US health care costs annually.[2] Healthy eating can lower the risk of obesity and related conditions[3,4] and a critical component of a healthy diet is consumption of plant-based foods.[5] Fruit and vegetable (F/V)[6,7] and whole grain (WG) consumption[8,9] have been linked to reduced risk of heart disease and all-cause mortality. Whole grain consumption has also been linked to reduced risk of cancer[8] and type 2 diabetes.[10] Establishing plant-based eating patterns early in life may impact diet-related chronic disease trends[11-13] through the tracking of adolescent eating patterns into adulthood[11-16] and through potential associations between adolescent dietary intake and adult disease risk.[17]

[a]Associate Professor, (harley@uwm.edu), Joseph J. Zilber School of Public Health, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201-0413.

[b]TRIUMPH, Program Manager, (melissa.lemke@aurora.org), Center for Urban Population Health, 1020 North 12th Street, Suite 4180, Milwaukee, WI 53233.

[c]Associate Professor, (ruta@mcw.edu), Division of Biostatistics, Medical College of Wisconsin, Milwaukee, WI.

[d]Assistant Professor of Statistics, (nicole.carnegie@montana.edu), Department of Mathematical Sciences, College of Letters and Science, Montana State University, P.O. Box 172400, Bozeman, MT 59717-2400.

[e]Graduate Assistant, (labokowy@uwm.edu), Joseph J. Zilber School of Public Health, UW-Milwaukee, P.O. Box 413, Milwaukee, WI 53201-0413.

[f]Public Health Nutritionist, Culinary Educator, Founder, (lkingery@foodright.org), FoodRight, LLC, P.O. Box 510622, Milwaukee, WI 53203.

Address correspondence to: Amy Harley, Associate Professor, (harley@uwm.edu), Joseph J. Zilber School of Public Health, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201-0413.

The project described was supported by the Clinical and Translational Science Award (CTSA) program, previously through the National Center for Research Resources (NCRR) grant 1UL1RR025011, and now by the National Center for Advancing Translational Sciences (NCATS), grant 9U54TR000021. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. Support for the curriculum's development was funded in part by the Fondy Food Center.

National data confirm that youth are not eating recommended amounts of F/V, legumes, and WG.[4,18-22] National Health and Nutrition Examination Survey (NHANES) data from 2003 to 2010 show that while whole fruit consumption increased across this time period, total vegetable and vegetable subgroup intake did not increase over time and no sociodemographic group met *Healthy People 2020* targets for F/V consumption.[20] Similarly, 2001-2010 NHANES data show no significant increase in WG consumption for any age group.[22] Effective strategies are needed to improve F/V and WG consumption among youth.

A growing body of evidence shows that nutrition education combined with culinary training improves diet.[23] The 2015 Dietary Guidelines for Americans recommends action strategies for professionals such as ''teach skills like . . . cooking, meal planning, and label reading that help support healthy eating patterns.''[4] Applying this recommendation to youth through cooking-based nutrition education programs may provide a promising approach to improve plant food consumption and prevent obesity.[24] Learning activities like cooking which feature fun, collaborative, authentic work are associated with higher student engagement and may promote learning across academic subjects.[25] Research examining eating behaviors of youth has shown a positive link between cooking family meals and eating a healthy diet.[12,26] Because middle-school-aged adolescents may cook at home more frequently than high schoolers,[26] culinary education during early adolescence could leverage this time of increased cooking responsibilities to impact diet quality.

Although home economics classes once served to introduce students to the basics of cooking, these programs have declined by nearly 40% since 2003[27] and their impact on diet composition has not been studied. In the intervention literature, published accounts of youth nutrition programs with cooking components are limited and vary in the degree of hands-on cooking permitted and ages targeted.[28-37] Nearly all in-school interventions target elementary school students (5- to 11-year-olds) while middle school programs (sixth-eighth grade: 11- to 14-year-olds) take place in camps and afterschool settings, limiting the consistency in attendance that a classroom-based program affords. While not delivered in middle school classrooms, 3 programs with cooking components measured change in consumption. Two reported significant behavioral change[32,33] and the third reported significant change in plate waste.[28]

While few culinary programs for youth have reported significant increases in F/V consumption, several have documented changes in other variables related to dietary behavior such as attitudes, awareness, knowledge, self-efficacy for cooking, and food preferences.[28-30,32-36,38] Some of these variables have been established as precursors to changing or predicting dietary behavior in youth. For example, Bere and Klepp[39] reported that change in F/V preferences was a significant predictor of future change in F/V intake among sixth/seventh graders. Backman et al[40] showed that intention to eat a healthy diet among adolescents predicted their consumption of F/V. Additionally, a 2006 review of determinants of F/V consumption among youth reported that nutrition knowledge and self-efficacy showed positive associations with F/V consumption, although additional evidence is needed.[41]

Given the importance of diet to health and the stagnant trends in plant food consumption among youth, innovative and effective strategies addressing healthy eating are critically needed. The purpose of this pilot study was to examine the effectiveness of Youth Chef Academy (YCA), a classroom-based, hands-on culinary and nutrition literacy curriculum, for middle school-aged students in a large, urban public school system. YCA's nutrition literacy focus refers to program components designed to deliver a systems level context (eg, historical, social, economic, cultural) for practicing healthy eating and developing culinary skills. YCA has the potential to add to evidence-based nutrition education. Its constellation of features, including linkages to academic standards, are not fully present in other published interventions. The primary hypothesis was that students assigned to the YCA curriculum would demonstrate greater improvement in times per day of F/V, vegetable only (VG), and WG consumption over the 6-week intervention compared to students in the control group.

METHODS

This study, implemented 2011-2013, employed a nonequivalent control group design with 8 public kindergarten-eighth grade (K-8) schools in one school district. One sixth- or seventh-grade classroom (11- to 13-year-olds) per school was included in the study. Four intervention classrooms received the YCA curriculum and 4 control classrooms received their usual academic curriculum. No in-depth nutrition education was offered as part of the usual academic curriculum. This design helped minimize threats to internal validity including history and testing effects. The outcome evaluation utilized a baseline and post test survey, administered the week after YCA ended, in all 8 classrooms.

Participants

With approval of the school system superintendent (director of school district) and working in partnership with the school system's curriculum specialist for health and physical education, study investigators

recruited 4 intervention schools by initiating one-on-one meetings with principals. With teacher engagement and principal approval, study investigators identified 1 classroom in each school for the intervention. The school system research office then selected the control schools for similarity on free/reduced-price lunch utilization, race/ethnicity, grade, and student mobility rate.

All students in the intervention classrooms experienced the YCA curriculum. Students' parents provided passive consent for their child's participation in the surveys and students provided written assent. Students without parental consent or personal assent completed work as directed by their classroom teacher during the surveys. The university's Institutional Review Board and the public school system's Research Review Board approved this study prior to implementation (ClinicalTrials.gov Identifier: NCT02463149).

Intervention

YCA was developed by one of the lead investigators through 4 iterative classroom demonstration projects with program revisions based on student, teacher, and parent feedback (unpublished data). It promotes intake of a whole-food, plant-based diet by giving youth the opportunity to (1) explore the connections between foods, the food system, and health and (2) create meals ''from scratch'' as young chefs in training.

Guided by the tenets of Social Cognitive Theory,[42,43] YCA is comprised of 6 2-hour sessions (Table S1, Supporting Information presents theoretical linkages). Each session begins with a nutrition lesson focusing on an aspect of health or the food system (Table 1 presents curriculum detail). Nutrition lessons were linked to academic standards in math, literacy, and social studies. For example, students calculate their dietary percentage from plant foods, locate the origin of various cuisines on a world map noting distinctive ingredients and flavorings, and compare local and global food systems. Following the nutrition lesson, students divide into smaller teams to learn cooking techniques, knife skills, and explore ingredients by preparing recipes from world cuisines. Each YCA lesson ends with students eating the foods they prepared while discussing the dishes in constructive and descriptive ways. Students take home parent newsletters and at-home cooking assignments.

One of 2 instructors led the entire class in the weekly session and supervised the classroom support team. Both instructors were members of the study staff. One was a registered dietitian with extensive experience in school-based culinary interventions and the developer of the YCA curriculum. She trained, observed, and coached the second instructor. The classroom teacher and 2 dietetic interns completed a 2-hour training and provided classroom support. Table 2S presents a summary of key personnel and financial resources needed for YCA implementation.

Instrumentation

Students completed a survey measuring the primary outcomes and other variables. The survey was compiled from previously published measures, adapted measures, and measures created for this study. Cognitive interviews were conducted with several youth to ensure comprehensibility of survey items and acceptability of length.

The primary outcome measures were times per day F/V, VG, and WG consumption. Other measures included psychosocial, knowledge, and engagement variables potentially related to the primary outcomes.

Primary outcomes. Fruit and vegetable consumption was measured using validated, self-report items from the Centers for Disease Control and Prevention (CDC)'s Youth Risk Behavior Surveillance System (YRBSS).[44,45] Seven items (2 fruits, 5 vegetables) assessed F/V and VG consumption over the past week with responses ranging from 0 to 4 or more times per day using a 7-point scale. Eight items assessing WG consumption were adapted from the Power of 3: Get Healthy with Whole Grains Foods program adult survey (University of Minnesota Extension). The recall frame for WG consumption and the response scale were changed to align with the YRBSS questions. Responses were reported in times per day. Internal validity of the modified scale in the study population was moderately strong (Cronbach's $\alpha = .72$).

Other measures: Readiness to increase F/V consumption. The survey included 2 questions from the University of California Fruit and Vegetable Inventory to assess readiness to increase F/V consumption that were validated in adult women.[46] The 5 response choices were based on the stages of change model and ranged from ''I am not thinking about eating more F/V (precontemplation),'' to ''I am already eating 3 or more servings of F/V a day (action).''

Self-efficacy. Self-efficacy measures asked questions in 3 domains: confidence in tasting new foods (1 question), confidence in personal cooking skills (3 questions), and confidence in ability to consume 5 servings of F/V a day (2 questions). The self-efficacy questions on tasting new foods and cooking skills were constructed and validated in adults for the Cookwell[47] community-based cooking skills intervention and used a 7-point Likert scale ranging from ''extremely confident'' to ''not at all confident.'' Internal validity in this study population was modest (Cronbach's $\alpha = .6$). By adapting the Cookwell format, YCA investigators created the items to assess confidence in ability to consume 5 servings of F/V a day.

Nutrition knowledge. Nutrition knowledge was assessed using 17 survey items compiled by study

Table 1. **Youth Chef Academy: Culinary and Nutrition Literacy Curriculum Overview**

Lesson	Focus of the Food and Nutrition Lesson	Focus of the Cooking Lesson	Recipes
Lesson 1: Kitchen basics	• Explore kitchen equipment • Identify kitchen dangers and learn to prevent accidents including safe food handling • Learn and use measurement tools and units	• Hand washing • Wash and handle salad greens and other vegetables • Culinary methods and skills—measure, whisk, emulsify, peel, and grate	Tossed white bean salad with lemon vinaigrette
Lesson 2: Food today	• Explore how and why food has changed in 100 years • Identify and describe whole and highly processed foods • Build awareness of the processes that transform whole foods	• Recipe reading • Teamwork • Learn and apply new culinary terms, methods and skills—stove usage and safety; stove-top popcorn • Map and explore ingredients	Perfect stove-top popcorn • Bombay behl popcorn • Cajun popcorn • Cinnamon-sugar popcorn
Lesson 3: Informed choice	• Understand nutrient and calorie density • Analyze food packages • Discover the economic and nutritional impact of processing on food	• Recipe reading • Teamwork • Learn and apply new culinary terms, methods and skills—pureeing, folding, grate peel and garnish • Map and explore ingredients	Dips made with legumes • French white bean dip • Mexican black bean dip • Hummus • Thai peanut dip
Lesson 4: Plant power	• Describe a plant-based diet and understand the health benefits • Identify different parts of the plants we eat	• Learn and practice knife skills—chop and rock chop • Learn cuts for various vegetables	Whole plant salad—students assemble a chopped salad using all the parts of a plant
Lesson 5: Whole plant foods and your health	• Recall one's diet • Assess one's diet using a modified My Plate • Calculate ratios and percentages of dietary components • Strategize ways to increase intake of whole, plant foods	• Recipe reading • Teamwork • Learn and apply new culinary terms, methods and skills—soup preparation, sauté, boil, simmer • Reinforce and expand knife skills—slice and mince • Map and explore ingredients	• Korean vegetable soup • Guatemalan vegetable soup • Spanish gazpacho • Italian minestrone
Lesson 6: Seeds—grains and India	• Learn what a whole grain is • Learn about the food system comparing a local food cooperative to a national supermarket chain • Explore and identify types of whole grains, processed grains and refined grains	• Recipe reading • Teamwork • Learn and apply culinary terms, methods and skills—tempering spices; pilaf and grain dish preparation • Reinforce knife skills and practice new cuts • Map and explore ingredients	Indian cuisine • Vegetable pulao • Red lentil dal
Supplemental materials	• Student food journals: organize all relevant food and cooking information—record outcomes of recipes, reflections on foods and lessons, define new culinary and food terms, keep recipes, handouts, homework assignments, etc. • Parent newsletters: inform parents of lessons, recipes prepared in class, and give homework assignments. Also provides parents with useful culinary and nutrition information as well as give recommendations for exploring the local food system with their child. • Field trip report: document local food system field trips that students can take with their families or as a class • Recipe reports: document student experiences when they cook at home for or with their families • Videos: students watch and review proper knife skills and cooking techniques that will be used in the recipe • Exploration stations: used during the cooking lesson, they provide students a meaningful, hands-on way to reinforce and expand on concepts and skills introduced during the food and nutrition lesson while students are between cooking activities		

Table 2. **Classroom-Level Characteristics of Youth Participating in the Youth Chef Academy Pilot Study, by Intervention Condition (N = 8 Classrooms)**

Classroom Characteristic	Intervention Classrooms (N = 4)	Control Classrooms (N = 4)	
Students receiving free/reduced-price lunch	88.9% (74.1, 100.0)*	79.6% (53.1, 92.0)	p = .35†
Race/ethnicity			p < .0001‡
African American	47.3% (0, 95.2)	22.0% (4.0, 56.2)	
Hispanic	37.2% (3.4, 100)	29.6% (6.2, 72.0)	
White	14.6% (0, 44.4)	33.5% (6.2, 54.5)	
Other	0.9% (0, 3.7)	15.0% (4.0, 31.2)	
School mobility	12.4% (0, 33.3)	7.9% (0, 15.6)	p = .57†
Mean attendance (percent days in school during semester of YCA)	93.1% (91.2, 97.1)	95.1% (94.7, 95.4)	p = .18†

*Values given are mean (min, max). The range is used rather than a conventional confidence interval due to the small number of observations and high variability in most characteristics.
†Differences between groups assessed using 2-sample *t* tests.
‡Differences between groups were assessed using chi-square tests of independence.

investigators. One question assessed understanding of general health benefits of F/V consumption.[48] Five items from the Power of 3 survey asked youth to identify WG items from paired food choices. One question regarding WG food identification was used from the University of Georgia Whole Grain Intake survey for adults.[49] Another question on WG food identification was adapted from that survey.[49] One question from the Hawthorne Unified School District asked students to identify a healthy snack from a list of options (unpublished). Study investigators created 8 items to assess knowledge about food processing topics specific to the YCA curriculum.

WG preference. Students completed a measure from the Power of 3 Program youth survey to indicate preference for 7 paired WG and non-WG choices.

Vegetable preference. Vegetable preference was measured using a 26-item tool adapted from Cookshop's model for kindergarten-sixth grade youth (5- to 12-year-olds).[28] Study investigators modified the list of foods to those relevant to YCA and adapted the wording of response choices. Internal validity in the study population was high (Cronbach's $\alpha = .81$).

Student engagement. Student engagement, defined as behavioral and emotional participation in academic activities in the classroom, was measured by a 20-item tool developed by Skinner et al[50] (Cronbach's $\alpha = .85$). Response options were on a 4-point Likert scale ranging from ''very true'' to ''not true at all.''

Procedure

The survey was paper-and-pencil, closed-ended, and took approximately 30 minutes to complete. To enhance comprehension, students had the survey in front of them while a study staff member read the survey aloud to the whole class. To minimize reporting bias, this study staff member was not present in the classroom for any of the YCA sessions. The survey was administered approximately 1 week prior to the first YCA session (baseline) and approximately 7 weeks later, after the sixth YCA session (post-intervention).

Data Analysis

The primary outcomes were changes in times per day of (1) F/V consumption, (2) VG consumption, and (3) WG consumption after the 6-week program. Secondary outcomes included vegetable and WG preferences; self-efficacy for cooking, tasting new foods, and eating 5 servings of F/V per day; student engagement; readiness to increase F/V consumption; and nutrition knowledge.

Two-sample, t-statistic-based confidence intervals (CIs) were used to assess the unadjusted differences between pre-post changes in primary outcomes for intervention and control groups.

Missing data was handled using multiple imputation of item missingness (when full surveys were missing, no imputation was attempted). This was accomplished using the *mi* package in the R software program.

Multilevel models with school effects were used to estimate associations between the primary and secondary outcome variables and the intervention after adjusting for clustering by classroom. Matching variables (student ethnicity, grade level, mobility, and free/reduced-price lunch) were included as random effects at the school level to adjust for any inconsistencies between matched schools. Other confounders included at the individual level were attendance rate, sex, and baseline values of all primary and secondary outcomes. Attendance rate was the percentage of days in the semester of YCA implementation that a student was in school. These data came from school district records.

The cutoff $p = .05$ was used to establish statistical significance in all analyses.

RESULTS

Final sample size was 248 students (125 intervention, 123 control). Fifty-nine of these students missed

the survey at baseline and/or posttest. This was likely due to absences or other random mechanisms. After imputation of skipped survey items, there were 195 students included in analyses (100 intervention, 95 control). There is little evidence of differences in baseline characteristics between those who did and did not complete the posttest (full results available from authors); only the stage of change for vegetable consumption showed a significant difference, with those not completing the posttest scoring an average of 0.5 points lower (95% CI: −0.88, −0.14).

Classroom size ranged from 30 to 34 students. Classes had high rates of participation in the free/reduced-price lunch program and were racially/ethnically diverse (Table 2). The average rate of school change per year (school mobility) for the intervention and control groups were 12.4% and 7.9%, respectively, though this is not a statistically significant difference. Intervention and control groups varied significantly with respect to race/ethnicity, with control classrooms having a higher proportion of white and other race/ethnicity students. One method for evaluating the potential impacts of baseline imbalance on outcomes is a sensitivity analysis. In a separate analysis, consumption of F/V and VG were shown to be quite robust to possible unmeasured confounding (paper forthcoming).

Three process indicators for this study were classroom attendance, instructor effect, and intervention fidelity. Mean attendance rate was high at 93.1% of school days in the semester of YCA implementation in intervention classrooms and 95.1% in control classrooms (Table 2). Attendance rate was not a significant predictor in any of the models. There was no evidence of differences in student outcomes by YCA instructor ($p = .25$ for WG, $p = .37$ for F/V, $p = .94$ for VG). To ensure intervention fidelity, all 6 sessions in the 4 intervention classrooms were fully implemented by 1 of 2 members of the research team.

Baseline values of primary and secondary outcome measures were comparable between intervention and control groups (Table 3). A borderline significant difference was observed for self-efficacy for consuming 5 servings of F/V per day. The average percent of school days attended in the semester of YCA implementation was statistically significantly lower in intervention classrooms; the difference corresponds to only about 3.5 days of school missed. Of note, both groups reported high F/V, VG, and WG consumption at baseline.

Raw estimates of the primary outcome yielded a change of −0.61 times/day of F/V consumption in the control group, compared to 0.21 times/day in the intervention group (difference 0.82, 95% CI [−0.14, 1.78], $p = .096$). A difference in the direction of change was also observed for the change in VG consumption: −0.53 times/day in the control group and 0.05 in the intervention group (difference 0.58, 95% CI [−0.15, 1.31], $p = .12$). For WG consumption, we observe a change of −0.7 times/day in the control group compared to −1.0 times per day in the intervention group (difference −0.3, 95% CI [−1.3, 0.7], $p = .56$).

For the primary analyses, we excluded observations where the change in consumption was more than 10 times/day over 6 weeks; these values were both unrealistic as observations and destabilized model estimation. Three cases were excluded for analyses of WG consumption and 2 for analyses of F/V consumption (no reported changes in VG consumption exceeded this threshold). Attendance rate was transformed (using the arcsin-square root transformation) to reduce skewness and linearize the relationship with changes in consumption.

After adjustment for matching variables and individual-level confounders, we observe a significant increase in F/V and VG consumption, and a marginally nonsignificant increase in WG consumption (approximately 1.2, 0.9, and 0.9 times/day, respectively) (Table 4). Baseline consumption of F/V was a significant predictor of change in F/V and VG consumption, while stage of change for fruit consumption had a significant association with change in vegetable consumption. Baseline WG consumption, stage of change for fruit consumption, and baseline self-efficacy for cooking were significant predictors of change in WG consumption. Consumption at baseline was negatively associated with the change in consumption in all cases, as expected. Children who consume F/V or WG frequently at baseline are unlikely to increase their consumption much further due to constraints on possible intake of food in any given day.

In the secondary analyses (Table 5), vegetable preference, student engagement, and nutrition knowledge showed significant intervention effects. Notably, the effect on vegetable preference changed from a statistically significant increase to a statistically significant decrease after imputation; suggesting that the result is more uncertain than the p-value would imply. As such, vegetable preference was not included as a significant finding.

DISCUSSION

These data support our primary hypothesis that, compared to the control classrooms, students exposed to the YCA curriculum would demonstrate greater improvement in F/V and VG consumption over the 6-week intervention period. Our hypothesis about greater improvement in WG consumption among students exposed to YCA was not fully supported with a positive increase (0.9 times per day) approaching but not reaching significance. In comparing our findings (reported in times per day consumption) to the literature, it should be noted

Table 3. **Baseline Characteristics and Measures for Youth Participating in the Youth Chef Academy Pilot Study, by Intervention Condition (N = 195)**

Baseline Characteristic	Intervention (N = 100)	Control (N = 95)
Percent female	51.4(50.2)*	54.3(50.1)
Percent school days attended	93.0(0.08)	95.1(0.04)†
Fruit and vegetable consumption (times per day)	4.3(3.1)	4.5(3.6)
Whole grain consumption (times per day)	4.3(4.4)	3.4(3.1)
Vegetable preferences (0-78)†	37.4(10.0)	39.6(10.1)
Whole grain preferences (0-7)	2.9(1.7)	2.9(1.7)
Self-efficacy for cooking (0-18)	16.5(4.5)	15.4(4.6)
Self-efficacy for tasting new foods (0-6)	3.2(2.1)	3.3(2.3)
Self-efficacy for eating 5 servings of fruit and vegetables per day (0-12)	9.4(3.7)	10.4(3.3)‡
Student engagement (0-60)	38.7(8.8)	40.8(8.6)
Readiness to increase fruit consumption (0-3)	2.0(0.8)	2.1(0.9)
Readiness to increase vegetable consumption (0-3)	1.7(0.9)	1.7(1.1)
Nutrition knowledge (0-17)	9.6(2.8)	10.0(2.7)

*Cell values are mean (SD) unless otherwise noted.
†Scales include range of possible values as Scale Name (min-max).
‡Difference significant at $p < .05$ using a 2-sample *t* test.

Table 4. **Multilevel Model Results for Primary Outcomes of Change in Fruit and Vegetable (F/V), Vegetable, and Whole Grain Consumption From Baseline to Posttest Among Youth Participating in the Youth Chef Academy Pilot Study (N = 195)**

Variable	F/V Model Coefficient (N = 113)	Vegetable Model Coefficient (N = 116)	Whole Grain Model Coefficient (N = 115)
Intervention	1.2*	0.9*	0.9†
F/V consumption	−0.6***	−0.4***	−0.07
Whole grain consumption	0.1	0.003	−0.7***
Readiness to increase fruit consumption	0.4	0.5**	0.6*
Readiness to increase vegetable consumption	−0.2	−0.2	−0.3
Attendance rate (transformed)	−0.04	1.0	−0.8
Male	0.2	0.5	−0.3
Self-efficacy for cooking	−0.1	−0.04	−0.1**
Self-efficacy for tasting new foods	−0.07	−0.03	−0.1
Self-efficacy for consuming 5 F/V servings per day	0.04	0.1	0.002
Student engagement	−0.02	−0.02	−0.01
Nutrition knowledge	0.05	0.06	0.1
Vegetable preferences	−0.01	−0.02	−0.02
Whole grain preferences	−0.07	−0.1	0.1

Significance:
†$p < .10$;
*$p < .05$;
**$p < .01$;
***$p < .001$.
Variables used for matching schools (race/ethnicity, grade level, mobility, and free/reduced-price lunch) are included as school-level random effects. All variables are as measured at baseline.

that some studies report consumption in servings per day; these may not be equivalent measures. With that consideration, Evans et al[51] found an increase of 0.25 portions per day of F/V in a 2012 meta-analyses of 21 school-based nutrition programs. Examining cooking programs specifically, 2 studies reported statistically significant change in F/V consumption and showed increases of 1[32] and 2[33] servings per day. A cooking program reporting significant positive change in WG consumption could not be found. The Wang et al's[32] and Brown and Hermann's[33] programs show success in changing F/V consumption. With a constellation of features not fully present in these 2 programs, YCA adds to this evidence as an in-school, in-depth culinary program for middle-school-aged youth targeting F/V and WG consumption and linked to academic standards. Future research should examine whether treatment effects persist over time as well as whether increases in times per day consumption translate into increases in consumption volume.

Significant changes were found in nutrition knowledge in the intervention group compared to the control group. Nutrition knowledge[41] has been shown to be a determinant of dietary intake; indicating that this variable may be a pathway through which an intervention can influence dietary change. Similar to YCA, studies that specifically used cooking as a means of changing

Table 5. **Estimated Effect of Intervention on Change in Secondary Outcomes From Baseline to Posttest Among Youth Participating in the Youth Chef Academy Pilot Study (N = 195)**

Variable	Estimate (SE)	p-Value
Vegetable preferences	−4.4(1.7)	.002
Whole grain preferences	0.6(0.3)	.10
Self-efficacy for cooking	0.9(0.8)	.28
Self-efficacy for tasting new foods	0.5(0.3)	.14
Self-efficacy for eating 5 servings of fruit and vegetable per day	−0.3(0.5)	.48
Student engagement	2.3(1.0)	.03
Readiness to increase fruit consumption	0.1(0.3)	.56
Readiness to increase vegetable consumption	−0.05(0.2)	.80
Nutrition knowledge	1.7(0.4)	<.001

Model includes variables used for matching schools (race/ethnicity, grade level, mobility, and free/reduced-price lunch) as school-level random effects and all variables used in primary outcome models (see Table 4).

knowledge related to eating F/V generally reported positive results.[24,28-30,32-35,38,52] Differing from previous studies,[41] YCA did not produce significant changes in any of the measured self-efficacy variables. It is possible that the self-efficacy measures in this study were not robust enough. This finding suggests that YCA produced change in a known determinant of dietary behavior change, helping focus culinary-based nutrition education programs on key elements for change and possibly increasing feasibility by reducing measurement burden.

Relevant to school administrators and teachers, student engagement (behavioral and emotional participation in learning activities across the school day) improved significantly. This finding suggests that an experiential program like YCA can increase general interest in the classroom beyond the time spent in the program itself, which could be an important incentive for school administrators to add experiential nutrition education to their curricula.

Public health advocates have noted that school-based cooking education could improve long-term dietary consumption in youth.[24,53] Linking culinary curricula to academic standards increases the feasibility of adding programs like YCA to an already-stretched school day. Other feasibility considerations remain for optimal implementation effectiveness. For example, homework assignments, including home cooking, hone skills and encourage changes in the home eating environment. However, monitoring homework completion can be challenging. The homework completion tool used in this study was not consistently completed by the students even though anecdotal reports revealed that most students cooked at least one, if not several, of the YCA recipes at home. Use of incentives or other monitoring tools, such as social media, should be researched to improve reporting of these data, as should strategies to increase parent involvement in supporting cooking at home as noted by Fordyce-Voordam.[54] Additionally, while several studies measured confidence and perceived self-efficacy in cooking skills or attitudes toward cooking,[55-58] no method for measuring actual cooking skills in youth has been validated other than through direct observation, which may be unfeasible depending on sample size and constraints of the classroom setting. Development of such a method would constitute a significant contribution to the literature in this domain due to limitations of using measures of perceived ability as a proxy for actual ability.

Limitations

The nonequivalent control group design can result in the intervention and control groups having different characteristics at baseline. Statistically significant differences in the outcome variables between groups at baseline were not found. There were significant differences in race/ethnicity between groups at baseline, which could impact generalizability. This design is common when groups are naturally assembled, like classrooms, and is considered quite strong.[59] Another consideration is that the approach used for classroom selection introduced the potential for selection bias, though our sensitivity analysis showed our outcomes were quite robust to unmeasured confounding. Considering measurement bias, the complete survey and some of the individual measures were not previously tested in the population of interest, though we calculated internal validity where possible. The YRBSS questions are best suited to population-level monitoring rather than assessment of individual change. Additionally, assessment of the outcomes was based on self-reported data, which can be subject to bias related to accurate reporting of food consumption.

Conclusion

Nutrition education incorporating hands-on cooking skills, food system knowledge, and links to academic standards has potential to improve dietary patterns among youth. Practitioners can consider whether incorporating hands-on cooking lessons into existing nutrition education programming could improve behavioral outcomes. Future research should examine experiential nutrition education in the school setting to determine if a higher frequency or intensity of this type of curriculum impacts the program outcomes and longer-term maintenance of postintervention behavior changes.

IMPLICATIONS FOR SCHOOL HEALTH

The results of this study demonstrate that culinary-based nutrition education can successfully be linked to academic standards in math, literacy, and social

science while developing tangible skills and changing dietary behavior in as few as 6 lessons. Urban schools serving low-income students struggling with low attendance and test scores may want to consider including hands-on cooking-based education as this project provides evidence that an active learning model can increase student engagement in classroom activities beyond the nutrition curriculum itself.

Since this study, demand for the YCA program has increased greatly with teachers and administrators citing student enrichment as the key attribute that makes this program a desirable addition to their classroom. Enrichment education programs, including culinary arts, are frequently the first programs eliminated when schools suffer budget cuts. The district where YCA was tested is no exception, and enrichment programs have been greatly decreased over the years. Interdisciplinary curricula like YCA, which promote health while teaching academics through fun, hands-on learning, provide schools with a cost- and time-effective solution to improve students' academic performance while still providing these enrichment educational experiences.

Human Subjects Approval Statement

This project was approved by the Institutional Review Boards of University of Wisconsin-Milwaukee (protocol #11.336) and the public school system.

REFERENCES

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA*. 2014;311(8):806-814.
2. Trasande L, Chatterjee S. The impact of obesity on health service utilization and costs in childhood. *Obesity*. 2009;17(9):1749-1754.
3. Office of the Surgeon General. *The Surgeon General's Vision for a Healthy and Fit Nation*. Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General; 2010.
4. US Department of Health and Human Services and U.S. Department of Agriculture. *2015-2020 Dietary Guidelines for Americans*. 8th ed. Washington, D.C.: Office of Disease Prevention and Health Promotion; 2015. Available at: http://health.gov/dietaryguidelines/2015/guidelines/. Accessed January 4, 2018.
5. Brown C, Halvorson E, Cohen G, Lazorick S, Skelton J. Addressing childhood obesity: opportunities for prevention. *Pediatr Clin North Am*. 2015;62(5):1241-1261.
6. Zhan J, Liu Y-J, Cai L-B, Xu F-R, Xie T, He Q-Q. Fruit and vegetable consumption and risk of cardiovascular disease: a meta-analysis of prospective cohort studies. *Crit Rev Food Sci Nutr*. 2017;57(8):1650-1663.
7. Wang X, Ouyang Y, Liu J, et al. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ*. 2014;349:g4490.
8. Aune D, Keum N, Giovannucci E, et al. Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: systematic review and dose-response meta-analysis of prospective studies. *BMJ*. 2016;353:i2716.
9. Zong G, Gao A, Hu FB, Sun Q. Whole grain intake and mortality from all causes, cardiovascular disease, and cancer: a meta-analysis of prospective cohort studies. *Circulation*. 2016;133(24):2370-2380.
10. Aune D, Norat T, Romundstad P, Vatten L. Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of cohort studies. *Eur J Epidemiol*. 2013;28:845-858.
11. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study. *Eur J Clin Nutr*. 2004;58(7):1038-1045.
12. Larson N, Neumark-Sztainer D, Hannan PJ, Story M. Family meals during adolescence are associated with higher diet quality and healthful meal patterns during young adulthood. *J Am Diet Assoc*. 2007;107:1502-1510.
13. Burgess-Champoux T, Larson N, Neumark-Sztainer D, Hannan PJ, Story M. Are family meal patterns associated with overall diet quality during the transition from early to middle adolescence? *J Nutr Educ Behav*. 2009;41:79-86.
14. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. *Am J Health Promot*. 2000;14(4):222-228.
15. Kelder SH, Perry CL, Klepp K-I, Lyle LL. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health*. 1994;84:1121-1126.
16. Northstone K, Emmett PM. Are dietary patterns stable throughout early and mid-childhood? A birth cohort study. *Br J Nutr*. 2008;100:1069-1076.
17. Farvid M, Chen W, Michels K, Cho E, Willett W, Eliassen A. Fruit and vegetable consumption in adolescence and early adulthood and risk of breast cancer: population based cohort study. *BMJ*. 2016;353:i2343.
18. Fungwe T, Guenther PM, Juan W, Hiza HAB, Lino M. *The quality of children's diets in 2003-04 as measured by the Healthy Eating Index-2005; Nutrition Insights 43*. Alexandria, VA: United States Department of Agriculture and Center for Nutrition Policy and Promotion; 2009. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.451.8619&rep=rep1&type=pdf. Accessed January 5, 2018.
19. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc*. 2006;106(9):1371-1379.
20. Kim S, Moore L, Galuska D, et al. Vital signs: fruit and vegetable intake among children - United States, 2003-2010. *MMWR*. 2014;63(31):671-676.
21. Larson N, Neumark-Sztainer D, Hannan PJ, Story M. Trends in adolescent fruit and vegetable consumption, 1999-2004. *Am J Prev Med*. 2007;32(2):147-150.
22. McGill C, Fulgoni V, Devareddy L. Ten-year trends in fiber and whole grain intakes and food sources for the United States population: National Health and Nutrition Examination Survey 2001-2010. *Nutrients*. 2015;7(2):1119-1130.
23. Condrasky M, Hegler M. How culinary nutrition can save the health of a nation. *J Extension*. 2010;48(2): Available at: https://www.joe.org/joe/2010april/comm2011.php. Accessed January 2015, 2018:1-6.
24. Nelson SA, Corbin MA, Nickols-Richardson SM. A call for culinary skills education in childhood obesity-prevention interventions: current status and peer influences. *J Acad Nutr Diet*. 2013;113(8):1031-1036.
25. Newman F. *Student Engagement and Achievement in American Secondary Schools*. New York, NY: Teachers College Press; 1992.
26. Larson N, Story M, Eisenberg M, Neumark-Sztainer D. Food preparation and purchasing roles among adolescents: associations with sociodemographic characteristics and diet quality. *J Am Diet Assoc*. 2006;106(2):211-218.

27. Werhan C. Family and consumer sciences secondary school programs: national survey shows continued demand for FCS teachers. *J Fam Consum Sci*. 2013;105(4):41-45.
28. Liquori T, Kock P, Contento IR, Castle J. The Cookshop Program: outcome evaluation of a nutrition education program linking lunchroom food experiences with classroom cooking experiences. *J Nutr Educ*. 1998;30:302-313.
29. Newell SA, Huddy AD, Adams JK, Miller M, Holden L, Dietrich UC. The tooty fruity vegie project: changing knowledge and attitudes about fruits and vegetables. *Aust N Z J Public Health*. 2004;28(3):288-295.
30. Parris C. The Effect of a Cooking Class Program on the Knowledge and Skills of 4th-6th Grade Children in a Low-Income Neighborhood [Electronic Thesis or Dissertation]. Ohio: Bowling Green State University; 2006
31. Walters LM, Stacey JE. Focus on food: development of the cooking with kids experiential nutrition education curriculum. *J Nutr Educ Behav*. 2009;41(5):371-373.
32. Wang MC, Rauzon S, Studer N, et al. Exposure to a comprehensive school intervention increases vegetable consumption. *J Adolesc Health*. 2010;47:74-82.
33. Brown BJ, Hermann JR. Cooking classes increase fruit and vegetable intake and food safety behaviors in youth and adults. *J Nutr Educ Behav*. 2005;37:104-105.
34. Meehan M, Yeh M-C, Spark A. Impact of exposure to local food sources and food preparation skills on nutritional attitudes and food choices among urban minority youth. *J Hunger Environ Nutr*. 2008;34(4):456-471.
35. Hyland R, Stacy R, Adamson A, Moynihan P. Nutrition-related health promotion through an after-school project: the responses of children and their families. *Soc Sci Med*. 2006;62(3):758-768.
36. Condrasky M, Corr A, Sharp J, Hegler M, Warmin A. Culinary nutrition camp for adolescents assisted by dietetic student counselors. *Top Clin Nutr*. 2010;25(4):362-370.
37. Caraher M, Seeley A, Wu M, Lloyd S. When chefs adopt a school? An evaluation of a cooking intervention in English primary schools. *Appetite*. 2013;62:50-59.
38. Beets MW, Swanger K, Wilcox DR, Cardinal BJ. Using hands-on demonstrations to promote cooking behaviors with young adolescents: the Culinary Camp summer cooking program. *J Nutr Educ Behav*. 2007;39(5):288-289.
39. Bere E, Klepp K-I. Changes in accessibility and preferences predict children's future fruit and vegetable intake. *Int J Behav Nutr Phys Act*. 2005;2:15.
40. Backman DR, Haddad EH, Lee JW, Johnston PK, Hodgkin GE. Psychosocial predictors of healthful dietary behavior in adolescents. *J Nutr Educ Behav*. 2002;34(4):184-192.
41. Rasmussen M, Krolner R, Klepp KI, et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. *Int J Behav Nutr Phys Act*. 2006;3:22.
42. Bandura A. *Social Learning Theory*. New York, NY: General Learning Corp; 1971.
43. Kelder S, Hoelscher D, Perry C. Chapter 9: how individuals, environments, and health behaviors interact. In: Glanz K, Rimer B, Viswanath K, eds. *Health Behavior: Theory, Research, and Practice*. San Francisco, CA: Jossey-Bass; 2015.
44. Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance System. 2005 State and local standard high school questionnaire. Available at: ftp://ftp.cdc.gov/pub/data/yrbs/2005/2005_hs_questionnaire.pdf. Accessed January 5, 2018.
45. Eaton DK, O'Malley Olsen E, Brener ND, et al. A comparison of fruit and vegetable intake estimates from three survey question sets to estimates from 24-hour dietary recall interviews. *J Acad Nutr Diet*. 2013;113(9):1165-1174.
46. Townsend MS, Kaiser LL. Development of an evaluation tool to assess psychosocial indicators of fruit and vegetable intake for two federal programs. *J Nutr Educ Behav*. 2005;37(4):170-184.
47. Barton KL, Wrieden WL, Anderson AS. Validity and reliability of a short questionnaire for assessing impact of cooking skils interventions. *J Hum Nutr Diet*. 2011;24(6):588-595.
48. California Department of Public Health. *Compendium of surveys for fruit and vegetable consumption and physical activity*. Sacramento, CA: California Dept of Public Health; 2006. Available at: https://www.childrenandnature.org/resource/compendium-of-surveys-for-fruit-and-vegetable-consumption-and-physical-activity/. Accessed January 5, 2018.
49. Ellis J, Johnson MA, Fischer JG, JL H. Nutrition and health education intervention for whole grain foods in the Georgia older Americans nutrition programs. *J Nutr Elder*. 2005;24(3):67-83.
50. Skinner E, Kindermann T, Furrer K. A motivational perspective on engagement and disaffection: conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educ Psychol Meas*. 2009;69(3):493-525.
51. Evans CEL, Christian MS, Cleghorn CL, Greenwood DC, Cade JE. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. *Am J Clin Nutr*. 2012;96(4):889-901.
52. Cunningham-Sabo L, Lohse B. Impact of a school-based cooking curriculum for fourth-grade students on attitudes and behaviours is influenced by gender and prior cooking experience. *J Nutr Educ Behav*. 2014;46(2):110-120.
53. Lichtenstein AH, Ludwig DS. Bring back home economics education. *JAMA*. 2010;303(18):1857-1858.
54. Fordyce-Voorham S. Identification of essential food skills for skill-based healthful eating programs in secondary schools. *J Nutr Educ Behav*. 2011;43(2):116-122.
55. Lohse B, Cunningham-Sabo L, Walters LM, Stacey JE. Valid and reliable measures of cognitive behaviors toward fruits and vegetables for children aged 9 to 11 years. *J Nutr Educ Behav*. 2011;43(1):42-49.
56. Dixon E, Condrasky M, Sharp J, Corr A. Cooking confidence and healthy eating choices of preadolescent participants at a cooking camp. *Top Clin Nutr*. 2013;28(1):21-33.
57. Wrieden WL, Anderson AS, Longbottom PJ, et al. The impact of a community-based food skills intervention on cooking confidence, food preparation methods and dietary choices - an exploratory trial. *Public Health Nutr*. 2007;10(2):203-211.
58. Wolfson JA, Smith KC, Frattaroli S, Bleich SN. Public perceptions of cooking and the implications for cooking behaviour in the USA. *Public Health Nutr*. 2016;19(9):1605-1615.
59. Campbell D, Stanley J, Gage N. *Experimental and quasi-experimental designs for research*. Boston, MA: Houghton Mifflin; 1963.

SUPPORTING INFORMATION

The following Supporting Information is available for this article:

Table S1: Social Cognitive Theory in the Youth Chef Academy Program

Table S2: Summary of Personnel and Financial Resources Needed for YCA Implementation

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table 1S: **Social Cognitive Theory in the Youth Chef Academy Program**

Theoretical Construct	YCA Component
Personal Factors	▪ Students eating together influences the social norms of foods that are acceptable in their peer set ▪ Cooking these foods at home impacts the social norms of family meals ▪ Repeatedly tasting new foods transforms expectancies and attitudes about plant foods even for food neophobic students ▪ Learning how the food system affects their choices, health, and environment shifts values and attitudes regarding highly-processed foods particularly in light of social injustice within the system ▪ Building awareness in the prevalence of diet-related diseases among their family members influences students' attitudes about the impact of food choices on personal health
Behavioral Capabilities	▪ Teaching students to taste food critically and describe it constructively in regards to taste, texture, aroma and appearance builds self-efficacy for trying new foods with an open mind ▪ Teaching students to read recipes, use chef knives, and learn culinary techniques builds self-efficacy for cooking plant-based meals from scratch ▪ Creating contracts where students commit to making one positive change in their diet for the week, increases skills in behavioral self-management
Environmental Factors	▪ Assigning cooking for homework increases exposure to plant-based foods at home ▪ Students teaching or demonstrating their cooking skills to their parents and preparing plant-based meals at home for family members, introduces new plant-based dishes and models healthy eating behavior for the family ▪ Influencing parents through newsletters and contract agreements, further impacts access to plant-based foods in the home environment

Table 2S: Summary of personnel and financial resources needed for YCA implementation

YCA Instructor Tasks	Time Requirement per lesson in hours	Time Requirement for 6 lessons in hours
Classroom Instruction	2.0	12.0
Prep time for each lesson	0.5	3. 0
One-time planning meeting with teacher and administration before implementing		0.5
Pre- and post-program management of equipment, service supplies and pantry items		3.0
		17.5 hours

School Staff Tasks	Time Requirement per lesson in hours	Time Requirement for 6 lessons in hours
Teacher classroom assistance during YCA instruction	2.0	12.0
Teacher prep time for each lesson—photocopy handouts and outreach to parents to volunteer	.33	2.0
Teacher participation in one-time planning meeting before implementing		0.5
Administration participation in one-time planning meeting before implementing		0.5
		15.0 hours

Supplies		Cost for 6 lessons
Cooking Equipment for 33 kids-(4 cooking teams)	One time input cost	$600.00
Service supplies for 6 lessons—33 kids and 4 adults		$35.00
Pantry items (spices, oils, dry goods)		$50.00
Fresh items (produce)		$108.00
		$793.00