The effects of a gardening, cooking, and nutrition intervention on gardening at home and food security status

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ABSTRACT

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Background: There is a need for a sustainable solution to food insecurity, and gardening may impact food security status by increasing food accessibility, availability, and stability.

Objective: To assess how a school-based gardening, nutrition, and cooking intervention (TX Sprouts) impacts gardening at home and to determine if changes in gardening behaviors impact household food security status within a large, racially and ethnically diverse population.

Experimental Approach: TX Sprouts is a cluster randomized controlled trial that targeted primarily low-income, Hispanic third- to fifth- grade students and their parents. The following measures were obtained at baseline and after the 9-month TX Sprouts program: household food security via the 7-item USDA household survey and gardening behavior at home via a 1-item survey. Descriptive and frequency statistics were run through SPSS Version 26. Change scores were computed from percentages of gardening behaviors and food security status at pre- and post-intervention. Chi-square tests and regression analyses were used to assess intervention effects on changes in gardening behaviors at home and how changes in these behaviors affected changes in food security status. The following *a priori* covariates were included in the regression models: sex, participation in the free or reduced lunch program, ethnicity/race, and age.

Results: Using regression analysis, participants in the intervention group were more likely to continue or start gardening compared to the control group, independent of sex, participation in the free or reduced lunch program, ethnicity/race, and age (β: 0.200; 95% CI: 1.031, 1.446; p=0.020). The intervention did not have an effect on household or child-reported food security status. Changes in gardening behaviors did not have an effect on household food security status, independent of intervention.

Conclusions: These results suggest that teaching children to garden at school can lead to increased gardening behaviors at home. Increased gardening at home may lead to increased access and availability of fresh produce in the home environment, which over time, may lead to reductions in food security status.

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Introduction

Cardiometabolic health is a serious public health concern in Texas as more than 1 in 3 Texans have obesity, and heart disease is the leading cause of death [1,2]. As adult obesity rates follow an upward curve, childhood obesity is on the rise as well. In 2018-2019, 17.3% of children ages 10-17 were classified as having obesity, up from 15.5% in 2017-2018 [3]. The state of childhood obesity has serious health implications for future generations, including reduced quality of life and poorer mental health outcomes [2].

Additionally, food insecurity, a commonly co-occurring condition with obesity, continues to impact millions of households in the U.S. and, more specifically, Texas. Food security, as defined by the United States Department of Agriculture (USDA), is "access by all people at all times to enough food for an active, healthy life" [4]. Food security is necessary for a well-nourished and healthy population; yet 13.7 million U.S. households are food insecure, including 1.4 million Texas households [5,6]. These households are unable to "acquire adequate food for one or more household members because [of]… insufficient money and other resources for food" [5]. These households face barriers to food availability, accessibility, utilization, and stability, the four dimensions of food security. Food insecurity is associated with poor dietary quality and quantity, and a number of poor health outcomes such as chronic cardiometabolic diseases [7].

Multiple strategies are needed to address the high rates of obesity and food insecurity among Texans, including school garden programs that reach children in disproportionally impacted groups. School garden programs show promise in providing access to healthy foods in low-

income, food insecure populations. In fact, 7,101 school gardens have been built across the United States, and there are over 270 school gardens in the Greater Austin area [4]. In addition to educating children about nutrition and increasing their access to nutritious foods, school gardening programs enhance environmental stewardship [8,9].

There is ample evidence of the role of school gardening programs in the improvement of student's dietary intake and related behaviors (i.e., preference, knowledge, and attitudes) [8]. However, there is little research supporting that school gardening programs can promote gardening at home. Home gardens have social, economic, and psychological benefits. Gardening at home enhances food and nutritional security, improves diet quality, and lifts participants' mental well-being [10]. Due to the numerous benefits of home gardening, there is a growing interest in home gardens as a strategy to increase food security and enhance household nutrition.

The objective of this study is to examine how TX Sprouts, a school-based gardening, cooking, and nutrition intervention, impacts gardening at home and determine if changes in gardening behaviors impact household food security status.

Food Security Implications

Food-insecure households, including marginal, low, and very low food security classifications, have diminished dietary quality and dietary quantity compared to food secure households. Additionally, food insecure households lack sufficient resources to acquire adequate food which forces them to alter their dietary choices. This often results in nutritionally-dense foods being

replaced with cheaper, calorically-dense and nutrient-poor foods. A literature review of eighteen cross-sectional studies revealed that food insecurity is significantly associated with diminished intake of nutrient-dense foods including fruits and vegetables, and increased intake of saturated fats and sugar-sweetened beverages [11]. Decreased vegetable, fruit, and dairy intake is concerning as these nutrient-dense foods promote health and are essential for development in young children. Reduced vegetable, fruit, and dairy consumption is associated with a lower intake of vitamins A and B-6, iron, calcium, magnesium, and zinc [12]. As a result, household and child-reported food insecurity are associated with lower micronutrient adequacy (MAR). Nutrient deficiencies during childhood are associated with a greater risk of poor bone health (including osteoporosis later in life), iron deficiency for females at menarche, and metabolic syndrome [11]. These dietary deficiencies also lead to the development of cardiometabolic disorders. An increased intake of saturated fats and sugar-sweetened beverages is linked to obesity, hypertension, type 2 diabetes, and dental caries during childhood, and an elevated risk of atherosclerosis and cardiovascular disease in adulthood [11]. Food insecurity is associated with diminished dietary quality and unhealthy eating behaviors that lead to adverse health outcomes including chronic cardiometabolic diseases, mental health challenges, and increased mortality risk [7].

Food insecurity has proven links with suboptimal dietary intake and poor cardiometabolic outcomes [7,11,12]. A unified strategy is needed to address food insecurity and obesity, two commonly co-occurring conditions, by increasing access to produce and promoting healthy eating behaviors [13]. Interventions such as TX Sprouts, the focus of this paper, have the potential to increase food access and improve dietary choices. Therefore, this study aims to

assess the effects of TX Sprouts on gardening behaviors at home and consequently, the impact of gardening behaviors on food security status, as a strategy to improve both food security status and its associated cardiometabolic outcomes.

Racial Disparities in Food Insecurity and Poor Cardiometabolic Health

There are persisting disparities in food security and cardiometabolic health as Hispanics experience increased rates of food insecurity, cardiometabolic diseases and diet-related mortalities. In 2016, 18.5% of households headed by Hispanics were food insecure compared to the national average of 12.3%. In addition, Hispanic households have a higher probability of remaining food insecure compared to white households, and a higher probability of falling lower in the distribution of food insecurity compared to white households [14]. The Hispanic population is the fastest growing demographic group in Texas, accounting for nearly 40% of the state's population; thus it is critical that interventions focus on curbing the high rates of food insecurity among Hispanic households in Texas [15].

Hispanics also experience high rates of obesity and type 2 diabetes mellitus (T2DM). Compared to Caucasians, Hispanics have 29% higher rates of overweight and obesity and a 66% higher risk of developing T2DM [16]. As a result, Hispanic people are disproportionally impacted by diet-related mortalities. In a comparative risk assessment, 50.0% of deaths among Hispanics were associated with suboptimal diets [17]. While cardiometabolic deaths were associated with unhealthful foods, insufficient intake of healthful foods accounted for at least as many cardiometabolic deaths. Therefore, this study revealed the need for dietary interventions focused

on the addition of healthful foods, rather than simply removing unhealthful foods [17]. To address the demographic disparities in diet-related deaths, intervention strategies should focus on improving access to nutritious foods in Hispanic communities.

There is a serious need to reach the growing Hispanic population in Texas, which experiences high rates of food insecurity and a disproportionally greater risk of severe cardiometabolic outcomes. The TX Sprouts intervention is implemented at primarily Hispanic, low-income elementary schools in order to reach populations that are disproportionally impacted by food insecurity and cardiometabolic diseases, with the aim of increasing access to fruits and vegetables and improving nutrition knowledge among school-age children and their parents.

Benefits of Gardening

Gardening is a promising approach to addressing the high rates of food insecurity and cardiometabolic diseases of low-income communities. The nutritional, psychological, and social benefits of gardening are well documented [18,19]. Thus, gardening can contribute to a holistic solution to food insecurity.

Gardening provides numerous nutritional and household food security benefits. Gardening has been shown to increase food security, especially in areas with rapid population growth, rising poverty, and with few affordable food options [18]. Gardening is cost-effective and provides easy access to fruits and vegetables. Gardening also promotes physical activity and allows for more time spent outdoors. Through active involvement in gardening, young people experience a

decrease in obesity [18]. The nutritional and household benefits of gardening demonstrate its potential as a strategy to decrease food insecurity rates among a fast-growing, low-income population.

In addition to dietary benefits, there is an established a connection between gardening and mental well-being. Interacting with nature has been shown to improve mood and mitigate anger. Gardens serve as outlets during high stress times and have been shown to decrease depression scores and reduce anxiety and stress [19]. In addition to these mental benefits, individuals experience an increase in self-esteem, creativity, and inspiration when cultivating a personal garden [18,19]. Home gardens allow children to personalize a space and express their creative and cultural identities [18]. Gardening has remarkable psychological benefits, especially for developing children.

In addition to nutritional and psychological benefits, gardening has been shown to offer social benefits. When children work with family members to cultivate a household garden, social capital increases and family relationships deepen. Memories are formed in home gardens as they become places of learning, healing, and celebration. In addition, gardens increase cultural awareness and create a sense of cultural identity among members of the household [18]. Gardens have the ability to strengthen communities by contributing to the overall wellbeing of its members.

There are numerous benefits to home gardening, however studies have revealed that households face barriers when building gardens, including limited knowledge and skills [18]. Texas Sprouts

teaches hands-on gardening lessons at elementary schools to close such knowledge and skill-level gaps. The TX Sprouts program teaches children from communities that are disproportionally impacted by food insecurity and cardiometabolic diseases in order to promote gardening outside of school. There is limited research examining the impact of school garden interventions on students' gardening behaviors at home. Therefore, this study examines whether the TX Sprouts intervention changed participants' home gardening behaviors after participating in a school garden intervention.

Interventions successful at improving access to nutritious foods

While there has been an increase in school gardening programs, there is little research regarding the impact of school gardening programs on food security status and gardening behaviors. However, there have been a few interventions that resulted in an increase in access and availability of fruits and vegetable in the home, which may lead to reductions in food insecurity.

Brighter Bites is a school-based program that provides fruits, vegetables, and nutrition education to low-income families over 16 weeks. Fruits and vegetables are distributed weekly at the school, and during distribution time parents and children engage in a fun food experience and nutrition education based on the Coordinated Approach To Child Health Program (CATCH). Brighter Bites was implemented at 9 schools and served 1530 families in the 2013-2014 school year. The program was successful at impacting children's dietary intake for two years post-intervention. Compared to baseline, child intake of fruits, vegetables, and fiber significantly increased while consumption of total fat, added sugars, and sugar-sweetened beverages

significantly decreased. Additionally, Brighter Bites increases families' access to fruits and vegetables for up to three years, thus reinforcing healthy habits in the home environment [20]. During the pandemic, BB switched to a delivering produce boxes at home and saw that the delivery-based program resulted in reductions in household food insecurity status. [21].

The Delicious and Nutritious Garden Intervention is a garden-based intervention that was implemented during a 12-week summer camp for children entering fourth, fifth, or sixth grade in southeastern Minnesota. Before and after participation in the intervention, children and parents completed surveys regarding children's opinions of the program and their FV preferences. During the program, children learned how to plant, maintain, and harvest a fruit and vegetable garden during 20-30 minute sessions twice a week. Following the intervention, parents' responses to the questionnaires displayed a similar theme in which parents reported that their children most enjoyed "watching the plants grow, preparing recipes, and tasting new food." Researchers reported significantly "greater FV asking behavior and FV availability at home" among intervention participants. One parent stated that their child even began gardening at home following the intervention [22]. The Delicious and Nutritious Garden Intervention provides a hopeful example for other school garden intervention programs and their ability to impact the home food environment. This study was limited by the small sample size of 93 children and did not examine the impact on food insecurity status.

Texas Sprouts

Numerous quasi-experimental, garden-based studies have shown that school gardening programs can increase FV intake, preferences for FV, self-efficacy, knowledge of, and attitudes towards FV [8,9,20,22]. However, many of these studies did not use a rigorous randomized controlled trial design, utilized small samples, and were not conducted with high-risk, minority youth. In addition, many prior school gardening interventions did not examine the impact on home gardening practices. Therefore, this study will examine the effects of a large-scale school gardening, cooking, and nutrition intervention to impact the home food environment through gardening behaviors at home and food security status.

The TX Sprouts research program is a randomized controlled school garden intervention at 16 Austin-area elementary schools [23]. The aim of this study is to examine the effect of the intervention on changes in gardening behaviors and assess the impact of changes in gardening habits on household food security status. Household food security status was determined using a 7-item USDA Household Food Security Survey Module (HFSSM) completed by parents. Changes in gardening habits were determined by comparing pre- and post-intervention survey data about the location of children's gardens *outside of school.* These questions serve as an indicator both of changes in gardening behaviors outside of school and household food security status. It is hypothesized that children who garden outside of the school setting will have increased food security.

Methods

Description of Study

The study utilized baseline and post-intervention data from the TX Sprouts research project, which was a cluster, randomized controlled gardening, cooking, and nutrition intervention that targets primarily low-income, Hispanic third- to fifth- grade students and their parents. In order to be included in the program, schools had to meet the following inclusion criteria: 1) high proportion of Hispanic children (> 50%); 2) high proportion of children participating in the free and reduced lunch (FRL) program (> 50%); 3) located within 60 miles of the University of Texas at Austin (UT-Austin) campus; and 4) no existing school garden or gardening program.

Of the 73 schools who met all of the criteria, 20 agreed to participate and the first 16 schools to submit letters of support were included in the study. The schools were randomly assigned to either an intervention group (n = 8) or a control (delayed intervention) group (n = 8).

The intervention was implemented in three schools per arm in school years 2016-2017 and 2017-2018 and two schools per arm in the 2018-2019 school year. The intervention schools received an outdoor teaching garden,18 student lessons including gardening, nutrition, and cooking taught during the school hours by hired educators, nine lessons taught monthly to parents and guardians, and the formation of an internal Garden Leadership Committee (GLC).

The outdoor teaching garden was designed by research staff, school principals, and GLC members and was built at the school by parents, children, teachers, and school administration alongside UT staff and students and local community groups (i.e., churches, small businesses, etc.). Each garden consisted of two raised vegetable beds, two in-ground native and herb beds, a

tools and materials shed, a whiteboard, and seating for classes. The classes were led by TX Sprouts educators during the students' normal school day. The TX Sprouts curriculum consisted of nutrition, cooking, and gardening components, and were aligned with the Texas Essential Knowledge and Skills (TEKS) standards. The concepts included healthy cooking/preparation of FV, low-sugar beverages made with fresh FV, and health benefits of FV. Every lesson included a garden taste-test or a cooking activity, and every lesson included a sample of different *aguas frescas*, infused water with no added sugar. Parent lessons were monthly 60-minute meetings led by TX Sprouts educators at parents' and school administrators' preferred dates and times. The curriculum paralleled the gardening and nutrition topics taught to the children. Parents were incentivized to participate with free meals, groceries, produce giveaways, water bottles, t-shirts, garden gloves, and free childcare. Control groups received the same intervention during the academic year following their post-intervention measurements [23].

Recruitment of Students and Parents

All third- to fifth-grade students and parents at the recruited schools were contacted to participate via information tables at "Back to School" and "Meet the Teacher" evening events, flyers sent home with students, and class announcements in the fall after the garden had been built at the school. All recruitment materials were available in both English and Spanish.

Ethics

While all third- to fifth-grade students from participating schools received the lessons as part of the in-school curriculum, students and parents had to provide informed written consent to participate in the student measurements. Among students who were measured, written informed consent was obtained from all parents, and assent was obtained from each student. This study was completed according to the guidelines of the Declaration of Helinski and all procedures involving human subjects were approved by the Institutional Review Boards of UT-Austin and the individual school district review boards.

Data Collection

Data collection occurred in three waves, each one academic year, from Fall 2016 to Spring 2019. Data was collected within the first month (baseline) and the last month (post-intervention) of the academic school year. Both children and parents completed a 12-page questionnaire packet.

The students completed questionnaire packets at their respective schools as part of a larger TX Sprouts data collection effort. The child questionnaire was developed based on a literature review and many of the questions were taken from the child questionnaire used in the LA Sprouts evaluation [25]. The final questionnaire included items on demographics [26], gardening behaviors [25], and food security [27]. Questionnaires were provided in English and Spanish and bilingual interpreters were available to assist students as needed.

The parent questionnaire consisted of similar questions to the child questionnaire, plus additional answer options. The questionnaire was available in English and Spanish and bilingual

interpreters were available to assist as needed. The final questionnaire included items on demographics [26] and food security [28]. Parents who completed and returned a questionnaire received a $15 gift card to a local grocery store.

Gardening Behavior Questionnaire

Gardening habits were assessed by children's responses to the following question: "Where do you grow vegetables or fruit outside of school? Please check all that apply". The question and the provided answer choices are presented in **Table 1.** The gardening behavior question has been validated [29]. The answers were coded as 0 if the student checked "I do not grow any vegetables of fruit outside of school" and 1 if the student reported gardening at any of the locations listed. Changes in gardening habits were determined by comparing the responses to this question from before and after the TX Sprouts intervention.

Table 1. Gardening behavior child questionnaire

Where do you grow vegetables or fruit outside of school? Please check all that apply.

o I do not grow any vegetables or fruit outside of school

o At a community garden

o In the ground at my home

o In pots at my home

o Inside a windowsill

o At a friend or relative's home

o Other. If you chose other, please tell us where: _____

Measurements and Classification of Food Security

Household food security status was determined based on the food security questions in the parent questionnaire. This study examined whether changes in gardening behaviors resulted in changes in household food security status.

The USDA has established a food security continuum with the following classifications: 1) high food security, 2) marginal food security, 3) low food security, and 4) very low food security [5]. The first two labels describe food security, and the latter two labels describe food insecurity. The method of classification for household food security was developed and completed by Matthew Landry of the TX Sprouts Project and is described below [24].

Household food security status was determined based on the food security questions in the parent questionnaires shown in **Table 2**. Parents completed a 7-item USDA Household Food Security Survey Module (HFSSM). The responses were coded as follows: “a lot” and “sometimes” were coded as “yes” = 1, “never” was coded as “no” = 0. Scores were summed ranging from 0 to 7. Four ordinal groups were created: 0 (high food security), 1 (marginal food security), 2-4 (low food security), and 5-7 (very low food security). These classifications were organized into two categories: food secure and food insecure. The high food security and marginal food security groups were defined as food secure. The low food security and very low food security groups were classified as food insecure. These were coded as follows: “food secure”=0 and “food insecure”=1 [24].

Table 2. Household food security questionnaire

A. In the last 12 months, which option best describes your child?	A Lot	Sometimes	Never	Don't Know
a. I relied on only few kinds of low-cost food to feed my child because I was running out of money to buy food.	o	o	o	o
b. I couldn't feed my child a balanced meal because I couldn't afford that.	o	o	o	o
c. My child was not eating enough because I just couldn't afford enough food.	o	o	o	o

B. In the last 12 months, which option best describes your child?	Yes	No	Don't Know
a. Was your child ever hungry but you just couldn't afford more food?	o	o	o
b. Did your child ever not eat for a whole day because there wasn't enough money for food?	o	o	o
c. Did you ever cut the size of your child's meals because there wasn't enough money for food?	o	o	o

d. Did your child ever skip meals because there wasn't enough money for food?	o	o	o

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Statistical Analysis

Study data was collected and managed using REDCap (Research Electronic Data Capture). Descriptive and frequency statistics were run through SPSS Version 26. Percent of subjects gardening outside of the home and percent of subjects who were food insecure at pre- and post-intervention were calculated. Change scores were computed from percentages of gardening behaviors, and household food security status at pre- and post-intervention. Chi-square tests and regression analyses were used to assess intervention effects on changes in gardening behaviors at home. The following *a priori* covariates were included in the regression models: sex, participation in the free or reduced lunch program, ethnicity/race, and age. Correlations were run between change scores in gardening habits and child food security status and household food security status. A p-value < 0.05 was considered significant.

Results

Demographics

The number of students in the study was 4329 with 3303 (78%) who consented to the study. Of the consented children, 2858 (87%) students provided complete gardening behavior data, both pre- and post-intervention. Demographics of the analytic sample are displayed in **Table 3.** Of the analytic sample, the intervention and control groups were a slight majority male (53.3% and 52%, respectively). There was a significant difference in mean age between the intervention and the control group (9.79 vs. 9.70; $p = 0.04$). Both groups were primarily Hispanic (59.6% intervention, 60.2% control). A majority of children in the intervention and the control group reported receiving meals as part of the FRLP (60.5% and 61%, respectively).

Gardening Behaviors

A chi-square test was completed to assess the effects of the intervention on changes in gardening behavior at home. The intervention resulted in significant differences in home gardening behaviors (p=0.037). Significantly more students from the intervention group started or continued gardening compared to the control group (68% vs. 64.3%) (**Figure 1**). There were 36% more students in the intervention group who started or continued gardening compared to those who stopped or never gardened (68% vs. 32%). Comparatively, there was a 28.6% difference in the control group between those who started or continued gardening vs. those who stopped or never gardened (64.3% vs. 35.7%).

A multivariate regression was used to model the effects of the intervention on gardening behaviors outside of school, controlling for the *a priori* covariates. Participants who started or

continued to garden post-intervention did not significantly differ by race or ethnicity (African American, $p = 0.081$; Hispanic $p = 0.604$; Other, $p = .142$) (**Table 4**). Students nine years of age and older were significantly more likely to start or continue gardening compared to students eight years of age and younger (β: -0.155; 95% CI: 0.78, 0.939; $p = 0.001$). Participants in the intervention group were more likely to continue or start gardening compared to the control group independent of sex, participation in the free or reduced lunch program, ethnicity/race, and age (β: 0.200; 95% CI: 1.031, 1.446; $p = 0.020$).

Frequency statistics revealed the out-of-school gardening locations of students post-intervention. Compared to the control group, more students in the intervention group gardened at a community garden (12.4% vs. 9.1%), in pots at their homes (21.4% vs. 17.4%), and inside a windowsill (6.7% vs. 5.5%) following the intervention (**Figure 2**).

Food Security Status

Chi-square tests were completed to assess the effects of the intervention on household food security status. Four groups were created based on changes in household food security status: became food insecure, remained food insecure, became food secure, and remained food secure. The intervention did not significantly alter household food security status compared to the control ($p = 0.420$).

Chi-square analyses examined the association between changes in gardening behaviors and changes in child food security status and household food security status. Changes in gardening

behaviors were not significantly associated with changes in household food security status (p = 0.993).

Table 3. Demographics of the analytic sample (n=2858; control, n=1578; intervention, n=1280).

Variable	Total	Intervention	Control	P-value
Sex (M)	1503 (52.9%)	682 (53.3%)	821 (52%)	0.623
Age (years)	9.74 ±0.91	9.79 ±0.87	9.70 ±0.94	0.04
Race/Ethnicity				0.910
Non-Hispanic White	517 (18.1%)	241 (18.8%)	276 (17.5%)	
Non-Hispanic Black	234 (8.2%)	106 (8.3%)	128 (8.1%)	
Hispanics	1715 (60%)	763 (59.6%)	950 (60.2%)	
Others	134 (4.7%)	61 (4.8%)	73 (4.6%)	
Eligible Free/Reduced Lunch	1738 (60.8%)	775 (60.5%)	963 (61%)	0.171

[a]All values are n (%) or mean ± standard deviation. T-tests were run to assess differences in age, and chi-square analyses were run on categorical variables.

Table 4. Multivariate regression model demographics in children that started or continued to garden post-intervention (n=2496).

Variable	Unstandardized β	Standard Error	95% CIs for β	P-value
Sex				
Male	Referent	----	----	----
Female	0.273	0.085	1.111, 1.553	0.001
Free or Reduced Lunch				
Recipient	Referent	----	----	----
Non-Recipients	0.261	0.99	1.070, 1.576	0.008
Ethnicity				
White	Referent	----	----	----
African American	-0.296	0.170	0.544, 1.037	0.081
Hispanic	0.060	0.116	0.846, 1.332	0.604
Other	0.323	0.220	0.897, 2.128	0.142
Age				
Eight years or younger	Referent	---	---	---
Nine years or older	-0.155	0.047	0.78, 0.939	0.001
Intervention				
Intervention	Referent	---	---	---
Control	0.200	0.086	1.031, 1.446	0.020

Figure 2. Chi-square analysis of changes in gardening behaviors

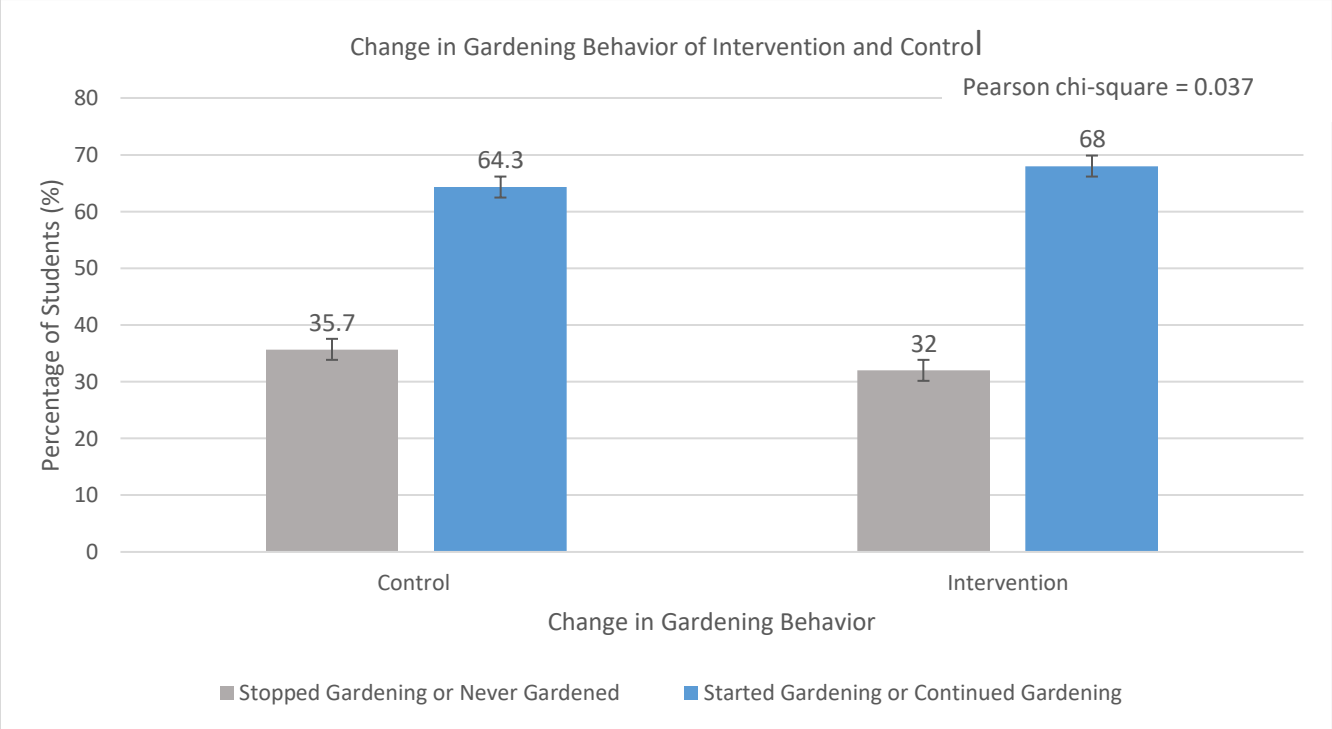
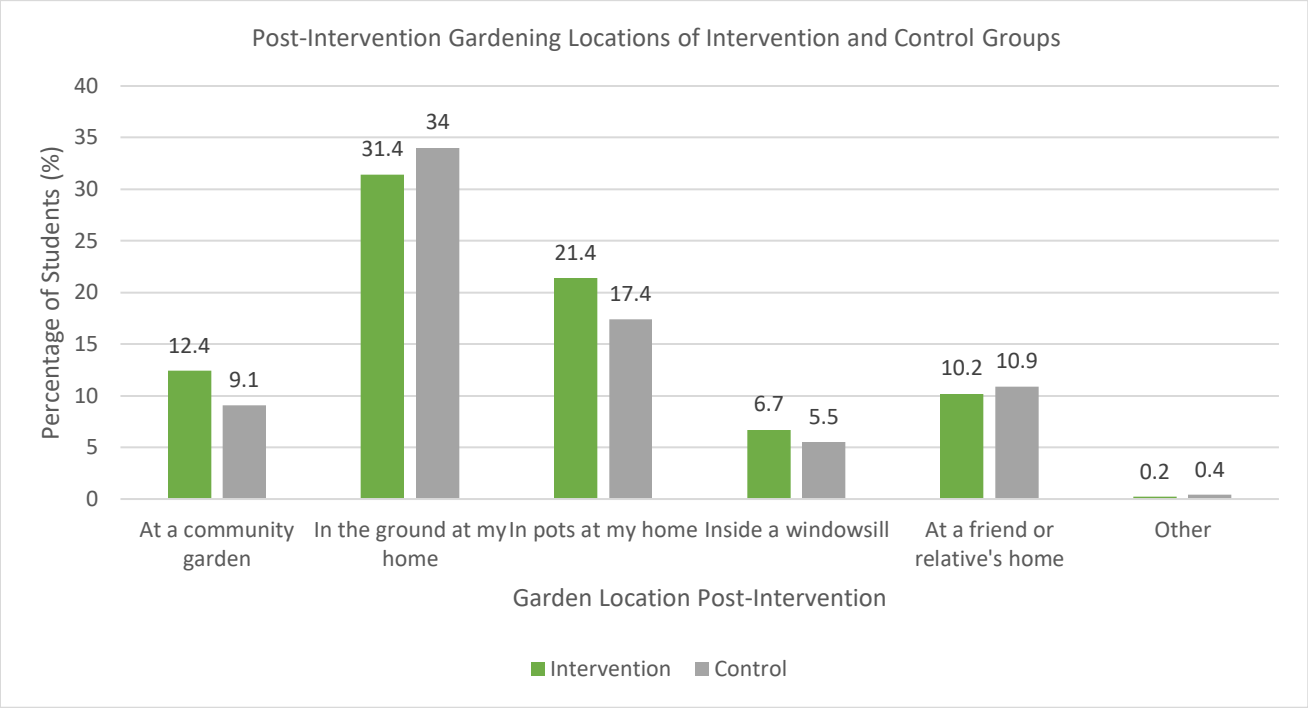


Figure 2. Frequency analysis of post-intervention gardening locations



Discussion

The aim of this study was to examine how TX Sprouts, a school-based gardening cooking, and nutrition intervention, impacts gardening at home and determine if changes in home gardening behaviors impact household and child food security status. The intervention resulted in increased gardening outside of school post-intervention. Additionally, students from the intervention were more likely to garden at a community garden, in pots at their home, or inside a windowsill post-intervention than students from the control group. These findings demonstrate how school gardening programs can impact the home food environment by promoting gardening at home. The potential for school gardening programs to increase gardening at home is crucial due to the far-reaching benefits of home gardening for physical, mental, and dietary health.

Previous research has established the nutritional, psychological, and social benefits of home gardening [18]. Gardening has been shown to decrease obesity in youth by promoting physical activity and increasing access to fruits and vegetables. In addition, gardening decreases food insecurity in areas with rapid population growth [18]. Thus, home gardening could play a crucial role in uplifting the rapidly growing Hispanic community in Texas that faces disproportionally high rates of cardiometabolic diseases and food insecurity [15]. Thus, the relationship between school gardening programs and home gardening is promising, especially because school garden programs, such as TX Sprouts, are able to reach children of high-risk groups. School garden programs should focus on promoting home gardening as it could be the foundation of a long-term solution to food insecurity and poor cardiometabolic health.

While home gardening behaviors did not significantly impact household food security status, future research can build upon these findings. It is likely that home gardens produced a small yield, insufficient to reverse food insecurity. Additionally, when examining gardening locations post-intervention, students in the intervention were more likely to garden in pots at their home or inside a windowsill when compared to students from the control but were also less likely to garden in the ground at their home. This exemplifies the limited size of home gardens. Future studies should measure the size of home gardens and the seasonal FV yield and examine how these measures impact household food security. The Brighter Bites program saw a reduction in food insecurity by providing 16 weeks of produce, equating to about 400 pounds of FV, per family [20]. This suggests that yield must be at a much higher quantity in order to see a significant reduction in food insecurity. Also, TX Sprouts parent lessons experienced limited

attendance, which could limit parents' self-efficacy and knowledge about home gardening. Future interventions could implement longer student lessons with increased focus on gardening and increase the overall duration of the intervention beyond one school year in order to build upon children's gardening knowledge and self-efficacy, two barriers to home gardening, over a longer term [18]. Additionally, future interventions should focus on increasing parent class attendance to foster a supportive household environment where children can continue gardening post-intervention. In order to address food insecurity, a multi-pronged approach is needed, including the school, community, and home.

A limitation of this study was that it relied on children's reports of home gardening. While this is a potential indicator of home gardening status, the results were limited by children's understanding of the question. When reviewing children's answers, it was obvious that some children did not understand the concept of a garden. Anecdotally, some children described their home garden locations as "Target" or "HEB." This type of misunderstanding may have led to some discrepancies regarding children's gardening behaviors and locations. While this may have limited the study, this question was an effective measure of home gardening behaviors and has been validated by a panel of experts [29].

A noteworthy strength of this study is the sample size. The TX Sprouts intervention was able to reach 3303 students. Of the consented children, 2858 (87%) students provided complete gardening behavior data, both pre- and post-intervention. The TX Sprouts intervention was implemented at 16 schools, providing a substantial amount of data for this project. As discussed earlier, the Delicious and Nutritious Garden Intervention showed the ability of a school-based

intervention to affect the home environment but was limited by a sample size of 93 students [22]. Thus, it is exciting to observe an increase in home gardening behaviors following the TX Sprouts Intervention among a large population.

Conclusion

The TX Sprouts intervention resulted in increased gardening at home, however had no effect on food security status. Increased gardening at home was not enough to improve food security status, potentially due to the limited size and yield-producing capacity of home gardens. Future research should examine how the size and yield of home gardens impacts food security status. This study revealed that the TX Sprouts gardening, cooking, and nutrition intervention resulted in increased gardening at home, which is an exciting finding as prior research has not examined the impact of school gardening programs on gardening behaviors. This demonstrates the potential for school gardening programs to translate to the home food environment and contribute to a sustainable solution for food-insecure populations.

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