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Project Learning Garden: A Systematic Review of the Effectiveness of the Evaluation Techniques on School Gardens

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By

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Abstract

Introduction: For decades, school gardens have been on the rise, globally. These programs are all-encompassing programs that provide hands-on activities, such as planting and harvesting fruit and vegetables, with preparing and cooking foods which grow in the garden. There are not many studies that have looked into these school gardens, let alone how these school gardens get evaluated. The aim of this systematic review is to examine how intensely school gardens get assessed and how useful their evaluation tools can be.

Methods: Studies chosen for this review included peer-reviewed journal articles, found on PubMed, assessing the impact of learning gardens on elementary and middle school students. The items found focused on the change in children's attitude toward, preference for, knowledge and consumption of fruit and vegetables, along with their progress in school. The articles were not limited to date or location; therefore materials from other countries were included. From the search results, the author obtained eight full-text articles**.**

Results: All of the eight papers reviewed showed a positive change in children's health and behaviors as a result of having access to a school gardening and getting an additional nutritional education. Three papers showed no change in the consumption of fruit and vegetables, while four articles found significant increases in preference for fruit and vegetables. Also, one paper showed no major differences in fruit and vegetable knowledge, while four papers showed marked improvement. All eight of the studies used surveys in some way, one study used a food diary, three studies focused on 24-hour recall, and one looked at lunchroom observations to evaluate the research.

Conclusion: This systematic review showed that school gardens have a positive effect on children's attitude toward, preference for, knowledge and consumption of fruit and vegetables. The evaluation techniques used in these eight studies showed that surveys were more intensely written, as well as tools with less bias, were more efficient in determining the status of school garden effectiveness.

Project Learning Garden: A Systematic Review of the Effectiveness of the Evaluation Techniques on School Gardens

Introduction

1.1 Overview

Since the early 1900s, the United States Federal government has been encouraging school gardening. Through the building of a "School Garden Army" during World War I and supporting victory gardens at schools in World War II, school gardens have been progressing for decades (USDA (a) 2016). School gardening programs have become a national movement in the last 20 years (Blair 2009). From increasing children's consumption, knowledge and preference for fruits and vegetables, to enhancing their health and academic performance, school gardening has become a basis for elementary and middle school curriculum globally.

School gardens are programs that provide hands-on activities, such as planting and harvesting fruits and vegetables, with preparing and cooking foods which grow in the garden. Along with a hands-on learning experience, teachers provide classroom education since the garden learning process is becoming part of the school curriculum. School gardens can also be used to produce products for school cafeterias, like growing herbs to spice up pizza in the cafeteria and providing fresh lettuce for the school's salad bar. These gardens are becoming an integral part of elementary and middle schools globally.

School gardens are not limited to the warmer climates. Many northern states are implementing these programs into the curriculum through the use of indoor tower gardens and aquaponics systems to beat the cold climate. To date, the 2015 USDA Farm to School Census indicates that 42% of districts surveyed participate in farm to school activities, while 7,101 school gardens have sprouted up around the United States alone (USDA(b) 2017).

1.2 Gardens as School Curriculum

The purpose of a learning garden on a broad continuum expands from an academic and behavioral use to environmental remediation purposes. According to the USDA (2017), school gardens are effective when their use is (1) linked to classroom curriculum, (2) lessons involve opportunities to taste, prepare, and/or eat garden produce, (3) students are engaged in frequent garden visits throughout the school year, and (4) they are offered together with other school-wide farm-to-school activities such as family cooking nights, farm field trips, and taste tests.

According to the NC Cooperative Extension (2017), gardening allows for a hands-on experience for students to learn an array of disciplines, with regards to academic achievement. This range of disciplines can include: (1) an increase in science achievement scores, (2) contribute to a communication of knowledge and emotions while developing skills that help kids be more successful in school, and (3) have a positive impact on student achievement and behavior.

School gardens can be very beneficial to students over the course of a lifetime. Not only are school gardens able to help students in the present, but they can also help students in the future by improving life skills, such as working with groups and self-understanding, developing social skills and behavior, and instilling appreciation and respect for nature that can last into adulthood (NCCE 2017).

1.3 Purpose of the Study

The specific question addressed in this review of the literature is how intensely evaluated school gardens are and how useful these evaluations are. Excitement for gardens in elementary and middle schools is evident, but the literature on these school gardens has yet to look at the effectiveness of the gardens, as determined by the evaluation techniques. The approach is first to give an overview of the different evaluation techniques and the rationale for learning gardens, followed by an examination of the assessment techniques combined with the evaluative outcomes.

Chapter 2

Literature Review

2.1 Evaluation Techniques

With school garden programs developing around schools in the United States, many scientists are now working to evaluate these programs and determine their effectiveness. It is important for these programs to be extremely useful because they are the key to keeping children healthy and changing the health status of future generations. Teaching children healthy habits could help them use them into adulthood.

To evaluate the school garden programs, scientists use a range of evaluation techniques. The techniques discussed in the papers of this systematic review include (1) questionnaires/surveys, (2) taste testing, (3) lunchroom observations and (4) 24-hour recall/food diaries (CDC, 2011).

2.2 Biases Involved in Evaluation Techniques

With different assessment techniques come different biases. Various biases are depending on how the techniques get conducted and designed. For questionnaires, response bias and social desirability bias are potential obstacles. Response bias is defined as the tendency of a person to be untruthful when answering questions on a survey (Andale, 2016). The respondent may or may not know that he or she is answering the question untruthfully, based on how the question is written or perceived. Response bias can be seen through self-reporting issues when people want to portray themselves in a better light, or through questionnaire format issues when the wording of the question influences the way a person responds (Andale, 2016). Many papers in this systematic review use a Likert-style response which can be highly vulnerable to the effects of response bias (Furnham, 1986). These issues can be cleared up by having the interviewer: (1) make sure that the questions are well explained, (2) respondents are not being asked information on a topic that they are not familiar with, (3) making sure that the respondent knows the importance of being truthful, and (4) responses are made anonymously.

Response bias can also be found in the 24-hour recall, where a student states the food and drinks that he or she has had in the past 24 hours, along with many other types of bias. First, response bias can be seen in this recall because respondents may not want to be completely honest if they are reporting on a sensitive issue. For example, students may not want to say that they ate a bag of chips and pizza, along with drinking two sodas, the previous day if they are working on having a healthier diet. In this instance, the 24-hour recall may not be the best technique to try and figure out the truth about what people are eating. 24-hour recall can also be affected by social desirability bias, in which respondents misreport answers to avoid embarrassment and project a favorable image toward others (Fisher, 1993). This issue can be resolved by making sure the 24-hour recall is done individually and that respondents are away from their peers. Another issue with 24-hour recall is the use of recall bias. Recall bias is found in differences in the accuracy or completion of the recollections retrieved by study participants regarding events or, in this case dietary information, from the past (Freedman et al. 2017).

Taste testing and lunchroom observations do not have much of a bias related to them except for potential social desirability. Students may believe that a fruit or vegetable does or does not taste good based on what their peers think. If students react negatively to a taste test, then other students are more likely to respond negatively to the taste test because they do not want to be left out. Lunchroom observations could have a potential bias if students follow along with what other children are eating and not what they want to have themselves.

2.3 Rationale for Learning Gardens

There has been a substantial amount of growth in the number of school gardens globally in the past ten years or so. These school gardens come with a multitude of benefits for everyone involved, but especially for the students. The papers in this systematic review discuss the advantages of these gardens, as well as looking to see how productive the gardens are in maintaining these benefits. This section looks at the benefits of learning gardens and why schools should implement them.

Waliczek 1999 found that the main advantages of school gardens and the ones discussed in this chapter include (1) environmental stewardship, (2) community and social development, (3) healthy lifestyle changes, and (4) academic achievement. Through gardening, the students can become caretakers of the environment around them, as well as get a chance to bring life to their environments. School gardens give children an opportunity to learn the impact of land cultivation and to gain responsibility when taking care of a multitude of plants. As students continue gardening, they can determine interactions that occur between living and non-living entities of the world, giving them a greater understanding of the natural world (Waliczek and Zajicek, 1999). Finally, these gardens provide children with the opportunity to learn about water conservation and sustainable gardening practices, like composting, which help them to learn and understand maintenance issues on local and global scales (Skelly and Zajicek, 1998).

For social and community development, school gardens allow children the opportunity to work with other students, teachers, parents, and research volunteers to develop responsibility. Children are given the opportunity for positive reinforcement through the production of fruits and vegetables, while quickly learning negative consequences when forgetting to water the plants. On an individual level, gardening helps students gain confidence, patience, self-esteem and experience pride when seeing their hard work pay off during harvesting time (Robinson and Zajicek, 2005).

School gardens are vastly important in contributing to the healthy lifestyle changes of students. There are approximately one in three children who are overweight, or at risk of becoming overweight, in America and childhood obesity is becoming of great concern to parents because it can lead to more chronic diseases like diabetes (American Heart Association, 2016). With nutritional education and hands-on activities in the garden, children learn the importance of fruit and vegetables and how the essential vitamins and nutrients can improve their bodies and prevent illnesses like cancer and heart disease (Lineberger and Zajicek, 1999). Not only does gardening help with nutritional education, but it

allows for children to experience more physical activity through digging, planting and weeding (Pothukuchi, 2004). Not only will children gain knowledge and exercise, but they will increase their attitude and love towards fruit and vegetables over time (Lohr and Pearson-Mims, 2005).

Lastly, with learning gardens becoming a part of the main curriculum at many schools, academic achievement is a significant focus and benefit of these gardening programs. School gardens provide hands-on learning experiences for a broad range of subjects. Teachers can use the gardens as a laboratory to allow students to explore the ways that plants use photosynthesis, as well as a place to study weather, insects, ecosystems, soil and other environmental matters (Klemmer et al., 2005). In addition to science, the school gardens allow additional opportunities to teach mathematics, social sciences, and language arts. Students can use hands-on experiences in the garden to make learning more exciting and to link what they learn to the outside world (Western Growers Foundation, 2016).

Chapter 3

Methodology

3.1 Criteria for Considering Studies for this Review

Initial Selection Criteria

Studies chosen for this study included individual, experimental papers evaluating the impact of learning gardens on elementary and middle school students. These articles were narrowed to elementary and middle school interventions because these are the years when children are most influenced by what they learn and when their minds are easily molded (Perkins, 2017). By implementing learning gardens into schools, parents and teachers can change children's attitudes and knowledge about fruits and vegetables. There have not been many studies done on this subject. Therefore, the studies used in this review were not limited to the United States alone, but rather included other countries. Due to limitations in the study of learning gardens, the selection of articles was not limited by the survey

population. Papers that did not discuss the effectiveness of the learning gardens, based on knowledge, consumption, and attitude toward fruits and vegetables, and academic improvement, were excluded. Other articles excluded were those that looked at multiple influences on children, like farm-to-table activities, other interventions, and physical activity, outside of learning gardens in schools.

3.2 Types of outcome measures

Primary Outcome Measures

The primary outcome measures for this systematic review were chosen by the primary outcomes found in the literature of different studies used. These outcomes are the changes in fruit and vegetable intake, nutritional knowledge and intent to change behaviors.

Secondary Outcome Measures

The secondary outcome measures for this systematic review were chosen by the secondary outcomes found in the literature of the studies in the review. These outcomes include the changes in school gardening levels, a combination of garden level and fruit and vegetable intake, fruit and vegetable intake on its own, knowledge of fruit and vegetables, and attitude toward fruit and vegetables.

3.3 Search Strategy

PubMed was the database used in this literature review. The PubMed database searches were done with keyword searches pairing aspects of learning, school, and gardens against attitudes, knowledge and academic performance. No restrictions were put on the study date, location, or design. Additional articles included in the literature review come from sources of papers found in the search. A complete list of the key search and results for each search can be found below:

Table 1: Keyword search by name and results

SEARCH NAME	SEARCH RESULTS
Learning Garden Elementary Schools	3 (1)
Learning Garden	263 (1)
School Learning Garden	83 (1)
Project Learning Garden	23 (1)
Learning Garden Evaluation	34
Gardening Increases Vegetable Consumption	8 (1)
Learning and Garden and Fruit and Attitude	3 (2)
School Garden and Vegetable and Knowledge	31
School Garden and Academic Performance	10

*The numbers in the search results include the amount of papers found for each. The ones in parentheses are the number of papers from the searches used in this review.

TOTAL NUMBER OF ARTICLES FROM SEARCH:	458
TOTAL NUMBER RELEVANT TO REVIEW:	8

3.4 Data Collection and Analysis

Selection of studies

The author of this review screened titles and abstracts from the search results of PubMed. Titles that did not pertain to gardens used at schools for education purposes were automatically excluded. Studies that did not take place in either an elementary or middle school were discarded. The abstracts of each study remaining were examined. Any summary that did not discuss the effectiveness of learning gardens in

schools, with mention of a change in knowledge of fruits and vegetables, attitudes toward fruits and vegetables, academic performance, preference for fresh fruits and vegetables, and consumption of fruits and vegetables was also discarded. Figure 1 shows a flowchart of the extractions of articles to make sure the best ones were retained for this review. Full copies of the relevant papers have been obtained for review. As the studies were examined, their listed references were considered for potentially relevant studies.

Quality Assessment

All of the studies meeting the initial selection criteria by evaluating learning gardens in elementary or middle schools, based on a change in academic performance, knowledge, attitude toward, preference, and consumption of fruits and vegetables were included in this review.

The following table shows the criteria that were used to make sure that these studies met quality assessment guidelines.

Table 2: Quality Assessment

Authors	Was the purpose clearly stated?	Does the study apply to the research question?	Was relevant background literature reviewed?	Was the sample described in detail?	Were results reported based on statistical significance?	Were the conclusions appropriate based on the study methods and results?
Christian	Yes	Yes	Yes	Yes	Yes	Yes
Hutchinson	Yes	Yes	Yes	Yes	Yes	Yes
Koch	Yes	Yes	Yes	No	Yes	Yes
Lautenschlager	Yes	Yes	Yes	Yes	Yes	Yes
Lineberger	Yes	Yes	Yes	Yes	Yes	Yes
Morgan	Yes	Yes	Yes	Yes	Yes	Yes
Parmer	Yes	Yes	No	No	Yes	Yes

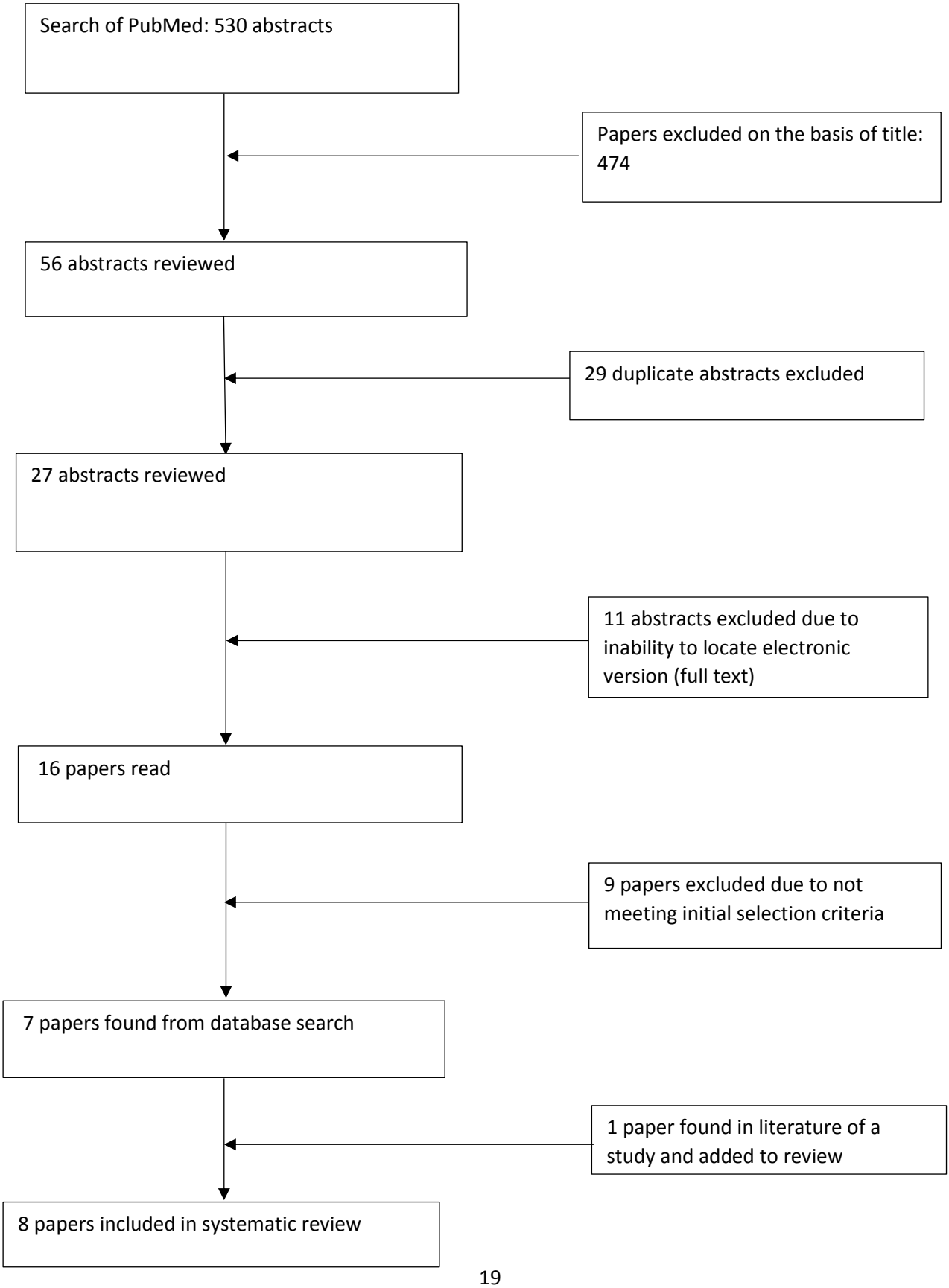
Somerset	Yes	Yes	Yes	Yes	Yes	Yes

Out of the eight studies used in this review, 6 of them met all of the quality assessment questions in the above table. Koch 2006 did not provide detail about the participants, other than grades. Also, not only did Parmer 2009 not have any background information, the study also did not give much information on the participants, like age and gender ratio. The study was stated to have taken place in the southeastern United States, but it is not accurate to the exact location.

Data Collection

Actual data within the studies and journal articles retrieved were used to determine the evaluation techniques used on school garden projects. The data analysis was conducted by reading the titles of the papers retrieved during the initial search, narrowing those down using criteria mentioned above. Then the articles available after that were narrowed down by reading the abstracts of the articles and looking for keywords. Once the papers were narrowed down, relevant information, including program details, outcome measures, results, and limitation, were retrieved from the full texts of the journal articles and synthesized to determine how intensely evaluated are school garden projects, along with the effectiveness of the evaluation tools.

Figure 1: Flow Chart of Study Selection Process



Chapter 4

Results

4.1 Results of the search

The initial electronic search, conducted on January 5, 2017, generated 372 studies. On January 20, 2017, an additional keyword search, including the keywords vegetable consumption, attitude, knowledge and academic performance was conducted. A total of 530 search results were obtained, and the titles were screened by the author. After screening the titles, the author narrowed done the results to 27 abstracts, which were then screened once more. After this second screening, nine articles were excluded due to the inability to access the full texts electronically, because of the requirement of access fees, and two were unable to be located. Finally, the remaining 16 articles were read in full. From here, nine papers were excluded due to not meeting initial selection criteria, and one article was added, after being found in the references of a relevant article. The reasons for exclusion can be seen in Table 3 below. In the end, the full texts of 8 relevant articles were retrieved. These studies were analyzed by the author.

Table 3: 20 studies excluded, after abstracts were reviewed, and reasons for exclusion

Author	Year	Title of Article	Reason for Exclusion
Aubel	1993	Learning from evaluation: the GAFNA nutrition education project	A nutrition intervention looking at prevention of anemia
Berezowitz	2015	School gardens enhance academic performance and dietary outcomes in children	A review of a multitude of articles
Block	2011	Growing community: the impact of the Stephanie Alexander Kitchen Garden Program on the social and learning environment in primary schools	Cannot access full text
Brouwer	2013	Watch Me Grow: A garden-based pilot intervention to increase vegetable and fruit intake in preschoolers	Intervention without the use of a garden
Davis	2011	LA Sprouts: a gardening, nutrition, and cooking intervention for Latino youth improves diet and reduces obesity	Looking at obesity prevention through another intervention

Erismann	2016	Complementary school garden, nutrition, water, sanitation, and hygiene interventions to improve children's nutrition and health status in Burkina Faso and Nepal: a study protocol	A study looking at health status of children to make program decisions
Evans	2012	Exposure to multiple components of a garden-based intervention for middle-school students increases fruit and vegetable consumption	Cannot access full text
Gibbs	2013	Methodology for the evaluation of the Stephani Alexander Kitchen Garden program	Cannot access full text
Graham	2005	California teachers perceive school gardens as an effective nutritional tool to promote healthful eating habits	Study looking at teachers' perceived attitudes
Heim	2009	A garden pilot project enhances fruit and vegetable consumption among children	Cannot access full text
Jaenke	2012	The impact of a school garden and cooking program on boys' and girls' fruit and vegetable preferences, taste rating and intake	Cannot access full text
McAleese	2007	Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents	Cannot access full text
Morris	2002	Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge on nutrition and preferences for some vegetables	Full text unavailable
Ozer	2007	The effects of school gardens on students and schools: conceptualization and considerations for maximizing healthy development	A review of a multitude of articles
Ratcliffe	2011	The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption	Cannot access full text
Robinson-O'Brien	2009	Impact of garden-based youth nutrition intervention programs: a review	A review of a multitude of articles
Savoie-Roskos	2017	Increasing fruit and vegetable intake among children and youth through gardening-based interventions: a systematic review	of a multitude of articles
Triador	2015	A school gardening and healthy snack program increased Aboriginal First Nations children's preferences toward vegetables and fruit	Cannot access full text
Viola	2006	Evaluation of the Outreach School Garden Project: building the capacity of two Indigenous remote school communities to integrate nutrition into the core school curriculum	Cannot access full text
Wang	2009	Exposure to a comprehensive school intervention increases vegetable consumption	Cannot access full text

4.2 Setting and participants by article

The eight studies included in this review were all diverse in population, study design, and intervention. The commonalities among the studies were that they included students in elementary or middle school and all of the interventions had a garden implemented at the school, either before the intervention or during the intervention.

Types of Participants

Participants in these studies and interventions were children between the ages of 7 and 13 years. All of the participants attended either an elementary or middle school where the study was being held. These studies were conducted in England, Australia, and the United States.

England: Christian 2014 was the first cluster randomized controlled trial that looked at evaluating school gardens and the effect they have on a child's fruit and vegetable intake. This trial took place in the London boroughs of Wandsworth, Tower Hamlets, Greenwich, and Sutton from the summer of 2010 to the fall of 2012. There was a total of 1,256 students, with a mean age of 8.1 years (7-11 years range), who started the trial. These students came from 23 schools and were randomized into two groups: one receiving the Royal Horticultural Society-led intervention and a teacher-led intervention. 10 schools were a part of the RHS-led intervention, and 13 schools were in the teacher-led intervention. Of the 1,256 students who began the trial, only 641 completed all aspects of it.

Hutchinson 2015 was the other trial that took place in London, in the boroughs of Wandsworth, Tower Hamlets, Greenwich, and Sutton, during the academic year from 2010 to 2011. There were 773 who completed this trial, ranging from 7 years to 11 years. The students were from the same 23 schools as the study above, using the same intervention layout as Christian 2014, with one group being RHS-led and the other being teacher-led. Instead of looking at intake, this study investigated children's knowledge of and attitude towards fruit and vegetables.

Australia: Morgan 2010 was a quasi-experimental study that evaluated children's knowledge of, consumption, and preference for fruit and vegetables, as well as their quality of school life. The trial took place in two primary schools in the Hunter Region, New South Wales, Australia over the course of 10 weeks. There were 127 students in grades 5 and 6 (ages 11-12 years) who participated in the study, with 54 percent of them being boys. The students were split into three groups: one group with nutrition education and gardening, one group with nutrition education only, and a control group, which did not complete any nutrition-based lessons or garden-based activities.

Somerset 2008 was a 12-month intervention that took place in a northern Brisbane suburb, in eastern Australia. This study was used to determine if a school garden could influence a child's ability to identify specific fruits and vegetables, as well as their attitudes towards fruit and vegetables. There were 152 students who began the survey in grades 4 through 7 (ages 8 to 13 years). This trial used a historical control in that it used questionnaires that students took before the intervention as a control for the final data collection. The last survey was completed in year two.

United States: Koch 2006 was a multi-level trial that took place in multiple counties in Texas, including Angelina, Hidalgo, Martin and Tarrant. The three different levels of the intervention were: a one-week summer camp format, every morning for one week, or a 12-week program where the students met once a week. The objectives of Koch 2006 were to evaluate the effect of the program on children's knowledge about the benefits of eating fruits and vegetables, as well as assessing the impact of the program on nutritional behaviors and attitudes of children. There were 135 participants, in grades 2 through 5, at the beginning of the study, who took the pre-test, but by the post-survey, there were only 56 participants.

Lautenschlager 2007 was a trial that took place in Minneapolis and St. Paul, Minnesota as a 10-week program for 8 to 14-year-olds. The children were of a multi-ethnic, low-income sample and participated in the program three days out of each week. The purpose of this trial was to evaluate whether a school garden could change the consumption of fruit and vegetables by children, using the Theory of Planned Behavior model. The trial started with 96 students taking the pre-survey and 66 taking the post-survey.

Lineberger 2000 was a study that took place during the spring semester of 1998 through the spring semester of 1999 in five elementary schools in Texas to evaluate whether students had positive attitudes about fruit and vegetables and whether their eating behaviors changed or not. There were 111 participants in this study who were in grades 3 and 5. For the study, an activity guide, Nutrition in the Garden, was used over the course of the academic year to introduce the participants to different aspects of garden and increase their knowledge of fruits and vegetables.

Parmer 2009 was a quasi-experimental study looking at the effects of school gardens on children's fruit and vegetable knowledge, preference and consumption. This trial took place in six second-grade classes in an elementary school in the southeastern United States for 28 weeks. The six classes were divided into three different treatment groups: one group receiving nutrition education and gardening, one group receiving only nutrition education, and one control group. There were 115 second-grade participants for this study, with 76 being part of the two treatment groups and 39 in the control group. Nutrition education lessons were received one hour every other week and those who received gardening as a treatment were given it one hour every alternating week.

4.3 Interventions

In Christian 2014, the participants of 23 schools were part of a cluster, randomized, controlled trial, where ten schools were randomly selected to receive Royal Horticultural Society (RHS)-led and 13 schools received a teacher-led intervention. The RHS is the United Kingdom's leading garden charity dedicated to advancing horticulture and promoting good gardening practices. Those who received the RHS-led intervention received the following:

- A day visit from the RHS regional advisor every 6 weeks for 4 terms to work in the garden with the children and teachers (summer 2010 to summer 2011)
- Follow-up visits to aid lead teachers with planning (August 2011 to August 2012)
- General on-going advice on the school garden, as well as free seeds and tools
- One twilight teacher training session each term (summer 2010 to summer 2011), based on seasonal tasks in the school garden
- Free access to a wide array of online teacher resources

On the other hand, the teacher-led interventions worked with the RHS by attending twilight training, to help them develop and use their gardens. This intervention did not receive help from the RHS regional advisor, except during twilight training, and the teachers were left to help the children on their own.

For Hutchinson 2015, the intervention methods were the same as above. There was an RHS-led intervention with all of the same aspects as Christian 2014, and there was a teacher-led intervention that was also the same.

The nutrition education program used for Koch 2006 was a program developed for children called *Health and Nutrition from the Garden* (Genzer et al., 2001). It was intended to teach the children

participating in the program healthy eating habits while working on a limited budget. The program consists of six concepts:

- Thrifty gardens
- Basic gardening
- Growing techniques
- ABC's of healthy eating
- Healthy snacks
- Food safety

Each concept is demonstrated with the use of six activities. Twelve activities from the *Health and Nutrition from the Garden* program were evaluated for this study. These 12 activities address issues including but not limited to:

- Fiber in the diet
- Budgeting
- Gardening
- Plant needs
- Healthy eating according to the food guide pyramid
- Label reading
- Storage methods

The research for this intervention took place from May through August of 2006.

The program design in Lautenschlager 2007 included a mixture of youth who had gardened with the Youth Farm and Market Project (YFMP) program the previous year and those who had not; but none had been exposed to the new, revised curriculum. According to Lautenschlager 2007, The YFMP is a "multi-cultural gardening enterprise that educates youth about environmental responsibility, empowerment,

and cultural expression through active involvement in the planting and harvesting of gardens… while fighting racism and poverty". The nutrition education portion of the program for Lautenschlager 2007 was taught by a nutrition educator and each week a new topic, like the food cycle and nutrients, was introduced and followed with an activity to continue the learning process. Also, a new gardening lesson was introduced each week, along with cooking curriculum, like kitchen skills and knife safety. The 10-week program (3 days per week) was voluntary, and therefore the youth experienced different amounts of exposure.

The garden activity guide, *Nutrition in the* Garden, in Lineberger 2000 was created to help teachers integrate nutrition education into the school's curriculum. The guide was divided into 10 units that incorporated horticulture and nutrition subjects. Within the 10 units, there were 34 activities, with each activity taking 20 minutes to complete. For this study, in particular, the teachers were required to introduce the activity guide into their curriculum and discuss the material in each of the 10 units, but they were able to choose any of the activities they wanted to complete. At the beginning of the study, 111 completed a pre-test questionnaire and journal before gardening, and a post-test questionnaire and journal after the gardening program were finished. Between the pre- and post-questionnaires, the *Nutrition in the Garden* activities were completed, and the students participated in gardening.

A quasi-experimental 10-week intervention was used for Morgan 2010. The intervention was divided into three groups: (1) nutrition education and garden, (2) nutrition education only, and (3) a control group. For the nutrition education portion of the intervention, three one-hour lessons were delivered to students by classroom teachers over the course of 10 weeks. Researchers looked at previous studies for curricula, and modified it to the Australian context and came up with a plan called "How do you grow?".

The following topics were used in the curriculum:

- What influences my health?
- Requirements of the body
- Requirements of plants
- Seed germination
- Nutrients
- Healthy eating
- Food labels
- Consumerism
- Lifestyle diseases
- Physical activity
- Exercising safely
- Setting goals

The activities for the program were incorporated into the primary curriculum of the schools, with the curriculum being delivered by the teachers, themselves. Three newsletters were provided to the parents during the intervention, teaching them the health benefits of eating fruit and vegetables and strategies to increase the intake of these foods at home. Besides the newsletters, parents were also asked to help with completing simple homework assignments with their children and helping them to work on a recipe to be included in a classroom recipe book.

The gardening portion of the intervention allows the children to spend 45 minutes, four times a week, planting in and tending to a school garden. The garden program was based on the Social Cognitive Theory because it is said that school-based nutrition programs that are based on a theoretical framework are more effective at changing the health behaviors of children (Contento 1995). The

gardening experiences of this intervention allowed students the opportunity to develop knowledge and skills of healthy eating, as well as enhancing their learning environment and surroundings.
Unlike the nutrition education and gardening intervention groups, the control group did not participate in any nutrition-related lessons, nor did this group get gardening experience. Instead, the control group just continued on with the normal school curriculum.

Just like Morgan's experiment, Parmer 2009 also took part in a quasi-intervention with three groups: (1) nutrition education and gardening (NE&G), (2) just nutrition education (NE), and (3) control group. There were two second-grade classes in each of the three groups, with a total of six classes. The treatment assignment was based on the interest of the teachers participating. This self-selection was a necessary component of this study, even though it may have caused bias. There were two existing curricula that were used for the treatment groups, *Pyramid Café* and *Health and Nutrition from the Garden.*
The students who participated in the gardening portion of the intervention planted both seeds and plants, from carrots to cabbage, and maintained a school garden. Students helped tend to obstacles, like rabbits and were able to create a salad in the end.

A 12-month intervention trial using a historical control was used for Somerset 2008. A garden-based teacher was employed to help the teachers incorporate garden activities into their curriculum. The classes in the school were responsible for planting, tending and harvesting in the garden. Along with a garden, an outdoor classroom was created, where the teachers could utilize their new curriculum.
A historical control design was employed in the intervention, in which students completed pre-intervention questionnaires, one month before the start of the intervention. The data collected from these questionnaires was used as a control for subsequent data collection.

4.4 Outcome measures

See tables 4, 5, and 6

In Christian 2014, the outcome measure was the mean change in fruit and vegetable intake between the two intervention groups, at baseline and post-intervention. The analysis was performed using clustered multilevel regression models. The students' diets were assessed using the Child and Diet Evaluation Tool (CADET) questionnaire, which uses age and gender specific food portion sizes to calculate daily food and nutrient intake. The CADET diary was split into two diaries: a School Food Diary and a Home Food Diary. The School Food Diary was completed by trained fieldworkers who observed the children during their meals at school. The Home Food Diary was completed by parents and checked by the fieldworker the next day, to complete any missing entries through the recall approach with the children.

The secondary outcome measures were the school gardening levels, as well as its association with the primary outcome, change in fruit and vegetable consumption. To find this measure, a gardening questionnaire was designed to identify the level of implementation and involvement of the schools in different interventions. The following scale is used to evaluate each school:

- Zero: no garden
- Level 1: planning
- Level 2: getting started
- Level 3: growing and diversifying
- Level 4: sharing best practice
- Level 5: celebrating with the wider community

To find a baseline, each school completed a telephone interview to assess their gardening level. The interview was completed again at follow-up to assess any change in the gardening level.

For Hutchinson 2015, the primary outcome is fruit and vegetable intake, measured by the School and Home Food Diary from the CADET tool, seen in Christian 2014. The CADET tool was completed the same way as stated above in Christian 2014.

The secondary outcomes, knowledge of and attitudes toward fruit and vegetables, were measured using a child questionnaire, developed specifically for this study. The questionnaire included questions on personal and environmental factors, perceived barriers, encouragement at home and knowledge of fruit and vegetables. The questionnaire was read out loud to the entire class by a trained university student, but the children completed it individually. For testing the children's knowledge of fruit and vegetables, the children were asked to draw a line from the name of 12 fruits and 16 vegetables, all of which can be grown and purchased in the United Kingdom, to the photo of each item. The children were also asked to answer how many servings of fruits and vegetables they thought they ate every day.

For fruit and vegetable attitude, children were given ten statements and asked to circle whether they (1) agreed on a lot, (2) agreed on a little, (3) disagreed a little or (4) disagreed a lot with the statements. The statements were again read out loud to the students to help with difficult wording and tareasked.

Examples of statements on the questionnaire include:

- "I'm good at preparing fruit and vegetables."
- "There's usually lots of fruit and vegetables to eat at home."
- "My family encourages me to eat fruit and vegetables."
- "I like trying new fruit."
- "I like trying new vegetables."

Koch 2006 had three segments of instrumentation used to evaluate the effect of a nutrition education program on nutritional knowledge, nutritional attitudes and eating behavior of children. The first segment was a written exam made up of eleven questions that contained a mix of true/false and

multiple choice. The questions pertained to the twelve different nutritional education activities. Each question was given a certain amount of points from 1-4 based on how difficult the question was, giving the exam a total of 18 possible points. The higher scores indicated higher retention and understanding of the information presented.

The second segment was a modified version of a fruit and vegetable preference questionnaire. The questionnaire measured the students' attitudes toward fruit and vegetables. The children rated their preference for fruits and vegetables on a scale of zero, for "I never tried it," to three, for "I like it a lot". The questionnaire was given a score on a scale of 0 to 60 so that the higher scores indicated greater fruit and vegetable preference and attitudes.

The third, and final, segment consisted of five interview questions pertaining to the following: questions one through four evaluated the children's knowledge of the twelve activities performed, and question five evaluated the children's eating habits by asking them about the type of snacks that they had the day before. A scoring rubric was created, where the children received one point for each correct answer given. The questionnaire was scored on a scale from 0 to 22, with the higher the score, the better the knowledge and behavior change.

A 24-hour recall, as well as a survey, were used in the Lautenschlager 2007 study to evaluate whether a school garden could change the eating or gardening behaviors of students. The 24-hour recalls were collected by trained researchers, and the students were asked to describe the foods that they ate the previous day. A 3-D food model was used to improve estimation of the food portions, and the food pyramid was used to reference the correct serving sizes for food groups.

Lautenschlager's survey included information obtained through six focus groups with inner-city youth, as well as a review of the literature. It focused on common themes, including gardening, dietary habits, social influences, nutrition knowledge, and cooking. The survey was comprised of 177 questions and

took 20-30 minutes to complete. Students were asked to choose from "strongly agree," "agree," "don't know," "disagree," and "strongly disagree." Lastly, the survey was self-administered to the students. They were asked to choose only one answer for each question, and research assistants helped the students to read and understand difficult questions. All of the surveys were checked and missed or multiple responses were corrected before the students left the sites.

Lineberger 2000 used a fruit and vegetable questionnaire to evaluate the nutritional attitudes of students. The questionnaire was comprised of three different sections. The first two sections had 17 and 13 questions on vegetables and fruit, respectively. The answers to these questions were associated with points including 2 being "I like this a lot," 1 being "I like this a little" and 0 being "I do not like this." The last section was comprised of 13 snack preference questions, where students had to decide between two different snacks, one being a fruit or vegetable and the other being a non-fruit or non-vegetable. Students received one point for the fruit or vegetable snack and zero points for the other snack. The students' scores were summed and averaged, with the higher score showing better fruit or vegetable attitude/preference.

Besides the questionnaire, students' eating behaviors were evaluated using a 24-hour recall journal. Students were asked to recall everything they had eaten the previous day, as well as how much of the items they consumed.

The primary outcome for Morgan 2010 was vegetable intake, with secondary outcomes being the vegetable preference, fruit and vegetable knowledge and quality of school life. The 24-hour recall was used for fruit and vegetable intake. There were two 24-hour recalls conducted as part of the pre- and post-intervention. The recalls were completed in three phases: (1) a quick list of what was eaten and drunk the previous day was given to the interviewer by the child; (2) the child was asked to provide

additional details on the items, like ingredients and portion sizes; and (3) the interviewer reviewed the list to see if there was an additional detail they needed. Besides a 24-hour recall, there were fruit and vegetable tasting days used to see if the children were eating the foods.

The taste testing days were also used to determine vegetable preference. Students completed the preference part of the study one-on-one with a trained research assistant to avoid influence from peers and teachers. The children were asked to identify six raw vegetables, give their willingness to taste, and their preference for each. Each question asked in the study was given a score. For the identification and willingness to taste section, students received one point for the correct answer or a positive response, for a total of 6 points. For the tasting section, students got a total of 5 points per vegetable, for a total of 30 points. Of the vegetables in the study, lettuce was chosen to be grown in the garden.

For the knowledge portion, a fruit and vegetable knowledge questionnaire was used. In the questionnaire, the children were asked about the health benefits of fruit and vegetables, as well as how they can increase their intake of fruit and vegetables. The questionnaire was completed in the classroom setting, by teachers.

To test the quality of school life, an instrument was used to collect information into students' attitudes toward school, learning, teachers and other students. The survey consisted of forty statements about school, and the children were asked to rate their level of agreement on a four-point scale. The survey was administered in a classroom setting by a teacher.

Parmer 2009 used three separate instruments to evaluate the effects of a school garden on children's fruit and vegetable knowledge, preference and consumption. The first instrument was a fruit and vegetable survey used to measure knowledge and preference of the students. For the knowledge portion, the survey assessed the placement of food in the food pyramid (6 questions), nutrient-food associations (5 questions), and nutrient-job associations (5 questions).

Another survey was used to measure fruit and vegetable preference. The survey consisted of 15 fruit and vegetables rated on a three-point scale, using smiley faces. A happy face meant "I like this a lot," a neutral face meant "I like this a little" and a sad face meant "I do not like this."

Besides the above preference survey, a "taste and rate" method was used. Students tasted different fruit and vegetables and were asked to rate them on a 5-point scale, ranging from "I hate this" to "I love this." Students completed this portion independently and in isolation to avoid peer pressure. Students had the ability to try five vegetables and one fruit: carrots, broccoli, spinach, zucchini, cabbage, and blueberries. The students were asked to answer three questions during the taste-tasting: (1) to identify the fruit or vegetables; (2) whether or not the participant would like to taste the item; and (3) how they rated their taste.

Finally, there was a lunchroom observation: students were given a choice of a school plate meal, with as many fruit and vegetables as the students wanted, and a grab-and-go lunch that had bagged carrots and a whole piece of fruit as sides. All of the students were observed for 2 lunch meals each at pre- and post-intervention. The investigators examined three variables: (1) what type of , was chosen; (2) what vegetable items were chosen by the students; and (3) whether the students ate the chosen vegetables.

Two questionnaires were used in Somerset 2008 to determine if school gardens could influence a child's ability to identify specific fruits and vegetables, as well as determining if their attitudes could affect long-term consumption of these healthy foods. The first, an attitude questionnaire, involved 38 questions that required one of three answers: "yes," "no" and "sort of." The second questionnaire, a fruit and vegetable identification survey, involved one-word answers for 31 items of different fruits and vegetables. The surveys were evaluated by a trained teacher for content validity.

4.5 Effects of intervention

See table 4

Primary Outcome:

CHANGES IN FRUIT AND VEGETABLE INTAKE

For both of the intervention groups, teacher-led and RHS-led, in Christian 2014, there was a small but statistically non-significant decrease in fruit intake (in grams) after adjusting for possible confounders (RHS-led: -8g, Teacher-led: -20g). There were also no significant differences in vegetable consumption for either model (Teacher-led: 29g, RHS-led: 16g). However, for the combined fruit and vegetable intake, there was a significant difference in the unadjusted model with the teacher-led group having a small increase (mean=8g) and the RHS-led group consuming less (mean=32g). On the other hand, the adjusted model, one that adjusted for possible confounders, was not statistically significant (-40g).

The fruit and vegetable intake of children in Lineberger 2000 showed no significant differences in pre- and post-test scores. The mean of the total fruit and vegetable consumption of the students was 2 servings, which is below the national average of 3.4 servings (Foerster et al., 1998). Only 10.8% of the students who participated in the program ate five or more fruit and vegetable servings a day.

NUTRITIONAL KNOWLEDGE

In Koch 2006, there was a significant difference found between the pre-test, mid-test, and post-test. The most improvement was made between the pre-test and the post-test with 3.69 points. It was found that each age level and gender significantly improved their scores ." the course of the intervention to show that the *Health and Nutrition in the Garden* curriculum works for children of all ages, as well as males and females.

For the interview portion of Koch 2006, question one was the only one with a significant difference of 1.3 points between the pre-, mid- and post-tests. For this question, students were asked to place

different food items into their correct categories on the food pyramid. Also, question five asked about healthy snacks and more students reported eating a healthy snack the previous day, on the post-test, than those who answered this question on the pre-test.

From pre- to post-test, the students of the Parmer 2009 study experienced an increase in their food group knowledge. For nutrient-food association, the treatment groups experienced a significant main effect, as well as a significant interaction. They experienced significantly greater improvement gains in nutrient-food association knowledge than the control group. For nutrient job-association, looking at the purposes of different nutrients, paired t-tests showed that both treatment groups had significantly greater improvement gains over the control group. For fruit and vegetable identification, the paired t-tests showed that both treatment groups had significantly greater improvement gains.

For Somerset 2008, there were significant improvements in the identification of the following fruits and vegetables: capsicum, potato, cucumber, aubergine, shallot, chili, garlic, onion, beetroot, avocado, radish, grape, courgette, coconut, starfruit, cherry, peach, mandarin, watermelon, and kiwi.

INTENT TO CHANGE BEHAVIORS

For Lautenschlager 2007, the results were separated between boys, girls, and all youth. For the boys, the pre-test found that subjective norm and attitude were significantly correlated with intention to change behaviors in eating. However, for the post-survey, it was found that subjective norms, attitudes, and perceived behavioral control (PBC) were all significantly correlated with intent to change behaviors. For the pre-survey, the attitude was the most predictive variable, while none of the variables predicted behavior for the post-survey.

Unlike the boys' data, the girls' pre-survey data showed a significant associated between intention and behavior. For the girls' pre-survey, the variables included subjective norms and attitude, while their post-survey included PBC and no association between behavior and intention.

As for all of the youth, results showed no significant differences for boys between the pre- and post-survey, but trends were found: (1) boys who intended to plant and weed the garden on the pre-survey followed through with it; and (2) boys who intended to help in their family gardens did not. On the other hand, significant differences were seen in seven variables for the girls.

Secondary Outcome:

SCHOOL GARDENING LEVELS

At baseline, for Christian 2014, fifty percent of the schools were only at a level 1: planning. However, at follow-up, sixty percent of the schools reported being at a level 3: growing and diversifying. The mean garden level for the RHS-led group at intervention was 2.7 compared to a 1.9 for the teacher-led group. Using multilevel regression analysis, scientists were able to determine that the difference between the mean garden levels of the two groups was not significant.

COMBINATION OF GARDEN LEVEL AND FRUIT/VEGETABLE INTAKE

For Christian 2014, multilevel analysis was used to see if a change in the garden level, from baseline to follow-up, was associated with changes in fruit and vegetable consumption. An increase in one gardening level showed little change in intake, while a change in two levels showed improvement in the children's fruit and vegetable intake by 37 grams, after adjusting for confounders. However, only a change in three garden levels showed a statistically significant difference. Children from schools that increase three garden levels showed an increase in fruit and vegetable consumption by 81 grams.

FRUIT AND VEGETABLE INTAKE

For the lunchroom observations of Parmer 2009, it was found that the NE&G group was more willing to choose vegetables in the school lunch during the post-test, compared to the pre-test than the NE and control groups. Also, the control group ate significantly fewer vegetables at the post-test compared to the pre-test, while the NE&G group ate significantly more vegetables. On the other hand, the NE group had no significant changes in their consumption.

KNOWLEDGE OF FRUIT AND VEGETABLES

In Hutchinson 2015, it was found that there were no significant differences between the RHS-led and teacher-led interventions in children's knowledge that five servings of fruit and vegetables should be eaten each day. In both intervention groups, 80% or more of children were able to recognize all of the fruit, except for blueberries and nectarines, in which 70% or more of children identified them. Sweet-corn, carrots, peppers and tomatoes were recognized by over 90% of the children in both intervention groups, while less than 50% of children were able to identify spinach, parsley, leeks and spring onions. When comparing total fruit recognized from baseline to follow-up, there was no significant difference between the intervention groups. However, the increase in vegetable recognition from baseline to follow-up was significantly smaller for teacher-led than RHS-led intervention. This was statistically significant only after adjustment, and this may be due to the significant difference at baseline.

For fruit and vegetable knowledge of Morgan 2010, there was a significant difference between the NE&G group and control groups, but only when comparing the students who started with lower fruit and vegetable knowledge. Similarly, the NE&G group improved significantly in their ability to identify vegetables when compared to the other two groups.

ATTITUDE TOWARDS FRUIT AND VEGETABLES

In Hutchinson 2015, over 85% of the children, from baseline to follow-up, agreed that eating fruit and vegetables every day will keep them healthy. It was also found that their families encouraged them to eat healthy by having a fruit and vegetables readily available in the home. Over 90% of children agreed that they enjoyed eating fruits, whereas only 67% of them enjoyed eating vegetables. On the other hand, children in the RHS-led intervention group were less likely to agree that they tried new fruits than the teacher-led group. Also, children in the RHS-led group were less likely to agree that there were plenty of fruit and vegetables at home than the teacher-led group, which was only statistically significant in the adjusted model. However, there were no significant differences relating to vegetables.

For Koch 2006, the fruit and vegetable preference scores of children did not significantly improve during or after participating in the program. However, the scores were high during the pre-, mid- and post-test indicating that students already had positive attitudes towards fruit and vegetables. Food consumption and preference are correlated, so this was a promising find.

For Lineberger 2000, significant differences were found in the vegetable preference scores before and after the program. Effect size calculations show that 47.6% of the change in vegetable preference scores were due to gardening. On the other hand, fruit preference score did not significantly improve after the program. Both the pre- and post-test scores were high for fruit preference showing that the students already had positive attitudes toward fruit. Finally, there were statistically significant increases in snack preference scores of children after participating in the program. The effect size calculations show that 37.7% of that change was due to gardening. Differences were also found between grade levels, with third-grade students having a greater increase in their snack preference scores than the fifth graders. This could show that younger students are more open to new ideas, as well as experiences.

For Morgan 2010, it was found at post-test that students in the NE&G group, as well as the NE group, were significantly more willing to taste vegetables and rate the tastes more highly than the students in the control group. For the preference portion of the study, there were significant differences between the groups. The NE&G and NE groups rated the taste of lettuce and peas more highly than the control group, while NE&G students rated pea more highly than NE only and rated tomatoes more highly than the control group. For the willingness to taste portion, the NE&G group was significantly more willing to taste capsicum, broccoli, tomato, and pea than the NE and control groups.

According to the data for Parmer 2009, the participants in the two treatment groups had a greater willingness to try fruits and vegetables than the control group. Also, over the duration of the study, the participants in all of the groups became more willing to try the items. The willingness to try was not dependent on the group. For the participants who did taste the fruits and vegetables, the treatment groups rated the fruits and vegetables significantly better tasting than the control groups.
For the preference questionnaire, the results were as follows: NE&G and NE groups had a greater increase in taste rating for carrots, broccoli, zucchini and cabbage than the control group; the NE&G group showed greater change than the NE group; NE&G gave higher taste ratings for spinach from pre- to post-test than either group. However, neither fruit nor vegetable preference indicated any significant differences between the groups.

For Somerset 2008, there was a shift toward more children in the seventh-grade rating fruit as tasting bad. However, even though it was not statistically significant, there were more children who agreed to vegetables tasting good following the intervention. For grades, 4, 5 and 6, more students said that they liked to eat vegetables every day, while fewer students in grade 7 did. Grades 5 and 6 showed slightly

higher post-intervention responses to wanting to taste fruit and vegetables in class, but grades 4 and 7 showed lower post-intervention responses.

Table 4: Summary of studies: Christian, Hutchinson, and Koch

	Christian	Hutchinson	Koch
Participant Number	641	1256	56 (who completed all 3 surveys out of 135)
Ages	Mean age of 8.1 years	7-10 years	2nd-5th grade
Setting	London boroughs	London boroughs	Counties in Texas
Study Type	1st cluster randomized controlled trial (RCT)	Cluster RCT	Experimental
Study Length	18 months	18 months	1 week (summer camp format or every morning) to 12 weeks (once per week) program
Looking At	FV intake; delivery of intervention	Knowledge and attitude	Knowledge of benefits of FV, attitude toward FV and consumption
Evaluation Method	CADET (uses age and gender specific food portion sizes to calculate daily food and nutrient intake) split into home food diary (completed by the parents)and school food diary (completed by fieldworkers), and questionnaire to identify the level of implementation and involvement of the schools in the different interventions	Child questionnaire (read out loud) for attitudes; recognition of FV in photos	Pre-, mid- and post-test 11-question MC exam based on educational activities performed (knowledge), FV preference questionnaire (attitude), interview question asking what they had as a snack that day (consumption)
Outcomes	A small decrease in fruit intake, no change in vegetable consumption, and teacher-led group consumed more fruit and vegetables combined. Positive change in garden level.	No significant differences in fruit and vegetable knowledge between intervention groups. The RHS-led intervention group had a lower attitude toward fruit and vegetables.	Each age level and gender significantly improved their scores on post-test. No change in preference scores. Scores were already high.

Table 4 continued: Summary of studies: Lautenschlager, Lineberger, and Morgan

	Lautenschlager	Lineberger	Morgan
Participant Number	96 (pre-survey) and 66 (post-survey)	111	127
Ages	8-14 years	3rd and 5th grade	5th and 6th (11-12 yrs. old)
Setting	Minneapolis/ St. Paul, MN	5 elementary schools in Texas	Australia
Study Type	Experimental	Experimental	Quasi-experimental (NE&G, NE only, and control)
Study Length	10-week program	1 year (spring of '98 to spring of '99)	10 weeks (baseline and 4-month follow-up)
Looking At	Youths eating and gardening behavior using the Theory of Planned Behavior	Attitude and nutritional behavior	FV consumption, V preference, FV knowledge and quality of school life
Evaluation Method	FV consumption assessed with survey questions and 24-h recall. Assessing theory constructs with pre- and post-survey	FV preference questionnaire and 24-h recall journals	24-h recall (consumption), taste and rate methods (V preference), questionnaire (FV knowledge), survey about school life
Outcomes	Association between intention, attitudes and perceived behavioral control.	No significant differences in fruit and vegetable consumption. Significant differences found in vegetable preference. Fruit preference score did not significantly improve. Statistically significant increases in snack preference.	Significant differences between NE&G and control groups for fruit and vegetable knowledge. NE&G improved significantly when identifying vegetables. Increase in preference for vegetables.

Table 4 continued: Summary of studies: Parmer, and Somerset

	Parmer	Somerset
Participant Number	115	152
Ages	2nd grade	4th to 7th grade (8-13)
Setting	SE United States	Australia
Study Type	Quasi-experimental	Intervention trial using a historical control (students completed questionnaires prior)
Study Length	28 weeks	12-months
Looking At	FV knowledge, preference and consumption	Identify FV, FV attitude
Evaluation Method	Self-report questionnaires, interview-style taste and rate, lunchroom observations	Attitudes questionnaire and a VF identification survey
Outcomes	Increase in food group knowledge. Increase in nutrient-food association knowledge. NE&G more willing to choose vegetables. Two treatment groups had greater willingness to try fruit and vegetables than control group.	Significant improvement in identification of fruit and vegetables. Increase in good rate for taste of vegetables.

4.6 Confounders

To lessen the misrepresentation of the effect of school gardens on children's knowledge of, preference for, attitude of and consumption of fruit and vegetables, most of the studies controlled for certain confounding factors. In both the Christian, 2014 and Hutchinson, 2015 studies the following variables were found to be confounders and the data was adjusted accordingly: gender, ethnicity, and index of multiple deprivation score (IMDS). An IMDS uses a child's postcode to make a deprivation score based on the area's income, employment, health, education, crime, access to services and living environment. Since some children did not provide their postcode's, this had to be adjusted. Unlike Hutchinson, 2015, Christian, 2014 also used age as a confounder. There were significant differences found for gender, but not the others.

For Koch, 2006 analyses were done to see if there were any differences among age level, gender, ethnicity, or county level, but no statistically significant differences were found.

In Lautenschlager, 2007, the only confounder was gender, because there were no differences found among ethnicities. However, the differences among gender were not statistically significant.

Lineberger, 2000 had grade level and gender as confounders. These factors were controlled for.

Morgan, 2010 used the analysis of covariance (ANCOVA) during its data step because it allows for existing differences between groups at baseline to be controlled for in the final analysis. There were no specific confounders mentioned in this study.

For Parmer, 2009, confounded for gender only, because there were far lower females than males in the study, but there were no differences in the results.

And lastly, Somerset, 2008, used chi-square analysis and frequency distributions to find the significant differences between the control and intervention groups to find out if there was anything needed to control. There were no specific confounders mentioned.

4.7 Study Strengths and Limitations

The limitations of Christian, 2014 was the study design where the lack of comparison group received no intervention. Also, the difficulties in delivery of the intervention and a lack of consistency of delivery may have caused problems with the analysis of the study. A final limitation of the study was the small sample size. Small sample sizes reduce the power to detect a statistical difference between intervention and control groups. A strength of this study is that it is the first cluster RCT to evaluate the effectiveness of a school gardening intervention on children's diets.

Strengths of Hutchinson, 2015 include the large sample size, the randomization of schools to the different intervention groups, reducing selection bias, and the use of schools as a random effect variable. Limitations of this study were children guessing the correct answer, the lack of a non-gardening comparison group in this trial, and the high dropout rate of students.

Limitations of Lautenschlager, 2007 included samples of children who already gardened, and the study did not include a control group because of program constraints.

A strength of Morgan, 2010 was that it was one of the first studies to evaluate the impact of nutrition education with and without a school garden which has also used a concurrent control group. Limitations of this study include that this trial was not a randomized controlled trial, the results were not generalizable, the study was restricted to only two schools, and dietary intake was measured using 24-hour recall.

Limitations of Parmer, 2009 include a low number of female participants, a lack of a randomized, controlled trial, a predominantly white sample, and a small sample size.

Finally, limitations of Somerset, 2008 include a difficulty in defining the precise nature of the intervention, a small sample size restricted to one school and 24-hour recall for dietary intake. A strength of this study includes a historical control, rather than a control from another school.

Chapter 5

Discussion and Conclusion

5.1 Discussion of the Research Question

The purpose of this study was to answer two questions: (1) how intensely evaluated are school gardens and (2) how effective are the evaluation tools. As the review of the different studies show, school gardens are not heavily evaluated. There are a small amount of studies that have looked at school gardens and these studies only seem to cover a few months to a year of evaluation. The studies could be more intensely evaluated through longer periods of study and the use of more evaluation tools.

The evaluation tools used in the studies reviewed included 24-hour recall, lunchroom observations, questionnaires/surveys, and taste tests. Some of the tools used had bias that interfered with the results, stated in the limitations of the studies. For instance, the 24-hour recall evaluation tool can be deemed as

ineffective if its recall bias is extremely high (Freedman et al. 2017). According to the National Cancer Institute, “because a single administration of a 24-hour recall is unable to account for day-to-day variation, two or more non-consecutive recalls are required to estimate usual dietary intake distributions. Also, the requirements of completing a 24-hour recall may limit participation in some groups, leading to potential selection bias”. Some of the studies accounted for selection bias, by making sure that students were asked a multitude of questions to gain all of the details possible from the 24-hour recall.

One 24-recall evaluation tool found to be effective, was the use of the Child and Diet Evaluation Tool (CADET). The CADET can be found in Christian, 2014 and Hutchinson, 2015. According to Christian et al., the two food diaries provide high-quality nutrient data suitable for evaluating intervention studies for children aged 3-11 years with a focus on fruit and vegetable intake. Also, the use of an interviewer and parents to complete the diaries make it even more useful. CADET is the only tool recommended by the National Obesity Observatory that has been validated in the U.K. population and provides nutrient level data on children’s diets (Christian 2015).

Besides 24-hour recall, there were multiple questionnaires used in each of the studies. Some questionnaires were survey-based while others were questions based on knowledge and the matching of pictures. The recognition of fruit and vegetables in photos is an effective evaluation tool, like in Hutchinson 2015 and Somerset 2008, because it allows the students to look at pictures and recognizes the foods that they may have learned about in the classroom or grown in the garden. Students are more apt to learn through pictures than through text (Carney and Levin 2002). As students are learning about fruit and vegetables, they see pictures, and therefore this is a good recognition tool (Reynolds-Keefer and Johnson 2011).

Another effective tool is the multiple choice questionnaire for knowledge used in Koch, 2006. This tool asked specific questions, from food storage to the most important meal of the day, which would judge

the knowledge that students had previously learned in the program about fruit and vegetables. Some questions were extensive and required thought. It is questions like these that challenge the minds of students. Another effective questionnaire was given by Somerset, 2008, where students had to answer 38 items based on their attitudes of fruit and vegetables. The multitude of questions in this survey allowed for the students to be specific on their attitudes and to judge how they felt about fruit and vegetable pre- and post-intervention.

Although some of the questionnaires seemed to be more effective than others, most of the studies seemed to be effective in evaluating the use of school gardens. Out of the 2 studies looking at the change in fruit and vegetable intake, both found that the students were more willing to choose fruit and vegetables, but one study found a decrease in fruit consumption. Out of the 6 studies looking at nutritional education, 5 of them found an increase in fruit and vegetable identification. Out of the 6 studies that looked at the preference for/attitude toward fruit and vegetables, all of them showed increases in positive attitudes and willingness to try different fruit and vegetables.

5.2 Study Strengths and Limitations

One limitation of this review is the small study sample. Even though school gardens have been around since World War I, researchers have only recently begun to evaluate the programs. There have not been many studies done on school gardens, let alone relating to the criteria of this systematic review. It is important for school garden programs to be evaluated, in order to see how important they are for the children who partake in the studies. Also, the small sample limits the ability to draw conclusions from the cases given, and is not representative of the entire school garden population. Another limitation is that some of the studies are older than ten years and the studies were completed in a multitude of different places. Finally, the studies varied in the amount of participants that they had and therefore the conclusions are hard to compare to one another. Some studies believed that they had large sample sizes

when they had 100 participants and some believed they had small sample sizes when they had 500 participants. Therefore, the studies are not comparable, nor are they representative of the entire population.

A strength of this review is that it is one of the first studies to look at the effectiveness of evaluation techniques of school gardens. Most reviews look at a multitude of studies and determine how effective the school gardens, themselves, are but none have looked into evaluating the techniques as whole and seeing how effective they are for the school garden programs. This will allow for more studies to see that it is important to look into the effectiveness of the evaluation tools before using them.

5.3 Conclusion

All of the eight papers reviewed showed a positive change in children's health and behaviors as a result of having access to a school gardening and getting additional nutritional education. Three papers showed no change in the consumption of fruit and vegetables, while four papers found significant increases in preference for fruit and vegetables. Also, one paper showed no significant differences in fruit and vegetable knowledge, while four papers showed significant improvement. All eight of the studies used surveys in some way, one study used a food diary, three studies focused on 24-hour recall, and one looked at lunchroom observations to evaluate the study. The CADET tool, used in 2 of the studies, was found to be an effective tool in measuring fruit and vegetable intake for children 3-11 years.

After reviewing all eight of these studies, it is concluded that school gardens are not intensely evaluated. Also, some tools, like the CADET and surveys with the use of pictures, are found to be more effective than others. Researchers need to put more time into studies of school gardens, as well as more research into what evaluation tools are most effective for these types of evaluations.

5.4 Recommendations for Research

More funding should be given to organizations to study the effects of school gardens and more funding should be given to schools to make gardens. The studies are important when looking and discussing how to improve current childhood health. With the use of school gardens, children can be taught how important fruit and vegetables are for their bodies, how they can grow them in their homes, and how easy it is to prepare healthy snacks with the foods that they grow. With this information and change in diet, diseases like childhood obesity, diabetes, and heart disease can be lowered from years to come. What children learn as adolescents is carried into adulthood. Also, more research should be done to look at the effects of school gardens on childhood obesity and weight status of students. As children eat healthier, it would be interesting to see how their weight and obesity status changes over the course of a year or multiple years.

Chapter 6

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