GARDEN-BASED NUTRITION EDUCATION PROGRAMS: A REVIEW OF IMPACT AND EVALUATION METHODS

by

Hollis Laird

BA, University of Nevada, Reno, 2011

Submitted to the Graduate Faculty of

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

2016

UNIVERSITY OF PITTSBURGH

Graduate School of Public Health

This thesis was presented

by

Hollis Laird

It was defended on

April 6, 2016

and approved by

Thesis Advisor:
Mary Hawk, DrPH
Assistant Professor
Department of Behavioral and Community Health Sciences
Graduate School of Public Health
University of Pittsburgh

Jeanette Trauth, PHD
Associate Professor
Department of Behavioral and Community Health Sciences
Graduate School of Public Health
University of Pittsburgh

Elizabeth Venditti, PHD
Assistant Professor
Department of Psychiatry
School of Medicine
University of Pittsburgh

Mary Hawk, DrPH

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Hollis Laird, MPH

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ABSTRACT

The goal of this paper is to examine the effects of garden-based nutrition education programs and their methods of evaluation. Current literature shows that garden-based nutrition education programs have positive effects on children including: increased knowledge about fruits and vegetables, increased knowledge about science, increased preference for fruits and vegetables, increased consumption of fruits and vegetables, and increased self-efficacy. The first objective of this paper is to review the extant literature regarding garden-based nutrition education programs in order to identify effective programs. The second objective is to review current methods used to evaluate of garden-based nutrition education programs in order to identify the limitations. Examining the evaluation methods for these interventions is vital as there are currently no standardized evaluation methods for garden-based nutrition education programs. By developing standardized evaluation tools we will be better able to study the impact of programs, but first these methods need to be examined. Lastly, this paper describes the evaluation of an existing community garden with a garden-based nutrition education component aimed at children, Enright Community Garden. The public health significance of this paper is that with disproportionate levels of childhood obesity in marginalized communities characterized by little to no access to healthy foods, we must identify effective interventions that increase knowledge, exposure, and access to fresh fruits and vegetables.

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1.0 INTRODUCTION

In the summer and fall of 2015, I completed an evaluation practicum at Enright Community Garden located in the East Liberty area of Pittsburgh, PA. With the help of the garden coordinator, Valerie Testa, I completed an evaluation of the impact of the garden program. During this process I received guidance from the Evaluation Institute located at the University of Pittsburgh Graduate School of Public Health (GSPH). The idea for this practicum was developed when I started working as a Team Member at Whole Foods and received a position to work in the garden. Enright Community Garden (ECG) is funded by Whole Foods and had never been formally evaluated. While working in the garden with Valerie Testa, I learned that the ECG might be in danger of losing its funding. In an effort to try and prevent this from happening, I worked with Valerie Testa and GSPH, to develop a plan to evaluate all components of the ECG. Due to time constraints, we selected specific components of ECG that were likely to have the most impact and could be completed within our time restrictions.

ECG is a multi-faceted community garden that serves different populations for a variety of purposes. Half of the plots in the garden are used to grow produce that is then donated to East End Cooperative Ministries (EECM). The other half of the plots are used by community members or Whole Foods Team Members to grow their own personal produce. Some of the community member plots were donated to women at Sojourner House, a faith-based recovery program for women with substance use disorders. In addition to the plots, there are numerous

participatory educational activities conducted in the garden. The garden has many classes during the season and invites community members to come learn about the process of gardening and nutrition. This season there was a pest identification class, a tomato class, an organic gardening class, and a healthy eating class. Additionally, the garden served as a green space for community members and there were monthly trivia nights and barbeques held at ECG. Lastly, a key activity in the garden was a collaboration with Kentucky Avenue School (KAS). Children in grades K-5 were brought to the garden once a week for 12 weeks to learn about the process of gardening, how to identify different fruits and vegetables, to taste them, and how to cook with them. Thus, it was decided that the most significant part of the garden program to evaluate involved the KAS activities for children.

A summative evaluation of the KAS activities in ECG was therefore conducted to provide insight on the impact the garden has on school children. Specifically we assessed their knowledge before and after classes, preferences for fruits and vegetables, as well as the degree to which changes in fruit and vegetable consumption occurred.

The overarching goal of this paper is to explore the effects that a garden-based nutrition education program had on children and methods used to evaluate these programs. School gardens and community gardens can have effects on different domains in a child's life that, in turn, impact the family, the school, and the surrounding community. Given the substantial rates of childhood obesity and food access problems in disadvantaged neighborhoods, gardens have been used as nutrition and science education tools, a way to increase food security within the school and community, and a tool to expose children to fruits and vegetables.

Given the vast number of garden-based nutrition education programs in school and community settings, this paper aims to explore the breadth of interventions and examine study

methods and designs. The first research question addressed is: “What kinds of impacts do garden-based nutrition education programs have?” In order to measure the impact of these programs and describe strengths and limitations, they need to be evaluated. Therefore, the second research question is: “What evaluation tools have been used to assess existing garden-based nutrition education programs?” In order to complete the first objective of this paper, I conducted a comprehensive review of the literature describing the range of garden-based nutrition education programs and the settings within which they are conducted- school, after school programs, community centers, community gardens, or local farms. The second objective of this paper is to examine the methods used to evaluate the interventions. The last objective of this paper is to summarize my experience evaluating the ECG, describe findings, and discuss how these compare to the literature. In summary, garden-based nutrition education programs are a promising way to positively impact childhood obesity. But unless an intervention is designed and evaluated properly, not only will outcomes be hard to measure, the potential impact that community gardens may have on childhood obesity rates will be limited.

2.0 BACKGROUND

Nationally, the rate of obesity has doubled in children and quadrupled in adolescents within the past 30 years (Ogden, Carroll, Kit, & Flegal, 2014). This is a major public health issue of concern. Between 1980 and 2012, the percentage of obese children aged 6-11 years increased from 7 to 18%; while obesity rates in adolescents aged 12-19 years increased from 5 to 21% (Ogden et al., 2014; Services, 2012). In 2012, more than one third of children and adolescents in the United States were considered overweight or obese (Ogden et al., 2014). Children who are obese are at increased risk for developing chronic diseases such as diabetes, high blood pressure, cardiovascular disease, and some forms of cancer. These numbers alone are compelling enough to bring the issue of childhood obesity not only to the table for discussion, but for intervention development as well.

Like other health issues, obesity is one that is plagued by disparities among racial and socioeconomic groups. It is also important to note that even though childhood obesity is a vast problem affecting all communities, ethnic minorities and poorer communities are disproportionately affected. Prevalence of childhood obesity is 22.4% higher in Hispanics, 20.2% higher in non-Hispanic black youth, and 14.1% higher in other marginalized populations than in non-Hispanic white youth (CDC, 2014). In 2007, Hispanic, non-Hispanic White, and American Indian children had 3.0 to 3.8 times higher odds of being obese or overweight than Asian children (CDC, 2014). In addition to racial disparities, children living in low SES

households had 3.4 to 4.3 times higher odds of being obese than those from higher SES households (Singh, Siahpush, & Kogan, 2010). With these disparities in mind, it is important to look at not only the proximal behavioral factors related to childhood obesity such as poor diet and lack of exercise, but intermediate factors such as family income and access to food (CDC, 2014).

Diet and exercise are two behavioral factors that heavily influence obesity on an individual level. Decreased physical activity and excessive inactivity among children have added to the growing rates of childhood obesity. One cross-sectional study in South Carolina observed that obese children spent less time participating in moderate physical activity than children who were not obese (Ebbeling, Pawlak, & Ludwig, 2002; G, M, S, & R, 2001). In a different national study, children who spent the most time viewing television and participated in the least amount of physical activity were more overweight (Ebbeling et al., 2002). Another study in Mexico showed that children who participated in physical activity for one hour per day decreased their risk of obesity by 10% and every hour spent watching television increased their risk by 12% (Ebbeling et al., 2002).

In regards to obesity, television viewing is of particular interest because children not only replace physical activity with watching television, but consume energy dense foods doing so (Ebbeling et al., 2002). Furthermore, television advertisements may also adversely affect a child's diet. On average, for every hour of television viewed, children are exposed to at least ten food commercials, and these commercials are mostly for fast food, soda, candy, and cereal (Ebbeling et al., 2002). Data show that when 3 to 5 year old children are exposed to a 30 second commercial, it increases the likelihood that they choose this food option when later given the option (Ebbeling et al., 2002).

Diet and eating habits play a major role in childhood obesity and there are a number of challenges to healthy eating. Research shows that families ate out much less in the 1970s than they do today. One study found that between 1970 and the mid-to-late 1990s, children ate nearly double the number of meals away from home (Perpich, Russ, Rizzolo, & Sedrak, 2011). Some studies have suggested that the convenience and cheaper cost of fast food and other restaurants, combined with more parents working longer hours, create an incentive for families to eat away from home. The cost of healthy foods, such as fresh produce, are steadily increasing making the price and convenience of many non-healthy foods more appealing, especially to low-income populations (Perpich et al., 2011). The cost of vegetables and fruits has increased 118% between the years 1985 and 2000, while the cost of fats and other oils has only increased by 35%. The increase in the cost of healthy foods, a lack of cooking, and the investment of time it takes to prepare fresh foods make fatty and sugary foods an appealing option for low-income families (Perpich et al., 2011). Studies have shown that diets low in fruits and vegetables and high in fats and sugar can lead to increased risk of childhood obesity and other adverse health outcomes (Perpich et al., 2011).

Social and economic inequalities have risen substantially over the last few decades (Singh et al., 2010) and these also contribute to the obesity problem in complex ways. One study showed that the magnitude of racial and socioeconomic disparities contributing to childhood obesity increased from 2003 to 2007; even after controlling for behavioral factors, substantial social inequalities were still present (Singh et al., 2010). Social conditions and inequalities affect the development of the child, which, in turn, affect short- and long-term health status (Hearst, Martin, Rafdal, Robinson, & McConnell, 2013). Children in marginalized groups tend to live in environments that are characterized by high social stress, which recent evidence links to

increased obesity among children (Chang, 2010; Gundersen, Mahatmya, Garasky, & Lohman, 2011; Suglia, Duarte, Chambers, & Boynton-Jarrett, 2013). Additionally, with an increased number of social stressors, the risk of obesity also increases (Suglia, Duarte, Chambers, & Boynton-Jarrett, 2012; Suglia et al., 2013). Increased social stressors in children can also lead to increased behavioral problems (Suglia et al., 2012). The relationship between behavioral problems and childhood obesity has been established by several longitudinal studies (Anderson, He, Schoppe-Sullivan, & Must, 2010; Duarte, 2010; Suglia et al., 2012). Increased food intake has been shown as a stress coping mechanism for adult populations. Children living in households whose adults eat with stress may adopt similar behavior patterns (Parks et al., 2012; Suglia et al., 2012). Social risk factors such as maternal mental health, maternal substance use, housing insecurity, food insecurity, and paternal incarceration were linked to higher prevalence of externalizing behavioral problems and increased risk of obesity for boys and girls (Suglia et al., 2012).

It is important to recognize that childhood obesity problems are multi-factorial. When using the social-ecological there are different levels in which one can intervene when focused on childhood obesity. On the individual level, it is hard to change behavioral factors such as diet and exercise in the school setting without having proper community support or change in environment outside the school setting (M. Sharma, 2006). There is a need for more comprehensive public health interventions aimed at child obesity. Research shows that community-based childhood obesity prevention programs that incorporate schools are more effective (Bleich, Segal, Wu, Wilson, & Wang, 2013). It is important to not just focus on diet and exercise on the individual level, but also on the community level. Where children live and go to school is a key-contributing factor to obesity risk (Bleich et al., 2013).

One contributing factor to childhood obesity is that communities face decreased access to fresh and healthy food. In order for a child to eat healthy, the community in which they live needs to have access to healthy food. Communities where residents do not have access to a grocery store within ½-1 mile are characterized as food deserts (Blumenthal, 2013). These areas have an increased number of convenience stores and fast food restaurants, and are subject to more advertising for junk food and fast food marketing. This kind of marketing is linked to an increased risk of obesity (Medicine, 2005). By increasing access to healthy and fresh nutritious food within these kinds of communities, there is the potential to improve health and decrease childhood obesity on both the community and individual level. This approach aligns with the social ecological model since it considers the multiple levels that influence behavioral outcomes. By adding a garden to the community with a garden-based nutrition education program implemented in the school setting, children and the community benefit. Additionally, by incorporating a component where the surrounding community is involved, this allows for behavioral modification outside the school setting.

2.1 INTERVENTIONS INVOLVING GARDEN-BASED NUTRITION EDUCATION

This section provides an overview of garden-based nutrition education programs and discusses the range of such interventions found in the literature. The literature review was conducted in the databases PubMed and PittCat+, a University Library System database that pulls articles from an extensive list of databases and publisher catalogs. The search terms used for the literature search were “garden-based nutrition education”, “gardens”, “gardening”, “nutrition education”,

"community gardens" and "school-based nutrition education". Articles were only chosen if they were peer-reviewed and published after the year 2002.

2.1.1 Overview of programs

There have been myriad interventions aimed at childhood obesity. Most interventions have been implemented in school settings and have focused on delivering nutrition education, promoting decreased sedentary behavior (e.g. hours in front of the television), modifying the types of food that is served in school, and physical activity programs (M. Sharma, 2006). In one meta-analysis of childhood obesity interventions, interventions were described as focusing on increased physical activity, improving dietary behaviors, modifying poor dietary and exercise behaviors, or a combination of these approaches. The rationale for these interventions is that behavioral modifications and healthy living promotion are sustainable and can be carried into the adult years. However, most interventions focus on short-term changes. Overall, the interventions reviewed showed modest behavioral changes and there were mixed results in regards to indicators of obesity, but one main limitations of school-based obesity prevention programs is they do not incorporate familial or community support outside of school (M. Sharma, 2006). Sharma et al. (2006) concluded that in regards to childhood obesity interventions, individuals need support to make behavioral changes in their diet and exercise, but there also needs to be changes in policy and their environments outside of school in order to increase community-wide support.(M. Sharma, 2006)

With the rise in childhood obesity, steep costs for some healthy foods, and an increased prevalence of obesity in low-income communities, many local agencies and communities have looked for ways to allow low-income residents to gain increased access to fresh and healthy

foods and promote increased physical activity and nutritional knowledge among children (Castro, Samuels, & Harman, 2013). One strategy implemented by local governments and communities is the use of community gardens or school gardens. A community garden is described as a piece of land for gardening, tended to by a group of community members, and seen as a resource that provides increased access to fresh fruits and vegetables while promoting increased physical activity (Castro et al., 2013). To date, there has been limited research on this kind of intervention, but recent studies show that gardening can improve participants' nutrition and physical activity and also has the potential to serve as a resource to influence public policy focused on obesity prevention via increasing awareness in the community and among policymakers (Castro et al., 2013; McCormack, 2010).

Another strategy that has been gaining in popularity is the use of school gardens as nutrition education programs for children. These kinds of programs are seen as a promising strategy for increasing preferences and improving dietary intake of fruits of vegetables (Robinson-O'Brien, Story, & Heim, 2009). Garden-based nutrition education programs are implemented in a wide variety of ways such as school-based, during normal school hours, afterschool hours, during an afterschool program but still on school grounds, and community based, in a community garden either on weekends or during school hours. (Robinson-O'Brien et al., 2009)

The use of community gardens or school gardens has received a great deal of attention in recent years and they are increasingly being used as teaching tools to address childhood obesity and fruit and vegetable consumption and exposure among children. Exposing children to a variety of fruits and vegetables at a young age and engaging them in the process of growing their own food promotes habitual consumption throughout life (Namenek Brouwer & Benjamin

Neelon, 2013). These programs are not new and provide a wide array of benefits not only to children, but to the whole community. The benefits include: enjoyment of nature, increased sharing, mental health activity, increased willingness to go to school, moral development, youth crime prevention, healing and therapy, and increased access to fresh and healthy food (Armstrong, 2000).

Farm-to-School programs, or programs that focus on connecting students with agriculture through the use of local farmers and community gardens, have been identified as an intervention strategy for childhood obesity (Berezowitz, Bontrager Yoder, & Schoeller, 2015). Peer-reviewed research in this area is limited, but the limited data available show a positive influence on children's knowledge and awareness of healthy food, willingness to try new foods, consumption of fruits and vegetables at school and home, physical activity, and behavioral change that includes reduced consumption of unhealthy foods and soda and reduced television time (Berezowitz et al., 2015). Not only do farm-to-school programs provide a positive opportunity to improve health, they also provide a platform for discussing health, nutrition, and food security issues at the school and community level (Berezowitz et al., 2015). These kinds of programs also impact the family in a po sitive way by improving the family's ability to influence family diets, increasing parental knowledge of healthy foods, and expanding local availability of healthy food (Berezowitz et al., 2015).

Table 1 includes an overview of garden-based nutrition and education programs aimed at children, including farm-to-school programs. The intervention setting and the target audience varies, as do the theoretical models underlying the intervention approaches

Table 1. An overview of garden-based nutrition education interventions

Author, Year	Target Audience	Intervention	Theoretical Framework	Results
(Berezowitz et al., 2015)	Literature review on school-day garden interventions with measures of dietary and/or academic outcomes	Literature review on school-day garden interventions with measures of dietary and/or academic outcomes	Social Cognitive Theory	• 12 studies identified • Improvement in prediction of fruit and vegetable consumptions • In 7 studies using self-report, 5 showed improved intake and 2 no change. • 4 studies measured academic outcomes; 2 showed improvements in science and 1 in math
(Castro et al., 2013)	95 children aged 2-5 years old	"Growing Healthy Kids" an intervention that included a weekly gardening session, a 7-week cooking and nutrition workshop, and social events for parents and children	Not stated	• 17% of obese or overweight children had improved BMI classification • 100% of children with a BMI classification of normal had maintained that classification • Parents reported an increase of 146% in the availability of fruits and vegetables and increase in consumption

Table 1 Continued

(Chaufan, Yeh, & Sigal, 2015)	School-aged children from 167 ethnically diverse families, 60% that qualify for free or reduced lunches.	"Garden of Eatin'" an early childhood education program featuring on-site food gardens, curriculum alignment, healthy eating policies for students and staff, family and community components that include weekly distribution of fresh produce from it's own gardens and the local food bank.	Not stated	• Participants reported program encouraged them to adopt healthy eating practices • Participants reported access to fruits and vegetables supported their ability to eat more healthfully • Interviews suggest underreport of structural challenges to healthy eating • The societal tendency to individualize the causes of poor health and neglect structural causes may discourage participants to share barriers to healthy lifestyles
(Ellsworth, Ernst, & Snelling, 2015)	408 middle school students from 7 low-income middle schools	45-minue lessons focused on nutrition education and sustainable farming concepts. Farmers' market was delivered to schools in a converted school bus, allowing for full market setup to provide local fruits and vegetables as teaching tools.	Not stated	• Average scores increased from 51% to 58% • Nutrition knowledge increased from 58% to 74% • Agriculture questions remained at 43%
(Evans et al., 2012)	246 adolescents (59% Hispanic, 70% low income)	The six components of The Sprouting Healthy Kids intervention: 1) in-class lessons 2) after school gardening program 3) farm-to-school 4) farmers' visits to schools 5) taste testing 6) field trips to farms	Social Cognitive Theory	• Students who were exposed to two or more components scored significantly higher on fruit and vegetable intake, self efficacy, and knowledge, lower preference for unhealthy foods

Table 1 Continued

(Gatto, Ventura, Cook, Gyllenhammer, & Davis, 2012)	364 third to fifth grade Latino children participating in afterschool programs in Los Angeles elementary schools	LA Sprouts: 12-week nutrition, cooking, and gardening intervention utilizing an evidence base curriculum demonstrated to decrease obesity.	Not stated	• Participants had an increased preference for vegetables • Increased preference for three target fruits and vegetables • Improved perception of taste • In overweight/obese subgroup, participants had a 16% greater increase in their preference for vegetables
(Graham, Beall, Lussier, McLaughlin, & Zidenberg-Cherr, 2005)	4194 California school principals	A self-administered internet and mailed survey was sent to all California principals to determine the status of gardens in California schools		• 43% of principals responded • Most frequent reason for having a school garden was for enhancing academic instruction • Gardens were used for nutrition, environmental studies, and science • Principals strongly agreed that having curriculum on nutrition and academic instruction for the garden would assist in using the garden for academic instruction • Principals largely did not think gardens were effective at enhancing the school meal program

Table 1 Continued

(Jaenke et al., 2012)	127 students aged 11-12 years old in fifth and sixth grade from two elementary schools in Australia. Groups were nutrition	Nutrition education program "How do you grow" included three 1-hour lessons in regular class time and gardening program "How does your garden grow?" included seven 1-hour sessions where students were involved in planting and tending to the school garden.	Social Cognitive Theory	• No significant gender differences in fruit and vegetable consumption of willingness to taste • There was a group effect ($p<0.001$) for overall willingness to taste, overall taste rating, and the taste rating of pea and broccoli, tomato, and lettuce
(Klemmer, Waliczek, & Zajicek, 2005)	647 third through fifth grade students from seven elementary schools in Temple, Texas. Experimental and control group.	Students in the experimental group received science curriculum involving garden activities in addition to traditional classroom methods. Control only received traditional classroom methods.	Not stated.	• Experimental group scored significantly higher on the science achievement test • No difference among genders • Garden curriculum was most effective for boys in third and fifth grade and girls in fifth grade
(Koch, Waliczek, & Zajicek, 2006)	56 children in second through fifth grade from four different Texas counties.	"Health and Nutrition from the Garden" – a program that teaches children how to eat healthy on a budget. Program was offered in a full week format, once per week over 12 weeks, or every morning for 1 week.	Not stated	• Knowledge about the health benefits of eating fruit and vegetables significantly improved • No differences were found in attitudes toward fruit an vegetables • Participants reporting eating healthier snacks after participating in the program

Table 1 Continued

(Lautenschlager & Smith, 2007)	40 boys girls aged 9-15 years old	10- week gardening project that involved youth in gardening, harvesting, cooking, and eating	Theory of Planned Behavior	• Youth garden participants were more willing to eat nutritious food and try ethnic and unfamiliar food • Garden participants had a stronger appreciation for other individuals and cultures • Participants more likely to cook and garden on their own
(McAleese & Rankin, 2007)	99 sixth grade students at three different elementary schools	"Nutrition in the Garden" a 12 week nutrition education program	Not stated	• Increased servings of fruits and vegetables in garden-based group • Increase of 1.13 fruit servings and 1.44 vegetable servings • Increases in Vitamin A, Vitamin C, and fiber
(Morris, Koumjian, Briggs, & Zidenberg-Cherr, 2002)	200 fourth grade students at three different schools	"Nutrition to grow on" a program designed to teach children healthy eating habits while simultaneously teaching them where their food comes from by using a garden over the course of 9 lessons.	Social Cognitive Theory	• Significant improvements in nutrition knowledge and vegetable preference
(Moss, Smith, Null, Long Roth, & Tragoudas, 2013)	65 third grade boys and girls	Two nutrition education classes and a farm tour	Not stated	• Significant differences found concerning knowledge of fiber ($p<0.001$) • Knowledge of vitamins and reported vegetable consumption behavior at school, and farm exposure were also significant ($p<0.05$)

Table 1 Continued

(Namenek Brouwer & Benjamin Neelon, 2013)	Preschoolers in 4 child care centers in North Carolina	Two intervention centers and two control centers. Intervention included fruit and vegetable garden, monthly curriculum, and gardening support.	Not stated	• Post intervention, intervention and control centers served fewer vegetables in intervention, • Intervention children consumed more than control children
(O'Brien & Shoemaker, 2006)	38 fourth grade students (17 in intervention group, 21 in control group)	An eight lesson gardening and nutrition curriculum with a hands-on gardening emphasis	Social Cognitive Theory	• No differences in nutritional knowledge between or within groups at baseline and end of program • Both groups had high preference for fruit at baseline and end of program • Experimental group maintained high self-efficacy and outcome expectation scores • Control group's scores increased significantly for gardening self-efficacy and outcome expectations
(Ozer, 2007)	Review on literature on the impact school gardens have on students and schools	Review on literature on the impact school gardens have on students and schools	Ecological theory	• School gardens have the potential to promote health and well being of students • School gardens can strengthen the environment within the school • There is currently no systematic study on the impact of school gardens

Table 1 Continued

(Poston, Shoemaker, & Dzewaltowski, 2005)	29 third through fifth graders (18 in intervention group, 11 in comparison group receiving nutrition only education)	Junior Master Gardener curriculum – a program focused on teaching nutrition through gardening. Eight different lessons from this curriculum were chosen for this intervention and data was collected at two intervals, summer and fall.	Social Cognitive Theory	• Neither program improved nutrition knowledge or fruit and vegetable reference • The summer intervention group had a change in self-efficacy
(Ratcliffe, Merrigan, Rogers, & Goldberg, 2011)	320 sixth-grade students 11 to 13 years of age at two intervention schools	1 hr/week for 13 weeks of 20 minutes of instruction followed by 40 minutes of hands-on garden experiences	Social cognitive theory and additional model building research	• Students were better able to identify vegetables after gardening • Increase of preference for vegetables • Students in garden group reportedly tasted more vegetables than those in control • Students in garden group significantly increased the average number of vegetables they consumed more than once a month
(S. V. Sharma, Hedberg, Skala, Chuang, & Lewis, 2015)	103, three to five years old children at two Head Start centers in Harris County, Texas	PLANT Gardens (Preschoolers Learn About Nutrition Through Gardens), teacher-led garden-based nutrition education program implemented over 8 weeks	Social Cognitive Theory	• 28.4% of the Head Start preschooler's population were overweight or obese, yet only 3% of parents perceived their preschooler as overweight • Significant increase in preschooler's willingness to try new fruits and vegetable

Table 1 Continued

(Smith & Motsenbocker, 2005)	119 students in fifth grade at 3 different schools.	Intervention: 14-week gardening curriculum from Junior Master Gardener. Students received 2 hours 1 time per week. Control group received no gardening curriculum	Not stated	• Science achievement was significantly different for experimental classes' pretest and posttest scores • No significant difference for control • Results show once weekly use of gardening activities and hands-on activities help improve science achievement test scores
(Wansink, Hanks, & Just, 2015)	370 high school students in upstate New York who purchase lunch at the school cafeteria	Using greens harvested from the school garden in the school salad bar at lunch time	Not stated	• When the salad bar contained garden produce, the percentage of students selecting salad rose from 2% to 10%and on average students ate two-thirds of the serving they took • Although waste increased relative to the control, more students were consuming at least some salad when it was from the school garden

Table 1 summarizes research on many different kinds of garden-based nutrition education programs and their successes. These include programs implemented during school hours, after school, farm-to-school programs, programs with a cooking component, and programs aimed at children but implemented in a community garden. One item each of these programs has in common is that they all include an agricultural component that involves children participating in hands-on activities with fruits and vegetables. In programs where the schools grow edible produce, students learn science and nutrition and harvest the vegetables. In some of the garden-based programs students not only harvest, but also learn how to cook and use these vegetables in their meals. In "farm-to-school" programs, schools purchase produce from local farmers or farmers' markets and they come to the school with the produce. Then, the children visit the farm to understand how the food is grown and where it comes from. There are multiple rationales for using each of these programs; most notably they are used as outdoor green spaces for teaching nutrition and science and as places for children to play. Most recently there has been a growing movement using these programs to promote the consumption of healthy food among a population of children with elevated rates of obesity (Ozer, 2007).

2.1.2 Benefits of garden-based nutrition education programs

Garden-based nutrition education programs have many benefits that are confirmed by a comprehensive review of literature. Table 1 clearly defines some of the benefits that these interventions can have. It is evident that these programs have the ability to influence perceptions about fruits and vegetables, improve eating behavior, improve access to fruits and vegetables, increase nutritional knowledge and scientific knowledge, and increase self-efficacy levels. There are multiple pathways by which garden-based nutrition education programs can potentially

strengthen the healthy development of children while also strengthening the school and surrounding community (Ozer, 2007). A more detailed discussion of the programs outlined above will help reveal positive effects of these programs, but also help identify areas for improvement.

A key area of focus for garden-based nutrition education programs has been to influence the consumption of fruits and vegetables. This has been an area of significant focus since childhood obesity is characterized by low fruit and vegetable consumption and U.S. school children on average consume less than five fruits and vegetables on a daily basis (Robinson-O'Brien et al., 2009). Research shows that only 6.2% of adolescents consume the daily-recommended amount of fruit and 5.8% consumed the daily-recommended amount of vegetables (Evans et al., 2012). Berezowitz et al. (2015) reviewed 12 different peer-reviewed studies about the impact of garden-based nutrition education programs and found that all studies showed improvement in predictors for fruit and vegetable consumption. Five of the seven studies that measured intake levels showed an increase of fruit and vegetable consumption. While these are positive findings, it is a small handful of studies and should be considered preliminary. (Berezowitz et al., 2015)

Despite the small number of studies reviewed by Berezowitz et al. (2015), there are still a handful of other interventions that showed positive improvement in fruit and vegetable consumption patterns. In a community based intiative conducted by Castro et al. (2013), the intervention was open to all families in the community with children less than 6 years of age. This pilot study was implemented in a low-income community and was aimed at using community gardens as a vehicle to provide low-income families with children access to healthy food and information about healthy eating (Castro et al., 2013). Through weekly gardening work

sessions, cooking and nutrition workshops, and social activites and events for families and children who participated in the program, there was a 146% increase in a family's access to fruits and vegetables, 33% increase in consumption of vegetables, and a 28% increase in consumption of fruits. Providing access can increase the likelihood of a child consuming fruits and vegetables, but does not guarantee it. (Castro et al., 2013). In a study conducted by Evans et al. (2012) a "Sprouting Healthy Kids" multiple-component intervention showed that participants who were exposed to more than 2 components of the intervention had significantly higher fruit and vegetable intake than those who were exposed to fewer components. (Evans et al., 2012) The six components of the intervention were as follows: 1) in-class lessons, 2) after-school gardening program, 3) farm-to-school 4) farmers' visits to schools 5) taste testing, and 6) field trips to farms. (Evans et al., 2012). Another study that showed improvements in fruit and vegetable consumption was conducted by McAleese et al. (2007). In this study, 99 sixth grade students at three different elementary schools were placed in a control or one of two treatment groups. One treatment group received a 12-week nutrition education program and the other received the same program, but with garden-based activities. Students in all groups completed a 24-hour food recall workbook before and after the intervention. Their findings showed that participants who received the garden intervention increased their servings of vegetables and fruits more than students in the two other groups. There was a 1.13 increase in number of fruit servings, 1.44 increase in number of vegetable servings, and additional significant increases in vitamin A, vitamin C, and in fiber (McAleese & Rankin, 2007). Ratcliffe et al. (2011) found that their garden-based nutrition education program, which was implemented one hour a week for 13 weeks at school, significantly increased the average number of vegetables participants consumed

per month for participants in a garden intervention group versus control. Additionally, they found that gardening also increased the variety of vegetables consumed (Ratcliffe et al., 2011).

In addition to changes in consumption levels, many programs measured changes in children's preferences towards fruits and vegetables. In a 12-week nutrition, cooking, and gardening intervention aimed at 364 third through fifth grade Latino children called "LA Sprouts", Gatto et al. (2012) found that participants in their program had an increased preference for vegetabls, increased preferance for three target fruits and vegetables, and improved perception of taste. Furthermore, participants who were considered overweight or obese had a 16% greater increase in their preference for vegetables compared with control participants (Gatto et al., 2012). Overall, this intervention shows promise to change attitudes and perceptions about gardening, cooking, preparing fruits and vegetables, and the advantage of eating home-grown vegetables as opposed to those bought in store (Gatto et al., 2012). In another study, Morris et al. (2002) found that in their intervention "Nutrition to Grow On," which was aimed at 200 fourth grade students at three different schools, participants in their program had significant improvements in nutrition knowledge and vegetable preference. When nutrition knowledge scores were analyzed by lesson, students in the nutrition and gardening group showed a 33% improvement in their knowledge of the topics reviewed in that lesson (Morris et al., 2002). In the intervention conducted by Ratcliffe et al. (2011) another positive outcome they found in additional to increased vegetable discussion was an increase in preference for vegetables among students in the intervention group. Sharma et al. (2015) found that in their intervention conducted among 103 preschoolers that after going through their PLANT Gardens (Preschoolers Learn About Nutrition Through Gardens) intervention, that there was a significant increase in preschooler's willingness to try new fruits and vegetables (S. V. Sharma et al., 2015). Another

interesting find from this study was that of the 28.4% of the preschooler's population who were considered overweight or obese, only 3% of parents perceived their preschooler as overweight (S. V. Sharma et al., 2015). Lastly, Wansink et al. (2015) found that school students had a stronger preference for vegetables grown in a garden, than from the store. When the salad bar at school contained garden produce, the percertage of students eating salad rose from 2% to 10%, but on average they only ate two thirds of the serving that they took. Although waste in the intervention group increased relative to the control, more students were consuming some salad when it was from the school garden (Wansink et al., 2015). Change in preference is an improvement, but there are multiple influences on fruit and vegetable preference. A child's preference may change during the course of an intervention, but if a child's environment goes back to what it was before the intervention a change in preference is hard to maintain.

While preference was not always an outcome that was measured or changed, a few programs demonstrated increased knowledge of healthy eating. In the literature review conducted by Berezowitz (2015), of the four studies they reviewed that measured change in knowledge, two showed improvements in science and one showed improvements in math (Berezowitz et al., 2015). Although improvements in science and math are not relevant to obesity, it shows school gardens can increase children's knowledge in a number of areas, not just limited to increase in nutritional knowledge. Ellsworth et al. (2015) found that in their farm-to-school intervention, nutritional knowledge increased from 58% to 74% and agricultural knowledge stayed at a constant 43% (Ellsworth et al., 2015). Evans et al (2012) also found significantly increased knowledge from their "Sprouting Healthy Kids" intervention (Evans et al., 2012). Lastly, Koch et al. (2006), Morris et al. (2002), Moss et al. (2013), and Smith et al.

(2005) were other studies summarized in Table 1, all of which showed increases in knowledge from their garden-based interventions.

In addition to children improving their knowledge surrounding nutrition and science in the garden, it is important to note that garden spaces for children are seen as effective learning laboratories for children, but schools still need the proper tools to implement these interventions properly. In a survey conducted by Graham et al. (2005) among 4,194 California school principals, they found that the most common reason gardens were used was for nutrition, environmental studies, and science. Principals strongly agreed that having curriculum on nutrition and academic instruction for the garden would assist in using the garden for academic instruction (Graham et al., 2005). Although this study was limited by a 43% response rate among principals, it showed a need for developing or utilizing a more comprehensive garden curriculum for schools that could help assist schools with garden-based nutrition education programs.

Another benefit of garden-based nutrition education programs is their ability to provide healthy food and the supportive structure that allows children to make healthy choices. An intervention by Chaufan et al. (2015) titled Garden of Eatin', works on the premise that nutritional practices develop over the life course. If a child develops healthy eating habits and practices at an early age this can help combat childhood obesity rates (Chaufan et al., 2015). This was a community-based intervention that focused on developing healthy eating habits among children, families, teachers, and staff through an on-site school garden. Overall, participants reported having good health and being able to eat healthy, having fresh fruits and vegetables at the school supported their ability to eat healthy foods, and fewer structural barriers to eating healthy foods. (Chaufan et al., 2015).

2.1.3 Gaps and limitations of garden-based nutrition education programs

While results measured in the above interventions are overwhelmingly positive, they each still come with their own set of limitations. In the literature review conducted by Berezowitz et al. (2015) the interventions they reviewed were methodologically diverse. They often had incomplete methodological descriptions, used convenience samples, lacked a control group, and had very small cohorts (Berezowitz et al., 2015). Not only were these limitations seen in Berezowitz et al. (2015), a majority of the studies reviewed exhibited the same limitations Berezowitz et al. (2015) describe. These kinds of shortcomings limit comparisons that can be made between studies and also limit any kinds of definitive conclusions that can be made.

In Evans et al. (2012) "The Sprouting Healthy Kids" intervention a major limitation was that the intervention was not implemented in all schools and the overall dose was much lower than they had originally planned. Additionally, with the data being self-reported, there are inherent limitations including recall bias. Lastly, there was significant selection bias as researchers had limited tools to contact students for recruitment. (Evans et al., 2012).

Gatto et al. (2012) was largely limited by the small number of participants in the study and that it was an exploratory study and not a randomized controlled trial (Gatto et al., 2012). Moss et al. (2013) was also limited by a very small number of participants as their study was implemented at one school only because of lack of funding and available resources. Their study was further limited by the time frame as it only lasted 4 weeks (Moss et al., 2013). Lastly, Namenek Brouwer et al. (2013), Obrien et al. (2006), Poston et al. (2005), Sharma et al. (2015), and Wansink et al. (2015) all had severe sample size limitations as well (Namenek Brouwer & Benjamin Neelon, 2013; O'Brien & Shoemaker, 2006; Poston et al., 2005; S. V. Sharma et al., 2015; Wansink et al., 2015).

Limitations of Jaenke et al. (2012) include the quasi-experimental design, use of convenience sampling, and small sample size. Because of the small sample size, their results were not generalizable to other schools (Jaenke et al., 2012). Morris et al. (2002) had similar limitations as Jaenke et al. (2012) with their quasi-experimental design as well.

Although in McAleese et al. (2007) they saw significant increase in fruit and vegetable consumption, they note that because of the nature of the study time (12 weeks), persistence of behavioral changes cannot be implied. Furthermore, because of the non-randomized nature of this study, the results are not generalizable (McAleese & Rankin, 2007). In Morris et al. (2002) Schools differed in ways that were measurable since they were not randomly selected or assigned. Only 3 schools participated in this study, meaning that the units of analysis were the individuals, which potentially resulted in a cluster effect of the data (Morris et al., 2002).

Largely, the biggest limitations for all studies were small sample size, recruitment methods, study design, and self-report bias. Given that all garden-based nutrition education interventions entail the same kinds of limitations, it would be ideal to develop a strong experimental study with a longitudinal design and a scientific recruitment process to truly evaluate the impact, short-term and long-term, that these kinds of interventions can have.

2.1.4 Theoretical frameworks underlying garden-based nutrition education interventions

In the world of nutrition education, theories aim to explain how our health behaviors are influenced. One theory that explains the influence on health behavior is the social ecological model. This is a relevant theory that describes 5 different levels on which health-related behaviors have the potential to be impacted. These levels are: intrapersonal, interpersonal, institutional, community, and public policy (Ozer, 2007). Garden-based nutrition education

programs vary, but they all encompass practical educational activities that are taught in a growing environment with adult figures who are supporting the students' learning. According to the social-ecological model, a child's development is viewed as being nested within different micro-systems (or levels of the social-ecological model), that influence each other reciprocally to shape a child's development (Ozer, 2007). The ecological principle of interdependence, which Kelly et al. (2000) describes, changes in one level of an ecosystem will produce changes in other levels of the ecosystem (Berlin, Norris, Kolodinsky, & Nelson, 2013; Kelly, Ryan, Altman, & Stelzner, 2000). This principle suggests that changes in one domain of the child such as nutrition, academic performance, self-efficacy, and peer relationships may set in motion changes within other domains. For example, changes in the school may set in motion changes in the family or the community (Ozer, 2007). There are multiple theories that explain how change can happen at each of these levels. The Social Cognitive Theory was used for most of the interventions reviewed for this paper.

Theory-based interventions that aim to influence health behavior are commonly utilized. This is important because conceptual framing of how school gardens impact participants, schools, and communities guides development of uniform research and evaluation literature. Social Cognitive Theory, which is mainly focused on interpersonal levels of influence, also contains factors that affect the intrapersonal, institutional, and community levels. Because of its emphasis on positive reinforcement and its applicability to public health issues, the Social Cognitive Theory is often the theoretical framework of choice when it comes to nutrition and food interventions centered on youth (Berlin et al., 2013). Social Cognitive Theory is a good choice surrounding garden-based nutrition education interventions when considering the factors that influence food consumption patterns among children.

Social Cognitive Theory explores the interworking of 3 variables that influence health related behavior: environmental factors, personal behaviors, and personal factors. These 3 factors work in conjunction with each other in a reciprocal manner that influences the constructs, which shapes intervention (Berlin et al., 2013). With regards to many of the interventions examined in the literature review, personal factors tend to be operationalized as self-efficacy in regards to healthy food choices and interest, knowledge, and preferences in regards to fruits and vegetables. Environmental factors are typically operationalized as household access to fresh fruits and vegetables and fruit and vegetable consumption among the family. These variables are constantly interacting with one another within the personal and environmental contexts. This is not a comprehensive explanation of the variables involved in the food and nutrition process, but simply one example of the frequent variables used in theoretically-driven interventions. The following list from Berlin et al. (2013) details how Social Cognitive Theory constructs might apply to behavior change that incorporates more healthy foods in garden-based nutrition education interventions:

- Behavioral capability: youth having the appropriate knowledge and skills necessary to choose and consume more fruits and vegetables
- Expectations: youth having knowledge and beliefs about the outcomes of consuming more healthy foods
- Expectancies: youth having the ability to value the results of consuming more healthy foods
- Locus of control: youth's perception of who controls and reinforces continued consumption of healthy foods

- Reciprocal determinism: the interaction between youth and their environment that results in consumption of healthier foods
- Reinforcement: a response exhibited by youth in relation to consuming healthy food that increases the chances of this behavior being repeated; reinforcement is a construct that can be provided internally (by oneself) or externally (by another)
- Self – control: youth having the ability to gain control by maintaining and adjusting personal behaviors that lend themselves to eating more healthy foods
- Self-efficacy: youths' confidence in their ability to consume more healthy foods
- Emotional coping response: how youth deal and cope with anxieties that surround their consumption of healthy foods

  (Berlin et al., 2013)

This list highlights the constructs of the Social Cognitive Theory and how they interact with each other. It is important to note that the main point of theory is that knowledge does not necessarily result in the targeted behavior changes of the intervention. To transfer a change in knowledge to a change in behavior, a child must have high self-efficacy about that behavior (in this case healthy eating). Additionally, a child must also be in an environment that promotes that behavior. For example a child can be educated about healthy eating behaviors and fruits and vegetables and a child can eat fresh fruits and vegetables at school, but if they do not have these items at home and do not believe it is within their power to eat healthy, this behavior is hard to maintain. Therefore, for interventions that only measure changes in knowledge, it is hard to document the overall effectiveness of the garden-based nutrition education program.

2.2 EVALUATION OF GARDEN-BASED NUTRITION EDUCATION PROGRAMS

Garden-based nutrition education programs have been extensively evaluated to measure change in knowledge, preference for fruits and vegetables, and consumption of fruits and vegetables. Each intervention goes about evaluating these items in different ways. As of right now there are no standardized tools used specifically for garden-based nutrition education evaluation. There are tools that have become standard for evaluating certain components of these interventions, such as food diet recalls, food frequency questionnaires, pre and post-tests, and preference questionnaires. However, validity is threatened with self-report items such as preference and consumption. Table 2 summarizes the evaluation techniques used from the interventions discussed in the literature review.

Table 2. An overview of the evaluation designs for garden-based nutrition education interventions

Author, Year	Type of Evaluation	Evaluation Method	Strengths of Evaluation Noted by Author	Limitations of Evaluation Noted by Author
(Chaufan et al., 2015)	Summative	Parent, teacher, and staff satisfaction surveys that assessed: their satisfaction with school meals, satisfaction with effects the school has on their child's dietary habits and development, their own food practices and program influences on their lifestyle	Not stated	Not stated
(Ellsworth et al., 2015)	Summative	6 question pre- and post test survey targeting two education objectives relating to nutrition and agriculture	This design has been used in farm-to-school programs before and previous studies have shown increases in student knowledge	Not stated
(Evans et al., 2012)	Summative	Pretest – posttest nonequivalent group design. Data on consumption behavior, psychosocial variables, and demographic information were collected in a student questionnaire.	All measures were developed with an emphasis on cultural appropriateness and were available in both English and Spanish.	Because of logistical issues baseline data was collected after one component of the intervention was implemented. Analyses only used comparison of intervention and control post-test data.
(Gatto et al., 2012)	Formative	Data on psychosocial factors and consumption patters were obtained in a questionnaire completed by participants at the elementary school 1 week before and 1 week after the intervention	Not stated	The questionnaire assessed attitudes, preferences, perceptions, and self-efficacy to eat and cook fruits and vegetables requires more rigorous validation.
(Graham et al., 2005)	Formative (for survey development) and Summative	An 18 item questionnaire with either categorical items or scales containing multiple items to measure variables in 3 areas pertaining to school gardens: practices, attitudes, beliefs	Questionnaire was developed specifically for this project by a team of nutrition and horticulture professionals	Not stated
(Jaenke et al., 2012)	Summative	Food preference assessment	Both assessment tools were	Not stated

Table 2 Continued

		with a five-item food preference assessment tool. Fruit and vegetable intake was measured using two repeat 24-hour recalls at pre and 16-week post-intervention	used from methods developed by earlier studies: Birch and Sullivan(1991), Morris et al. (2001), and Baranowski and Domel (1994).	
(Klemmer et al., 2005)	Summative	Grade-appropriate cognitive test for science achievement developed for this study	Tests were coded for student confidentiality and distributed by school faculty during science class	Not stated
(Koch et al., 2006)	Summative	Written exam made up of 11 true/false and multiple choice questions based on activities performed, preference questionnaire measuring students' nutritional attitudes regarding fruit and vegetables, and five interview questions assessing knowledge and child eating habits.	Not stated	Not stated
(Lautenschlager & Smith, 2007)	Summative	Focus groups	Not stated	Not stated
(McAleese & Rankin, 2007)	Summative	Food recall workbook	Food recall workbooks were made to be age-appropriate, included portion size illustrations, and other explanations for completion of workbook.	Self-reported data can be unreliable
(Morris et al., 2002)	Summative	Nutrition knowledge questionnaire and vegetable preference survey were used to evaluate the curriculum.	Reliability of questionnaire was determined using a group of students not exposed to intervention	Not stated
(Moss et al., 2013)	Summative	Baseline and post intervention nutrition knowledge survey with 22 questions and statements divided into four sections. Majority of survey items were taken from previous studies on school nutrition education	The surveys were reviewed and approved by a Delphi Panel.	Not stated

Table 2 Continued

		interventions.		
(Namenek Brouwer & Benjamin Neelon, 2013)	Summative	Dietary assessment at baseline and five months after baseline	Not stated	Not stated
(O'Brien & Shoemaker, 2006)	Summative	10-item questionnaire assessing nutrition knowledge from the Family Nutrition Program evaluation questionnaire for students in grades 3-6. Preference was assessed from an instrument adapted from other preference instruments. Self-efficacy instrument was adapted from previous research on self-efficacy instruments	Used the same questionnaires as previous studies	Not stated
(Poston et al., 2005)	Summative	Nutrition knowledge was assessed using a 10-item nutrition questionnaire provided by Purdue University Extension and Texas A&M. Vegetable preference was assessed using a 12-item list of common fruit and vegetables. Self-efficacy was assessed using items in a questionnaire modeling Bandura's (1997) recommendations	Not stated	Not stated
(Ratcliffe et al., 2011)	Summative	Knowledge, attitude, and behavior toward vegetables were assessed using the Garden Vegetables Frequency Questionnaire (GVFQ) and the Taste Test. GVFQ was self-reported instrument measuring consumption and preferences for vegetables. Taste Test included students naming, tasting, and rating preferences on 5 different vegetables.	The GVFQ was compared with a 24-hr recall completed by students to test for validity. Based on pretest findings, this tool was considered comparable to a 24-hr recall and was considered a reasonable measurement tool for vegetable consumption	Not stated
(S. V. Sharma et al., 2015)	Formative	Focus groups, teacher post-	Not stated	Not stated

Table 2 Continued

		intervention surveys to assess feasibility and acceptability of program, lesson plan evaluation forms, parent pre and post-intervention surveys measuring acceptability and perceived effectiveness.		
(Smith & Motsenbocker, 2005)	Summative	Science achievement pretest at the beginning of the semester on the first day of activities and then a posttest at the end of the fall program	The testing instrument showed reliability and validity	Not stated
(Wansink et al., 2015)	Formative	Before/after observation of food waste on 3 separate days	Not stated	Not stated

2.2.1 Literature review of evaluation methods used for garden-based nutrition education programs

As the Table 2 shows, the most common technique used to evaluate knowledge was a pre- and post- survey. Of the 19 studies reviewed examining their evaluation methods, seven of them used a pre- and post- design.

Overwhelmingly, questionnaires were used to assess knowledge, preference, consumption behavior, accessibility and feasibility, attitude, self-efficacy, and parent satisfaction. The most common domain assessed with the questionnaires was knowledge.

Food consumption was assessed in a number of ways. In Ratcliffe et al. (2011) used a Garden Vegetables Frequency Questionnaire to measure knowledge, attitude, and behavior regarding fruits and vegetables. McAleese et al. (2007) used a food recall workbook to measure consumption. Lastly, Jaenke et al. (2012) used three food recalls to measure consumption before and after the intervention, and then another one 16 weeks after the intervention. The remaining studies that assessed consumption levels used basic questionnaires that developed specifically for the intervention. As noted previously, self-report bias may limit validity of results.

Since it is often hard to gauge knowledge, preference, consumption levels, and self-efficacy in one evaluation tool, many interventions were evaluated using a mixed methods approach with multiple evaluation tools. Seven out of 17 studies used at least 2 methods to measure outcomes. In addition to the three food recall studies, Jaenke et al. (2012) used a five-item food preference assessment tool. Koch et al. (2006) not only had a written exam measuring knowledge but also conducted interviews with participants assessing knowledge and eating habits. Morris et al. (2002) used a nutrition knowledge questionnaire specifically for knowledge,

but also a separate survey for vegetable preference. Both items were used to help evaluate the curriculum. O'Brien et al. (2006) used three different pre-developed surveys to assess nutrition knowledge, preference, and self-efficacy. Poston et al. (2005) used the combination of a nutrition knowledge questionnaire from a pre-developed survey, a vegetable preference survey to assess preference, and a self-efficacy questionnaire that had already been developed. Ratcliffe et al. (2011) used the Garden Vegetables Frequency Questionnaire for knowledge, attitude, behavior, and a Taste Test to measure preference among participants. The taste test asked students to name, taste, and rate their preferences for five raw vegetables (carrots, string beans, snow peas, broccoli, and Swiss chard). Lastly, Sharma et al. (2015) used the combination of focus groups, teacher post-intervention surveys, lesson plan evaluation forms, and parent pre- and post-intervention surveys to assess for fruit and vegetable preference.

For evaluating garden-based nutrition education programs, there is very limited standardization in the tools used for evaluation. Many of the surveys, tests, and questionnaires were not previously used in other studies, but the methods were based on previous research. Few studies used measurement tools that had been previously developed and tested specifically for the curriculum. Additionally, there have been few rigorous and comprehensive evaluations of these programs. Developing more uniform evaluation tools for these kinds of programs would allow for standardization, better data analyses, and a more comprehensive collective understanding of the impact of garden-based nutrition education program. With better standardization, researchers could develop more rigorous study designs, a gap that currently needs to be filled by research.

3.0 ENRIGHT COMMUNITY GARDEN INTERVENTION

This section provides an overview of ECG, the methods used to evaluate the ECG, and the results.

3.1 PROGRAM OVERVIEW

Enright Community Garden was established in 2008 and developed by East Liberty Development Inc, GTECH Strategies, Grow Pittsburgh, Whole Foods, and a crew of enthusiastic neighbors, including parents, teachers, and students from Kentucky Avenue School. The Enright Community Garden is a prime example of many people coming together to transform a blighted area into a peaceful green space filled with sunflowers, vegetables, and fruit to be enjoyed by all.

The garden costs about $400-$500 a year to maintain, plus the costs of a Whole Foods team member to oversee and coordinate the activities. The team member maintenance costs is one of the garden's biggest expenses, but it also ensures a successful season of growing and collaboration among community members. The garden funds come from Let's Move grant money and Whole Foods.

Kentucky Avenue School, which is a private school located in the Shadyside neighborhood of Pittsburgh, and Enright Community Garden foster a partnership that allows students to grow and harvest vegetables in the garden and bring their homegrown ingredients

back to school where they can eat and enjoy them as part of their lunches. Lessons on healthy eating, sustainability, and life and earth sciences are part of the curriculum taught to all students in grades kindergarten through fifth grade. The garden in conjunction with Kentucky Avenue School gives students hands-on experience with the cycle of planting, growth, and harvest of healthy foods. The partnership between Kentucky Avenue School and Enright Community Garden has been featured in local publications such as Whirl Magazine, Table Magazine, and Keystone Edge.

3.1.1 Activities conducted at Enright Community Garden

Between Spring 2015 and Fall 2015, Enright Community Garden had a wide range of activities happening at the garden. Each of these activities involved varied age groups, from children to adults, and diverse activities that many people could participate.

The most prominent of activities was the garden-based nutrition education classes with Kentucky Avenue students. Enright Community Garden has partnered with Kentucky Avenue School and Kentucky Avenue Café since 2008, involving children in all aspects of the gardening process and then providing them fresh vegetables and fruits to cook at school as well as to take home. Participating children ranged between Kindergarten and fifth grade. Given that Kentucky Avenue School is located in a very affluent neighborhood in Pittsburgh, these children are primarily Caucasian and come from high income and high education families. This summer garden curriculum for Kentucky Avenue Students included classes on the growing process of garlic, which involved students planting the bulb; “eating the rainbow,” a class focused on mindful eating, where nutrients come from, and how different colors in food mean different nutrients, different kinds of herbs and what they are used for; and how to create your own garden

and cover crops. Grow Pittsburgh, a local non-profit organization whose mission is to promote the use of gardens in local communities, developed this curriculum and has made it free for people to use at their school gardens.

Another key aspect of the garden was its partnership with East End Cooperative Ministry (EECM), a non-profit organization that provides hot meals, a safe place to sleep, recovery groups, educational programs for youth, prevention programs, and a community food bank to those who need it. In this component of the garden, half of the garden plots were utilized to grow produce and donate to the community food bank at EECM.

With half of the plots being utilized for EECM, the other half of the garden plots were left open for local community members in East Liberty and Whole Foods Teams Members to use. Community members were sent a mailer enabling them to reserve a plot for Spring, Summer, and Fall for a $20 donation. Two of the open plots were donated to Sojourner House, a faith-based residential rehabilitation facility where women who are addicted to drugs are given a support system and a place to stay to help decrease poverty and drug abuse. The remaining plots that weren't used for the community or for Sojourner House were available for Whole Foods Team Members to use for a $20 donation as well.

Another activity conducted in the garden was community education classes. These classes were opened up to anyone in the community. Some had a small fee and some were free to attend. In the summer, there was a tomato class on how to grow and care for tomatoes, an organic gardening class that taught people about organic gardening practices, and a pest identification class where people were taught to identify the kinds of pests and bugs that can affect your garden plants as well as how to control for them organically. Lastly, there was a healthy eating class on how to cook healthy food items on a low budget aimed at clients at

Sojourner House. This was a really exciting class as most the clients at Sojourner House are on a low-income budget and could not afford healthy foods.

Lastly, the garden was also used as a green space and educational laboratory for other organizations or community members to use. In August, The Union Project, a non-profit organization that specializes in working with and giving classes to those with special needs, utilized the Enright Community Garden for their art camp. In addition to the art camp, they also had a weeklong Edible Flower class for their students. Whole Foods also used the garden for monthly barbeques and trivia nights, allowing team members a fun and safe green space to hang out at and have a good time.

3.1.2 Desired impact of Enright Community Garden

The anticipated outcomes as determined by the garden coordinator for the activities of Enright Community Garden are listed below:

- Increased knowledge of fruits and vegetables among children
- Increased preference towards fruits and vegetables among children
- Grow and donate more than 400 pounds of produce to East End Cooperative Ministry
- Increased knowledge about organic gardening procedures and general garden knowledge among community members
- Establish and maintain green space for local community members and organizations to use

3.1.3 Planning and development

Valerie Testa, the garden coordinator and Whole Foods team member, planned all of the garden activities with the aid of garden ambassadors, supported by funds from Whole Foods Market. Whole Foods Market helped fund all activities in the garden and sponsored all the maintenance and staffing needs. The curriculum for the Kentucky Avenue School classes, the organic gardening class, and the tomato class was developed by Grow Pittsburgh. The Union Project teamed up with Valerie Testa to develop the curriculum for the edible flower and weed class. The Healthy Eating Specialist at Whole Foods Market developed the healthy eating class curriculum and a local horticulture expert developed the pest identification class curriculum.

3.2 EVALUATION METHODS

The original intent for the Enright Community Garden evaluation was to evaluate all components of the garden. An evaluation map was created that detailed all focal areas and methods for evaluation. However, evaluation components that were prioritized were Kentucky Avenue School Students, educational garden classes, and use of the garden as a green space. Due to finite time and funding resources, other areas, such as surveying local community members as well as conducting interviews with community members and team members who had plots could not be conducted. Furthermore, the garden was committed to measuring the impact of produce donations on the community food bank at EECM, but due to the very confidential nature of their clients as well as funding limitations, that evaluation component was not an option.

To evaluate the impact of the garden as a green space, pre- and post- assessment surveys were developed for the Union Project art camp. These were 20 item surveys that were intended to measure knowledge among the participants before and after their camp. Curriculum was designed for the edible flower and weed class, and then surveys were developed based on the objectives of the curriculum. Due to the special needs of the participants, writing on the surveys was minimal and all questions included a photo to help participants identify items more readily. The pre-assessment was collected at the beginning of the week, before the start of the camp. At the end of the class, participants cooked a dinner at the Union Project home office, which was to have been the post-assessment data collection point. Unfortunately, due to the hectic nature of their final day and a sudden change of location, the director of the camp did not administer the post-assessment survey to participants. As a result, this component of the garden could not be evaluated.

Pre- and post- assessment surveys were also developed for two of the garden educational classes. Because pests and bugs that destroy or disease plants are contingent upon the location of the garden and the time of year, there was no designated curriculum for the course. In order to develop an evaluation tool for this class, I met with the pest identification expert a day before the class in the garden to identify the learning objectives of the class. Based on this information, a pre- and post- survey was designed specifically for the class, which focused on the kinds of pests that were in the garden and were developed to measure participants' changes in knowledge. For this class we simply wanted to measure if people were learning. We were unfortunately unable to gather follow up data at the conclusion of class. A more rigorous design that collected participant contact information could have prevented this.

Very detailed baseline and exit surveys were also were created for the healthy eating class that involved Sojourner House clients. These surveys were designed to measure behaviors, perceptions, attitudes and knowledge about healthy eating and cooking. More specifically, they were measuring how many times each participant ate breakfast, lunch, and dinner per week, how much access they have to healthy foods, the kinds of foods they eat on a weekly and daily basis, their perceptions of healthy foods, and measures for knowledge. There was a baseline survey, a post intervention survey, and a 1-month follow-up survey. Unfortunately, due to logistical issues at Whole Foods, this class was cancelled last minute and the class was never rescheduled.

The Kentucky Avenue School portion of the garden was the most rigorously evaluated part of the garden. To evaluate this component, pre- and post- assessment surveys were created for the students, which measured knowledge and preferences toward gardening and being outside. Surveys for students were developed from scratch based of the curriculum provided by Grow Pittsburgh. Surveys were administered before the start of the fall gardening classes and at end of 6-week program. Additionally, parents were sent an online survey before the start of the fall garden sessions, measuring their child's behavior and preferences. This survey was developed based off previous instruments used to measure behavioral changes, but the questions were altered to fit the content of this program. The same survey was sent to parents at the conclusion of the program to change over time.

3.3 RESULTS

This section provides a discussion of the results based on my experience of the evaluation of Enright Community Garden. In total there were 32 children in the intervention. Children were

asked knowledge questions based on the curriculum, questions about whether they garden at home, if they enjoy time in the garden, if they enjoy the fruits and vegetables they have tasted in the garden, and if they enjoy gardening.

Approximately 44% of the students have a garden at home and 38% of the students reported gardening with their parents or a teacher. Based on the results of the knowledge section of the pre- and post- intervention assessment given to the KAS students, there was a 45% increase in knowledge among students. The mean score on the knowledge section of the pre-assessment was 3.5 and the mean score on the knowledge section of the post assessment was 7.3. The distribution of means was approximately normal, but results were run through the Wilcoxon Signed Rank Test, as this is a more conservative test than a paired-T test. With a significance level at $P < .05$, the null hypothesis was rejected and it was concluded that results between pre- and post-assessment tests were significantly different. The garden did have a positive impact in improving the children's knowledge.

On the pre-test assessment, 53% of the students reported they enjoyed spending time in the garden, on the post-test assessment 87% reported that they enjoyed spending time in the garden. When asked if they enjoy the fruits or vegetables that they have tasted in the garden, 53% of the students reported on the pre-test assessment that they like the fruits and vegetables they have tasted and on the post test assessment 81% reported they like the fruits and vegetables they have tasted. When asked which vegetables they enjoy, students reported that they enjoy the following: strawberries, apples, basil, mint, broccoli, tomatoes, carrots, beets, herbs, flowers, cilantro, kale, raspberries, chocolate mint, cucumbers, lemon balm, and asparagus. One student wrote "I love all".

The last question asked if the students enjoy gardening. On the pre-test assessment 38% reported that they enjoyed gardening and on the post-test assessment 81% reported that they enjoy gardening. When asked specifically what students enjoy about gardening, they wrote the following:

- "Planting"
- "I like trying the things"
- "It is a quiet good place"
- "You help the plants"
- "Playing"
- "The bugs"
- "Cause I like plants"
- "Planting seeds"
- "Picking flowers"
- "I have fun gardening"
- "Plants and plant beets you see the root"
- "Well it makes me happy"
- "It's fun and hard"
- "Digging"
- "Water the plants"
- "Get to learn about garden"
- "Breaking up soil".

Overall, we saw positive increases in the number of children who improved their knowledge, children who reported enjoying time in the garden, children who reported that they

enjoy the fruits and vegetables they have tasted in the garden, and children who reported they enjoy gardening.

The results of the parent pre -and post-assessment were much harder to measure. In a survey emailed out to parents, there were 20 who took the pre-survey and 21 who took the post-survey. Looking at the results, parents reported slight increases in their child's enjoyment of fruits and vegetables and their child's enjoyment of spending time in the garden, but none of these increases were significant.

The most useful data obtained from the parent portion of the evaluation was the quantitative and qualitative data from the post-assessment questionnaire. When asked if children talked about their time in the garden with their parents, 95% of parents reported that their children talked to them. Parents reported that children stated the following:

- "They were very excited about it. It was special."
- "She really likes going to the garden, the fact that Grammy comes sometimes also, and really likes the helpers who are there. She is proud to come home and bring me flowers from the garden and tell me things about it."
- "Mostly how much fun it was to get outside during the day"
- "They liked going and learning about the different plants"
- "What plants they worked with"
- "She told me about the various foods that you grow. She is a little nervous around fruits due to oral allergy syndrome with many fruits, but she loves the veggies."
- "She now has a better understanding of the cyclical nature of plant life, and the role plants play in our ecosystem."
- "Loved seeing the praying mantis, trying some of the harvest, answering questions"

- “Would share things harvested and especially proud to give us flowers. Also wanted us to plant seeds at home.”
- “He learned so much and had an amazing time. What a wonderful experience!”
- “He liked the little tomatoes and told us about their color and taste.”
- “He talked about picking flowers and was very excited about bringing some home. He also told us about the delicious tomatoes that he tried.”
- “She talked about the seeds they planted. She also talked about harvesting, eating a rainbow and making tea from herbs.”

The fact that children were noted as going home and talking about their time in the garden suggests that they were interested in the garden learning opportunity. 95% of parents reported that their child seemed excited about spending time in the garden. Only 20% of parents reported seeing some kind of behavior change in their child after spending time in the garden. Some of the behavioral changes parents reported were the following:

-“ In general, I notice improvement in mood whenever she spends a lot of time outside. Working/playing outside inspires her to learn and take more physical risks.”

-“ She is more likely to come home interested in eating vegetables, which is a huge plus!”

When parents were asked if they felt the garden was valuable to their child’s education, 100% of parents reported that they found their child’s experience in the garden valuable. When parents were asked to express why they found the garden valuable to their child’s education, they reported the following:

- “As our global community grows and it becomes more difficult to sustainably feed the masses, learning about gardening and growing food will become more important.

I also think learning about growing food fosters more enjoyment of eating healthy foods, which is critical to proper brain and behavioral development”

- “Grass roots all the way - literally in this case.”
- “Children need a wide variety of types of education, not just 'academics'”
- “We believe there is a lot of value in knowing where your food comes from; how is grown/raised; and how it makes it's way to the market and into our homes. This is important from a personal consumption perspective, but also from political and environmental ones. The garden experience introduces kids to all of these concepts, which encourages healthy eating, and also encourages support for local, sustainable gardening/farming practices. My daughter has run into some of the garden workers around the community (e.g. when we are shopping in whole foods) and this excites her. I think this helps her make connections among the garden, grocery stores, and our kitchen. Also, in general I support any learning that can take place outdoors and which involves a hands on experience.”
- “I believe the weekly trips to the garden provide a concrete context as she learns more about science in school.”
- “Hands-on experiences are needed to supplement instruction in the classroom. I would encourage more activities like this.”
- “Getting out and doing things with their hands leaves more lasting memories than just learning about things from a book.”
- “Engages children to observe the world around them. Brings the classroom to nature and makes learning tangible and fun.”

Parents largely believe that not only was this kind of program valuable, but necessary to help their child learn about food. Parents saw the garden as something positive that encouraged health-eating habits, but still engaged the children in a hands-on and interactive way.

Although this was a small-scale intervention with a small sample size, it shows the positive effects gardening can have on children. Engaging children in hands-on and interactive ways, exposing children to fruits and vegetables, allowing them to taste a variety, and teaching them about fruits and vegetables have the potential to positively modify health behaviors.

4.0 CONCLUSION

Current literature on garden-based nutrition education programs shows that it is possible to improve knowledge about fruits and vegetables, perceptions of fruits and vegetables, and influence consumption patterns. However, the effects are small, and most of the studies utilized a quasi-experimental design, relied on self-report, and incorporated small sample sizes. Nevertheless, this paper reveals that these programs do have positive benefits and suggests that community gardens present a promising approach to improving the health of the children and creating better health outcomes.

4.1 STRENGTHS AND LIMITATIONS

Strengths of this evaluation were the pre-and post- design not only for the children, but also for the parents. By measuring the children's knowledge and preferences before the intervention, we could compare with the post- garden assessment and look for improvements. Additionally, being able to evaluate the parents' perspective added additional insight and created some unique qualitative data, making this a mixed methods evaluation. R. Burke Johnson in his paper "Mixed Methods Research: A Research Paradigm Whose Time Has Come" he states:

> "Investigators who conduct mixed methods research are more likely to select methods and approaches with respect to their underlying research questions, rather than with regard to some preconceived biases about which research paradigm should have hegemony in social science research. By narrowing the divide between quantitative and qualitative researchers, mixed methods research has a great potential to promote a shared responsibility in the quest for attaining accountability for educational quality. The time has come for mixed methods research." (Johnson & Onwuegbuzie, 2004)

By using qualitative and quantitative evaluation techniques we could measure change in knowledge and attitude, but then also the value of the program, which really added to the quality of the overall evaluation.

A limitation of this evaluation was the small sample size. It was hard to generate significant statistics because of this, but there was some significance. Another limitation is the lack of control group. The pre and post design of the assessments was developed to account for lack of control group and give a baseline to compare outcome data to. A huge limitation for the parent pre and post surveys was only being able to pair 11 of the pre surveys with 11 of the post surveys. Because of this it was hard to make any useful comparisons of behavioral changes as observed by parents.

Another limitation of this evaluation was the limited generalizability of results. In the future I would use a more rigorous design that randomized schools and classrooms to an intervention and then used classrooms receiving standard nutrition-education as a control group. The populations for this sample were not randomized and all were convenience samples, meaning the results from this evaluation can't be generalized to other programs. In order for

results to be generalizable, a much more rigorous evaluation and intervention must be implemented. Additionally, many children already have their own gardens at home meaning results might not only be a cause of this intervention. Children were not randomized to the intervention, but to account for lack of randomization the pre- and post- questionnaire design was used for parents and children. This allowed for comparison before and after the intervention. Furthermore, the participants in the garden were from high-income neighborhoods and were predominantly Caucasian. This intervention might not have had the same impact if it were implemented in a lower-socioeconomic community with a more ethnically diverse population. Lastly, considering the long-standing partnership KAS holds with Enright Community Garden, they are already a school that is on-board with this kind of approach. Results could potentially differ in marginalized communities that haven't had much exposure to gardens or the concept of garden-based nutrition education.

In spite of these limitations, some very important lessons were learned throughout this evaluation. Regarding methods, I would have liked to have done more research on previous methods used for garden based nutrition education programs before the evaluation was conducted. Because some classes were created and thrown together on a whim by the ECG, time did not always allow for proper methods research and tools were developed from scratch. For the healthy eating class, measures were developed based on previous interventions, but that class was unfortunately canceled and those measures were never used.

Other lessons learned had to do with the nature of working with multiple organizations to try and effectively evaluate each component of the garden. As stated, classes were cancelled or parts of the evaluation weren't conducted due to time constraints. With the Union Project portion of this evaluation, I learned that you can create effective tools to help measure outcomes, but

unless these tools are used and implemented properly, you won't have data you can use. I had created a comprehensive pre/post survey, but because of the organization's time constraints, not being able to administer the post-intervention survey to students limited the utility of my baseline data.

Overall, I learned that to effectively evaluate a garden-based nutrition program there needs to be comprehensive research on current methods and design prior to the evaluation data collection period. Additionally, a more structured environment with more concrete dates and deadlines would have helped provide more rigor. Nonetheless, this evaluation provided useful data and generated some interesting results.

4.2 IMPLICATIONS FOR FUTURE RESEARCH

Generally speaking, changes in health behavior and social behavior are hard to change. The evaluation of Enright Community Garden and most of the studies covered in the review of literature displayed changes of knowledge and some changes in perception. Not only is each garden-based nutrition intervention designed very differently from each other, each one of these interventions has different number of students participating, different number of schools participating, varied age groups, and different levels of intensity to implement the interventions. It is unrealistic to expect a large impact from an intervention that only engages a small proportion of the school for an extended time or one that engages a large proportion of the school for a small portion time.

To fully study the impact of these approaches, it is recommended that any further research use a strong experimental design with control groups, longitudinal design, and non-

convenience-sample cohorts to better study the impact. Evaluation strategies and curricula need to be improved and standardized to better compare populations and create more effective interventions. A mixed methods approach with a combination of surveys, observations, and interviews is suggested to truly measure the impact of garden-based nutrition education programs.

In a time where we are plagued by climbing numbers of child obesity, we have promising programs to not only give children the knowledge and exposure of healthy foods, but also potentially change their current environment by giving them increased access to healthy foods. Healthy children create healthy schools, which in turn creates healthy communities.

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