Abstract

Background: Although there are numerous health benefits associated with eating fruit and vegetables (FV), few children are consuming recommended amounts. Gardening interventions have been implemented in various settings in an effort to increase FV consumption of children by expanding knowledge, exposure, and preferences for a variety of FV.

Objective: The purpose of this review was to identify the effectiveness of gardening interventions that have been implemented to increase FV consumption among children.

Methods: A systematic review was conducted using four electronic databases: Web of Science, PubMed, Scopus, and CINAHL. English language studies conducted in developed countries between January 2005 and October 2015 were included in this review. Included studies measured FV consumption of children ages 2-15 years old before and after implementation of a gardening intervention in a school, community, or after school setting. All study designs were included in this review. A total of 891 articles were identified through database searching and cross-referencing. After removing duplicates, 650 articles remained and were screened using inclusion and exclusion criteria. Twenty-seven full text articles were analyzed and 14 articles were included in this review.

Results: Of the 14 articles reviewed, 10 articles found statistically significant increases in fruit or vegetable consumption among participants after implementation of a gardening intervention. However, many studies were limited by the use of convenience samples, small sample sizes, and self-reported measurements of FV consumption.

Conclusions: Although the evidence is mixed and fraught with limitations, most studies suggest a small but positive impact of gardening interventions on children's FV intake. Future studies

that include control groups, randomized designs, and assessments of FV consumption over at least one year are needed to advance the literature on this topic.

Introduction

Diets rich in fruits and vegetables (FV) have been associated with obesity and chronic disease prevention as well as improved overall health status among adults [1-6] due to the high amounts of fiber and phytonutrients founds in FV.[7-8] Despite the long-term benefits associated with consuming adequate FV, less than half of children in the United States are meeting the recommended intakes provided by the Dietary Guidelines for Americans.[9] Development of healthy eating behaviors during childhood has been associated with healthy food choices into late adulthood, therefore it may be important for children to consume a variety of FV at a young age.[10] Numerous public health programs and policies have been implemented to increase FV intake among children in effort to improve lifelong healthy eating habits and therefore reduce their risk of developing chronic disease.

Gardening-based programs have been implemented in school and community settings as a way to increase consumption of FV in children.[11-15] However, most studies to date have measured determinants of dietary behaviors such as knowledge, attitudes, and preferences for FV as opposed to changes in dietary intake.[12, 14-17] A systematic review of 11 studies investigating garden-based intervention programs in children found that only four studies assessed FV intake while the majority of studies investigated other factors such as knowledge, preferences, beliefs and values, and willingness to taste FV.[18] Authors of this review concluded that gardening interventions increase willingness to try FV among young children and increase preferences for FV among children whose preferences for FV had previously been low.[18] Although these factors are important determinants of FV consumption, assessment of nutritional intake through 24-hour recalls, Food Frequency Questionnaires (FFQ) and objective measurement tools such as blood

and skin carotenoid levels, more accurately assess FV intake among this age group.[19,20] Gardening interventions may be an effective strategy for increasing FV intake by teaching school-aged children how to plant, grow, harvest, and prepare FV.[18] Furthermore, encouraging children to regularly participate in gardening activities is consistent with the literature which suggests that regular exposure to FV increases consumption among this age group.[21,22]

Increasing the consumption of FV among children has the potential to reduce the risk of chronic disease and has been found to improve long-term health outcomes. There is a need to investigate the current peer-reviewed literature to determine if gardening interventions improve dietary intake of children. The primary purpose of this review was to identify the effectiveness of gardening interventions that have been implemented to improve FV consumption among children ages 2-15 years old in school, community, and afterschool settings. This review focuses on studies that assessed FV consumption. It augments previous systematic reviews[18] and meta-analysis[23] that primarily examined changes in FV knowledge, preferences, and attitudes.

Methods

Search Strategy

A systematic review of published literature on 14 studies investigating FV consumption among children receiving gardening interventions was conducted based on protocols established for reviews through Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[24] The databases Web of Science, PubMed, Scopus, and CINAHL were searched for MeSH terms and terms found in titles and abstracts of applicable studies. In addition, the following keywords were searched individually and in various combinations: youth, children, child, gardening, fruit

and vegetable, fruit, vegetable, nutrition, school, consumption, and intervention. Search strategies used for each database are listed in Table 1.

Study Selection

Studies meeting the following criteria were included: published in the English language between January 1 2005 and October 31 2015, conducted in developed countries, utilized gardening interventions, targeted children ages 2-18 years old, and measured FV consumption. For the purpose of this review, gardening-based interventions were defined as any gardening-related programming through outside gardens, micro-farms, container gardens or other alternative gardening methods that allowed children to receive hands-on experience with planting, growing, and harvesting FV. Excluding studies from less developed countries ensured a more homogeneous sample. Interventions could include any garden-related school-based, after school, or community-based program. Due to the relatively small number of available studies, all study designs were included in this review. Studies in which actual FV consumption was not measured before and after the intervention, or for which FV consumption was assessed using a single question were excluded. Studies investigating only knowledge, attitudes, beliefs, intentions, preferences, or other determinants of FV consumption or that implemented programs outside the target population were excluded. Multicomponent interventions were excluded if the gardening component was not discussed and evaluated in detail. Qualitative studies and studies that were not published in peer-reviewed journals or that were published only as an abstract from a conference proceeding and not a full paper were also excluded.

Data Extraction

One author independently reviewed all of the papers identified using the selection criteria as outline above using a standardized data extraction form. The data extracted from each study can be found in Table 2.

Methodological Quality Assessment

The Effective Public Health Practice Project (EPHPP) Quality Assessment Tool was used to assess the quality of each study included in this review.[25,26] This tool was used to rate individual studies on a variety of components including selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity, and analysis. Each component was rated numerically as strong (score=1), moderate (score=2) or weak (score=3) in the global rating system.[25,26] A strong paper (score=1) had no weak ratings, moderate papers (score=2) had one weak rating, and weak papers (score=3) had two or more weak ratings.[25,26] Two reviewers independently evaluated the 14 studies using the EPHPP Quality Assessment Tool. A final study quality was determined when two reviewers compared study component ratings and agreed on a final decision.[25,26]

Results

Study Selection

A total of 887 abstracts were identified in the databases using MeSH terms and keywords with an additional 4 articles identified from searching reference lists. Of these, 241 articles were duplicates resulting in a screening of 650 titles and abstracts. An additional 623 articles were excluded after screening for eligibility. Of the 27 remaining full text articles reviewed, 13 were

eliminated as a result of the inclusion and exclusion criteria listed above. The process by which studies were included in this review can be found in Figure 1.

Study characteristics

The reviewed studies were conducted in four developed countries: United States,[27-36] United Kingdom,[37,38] Australia,[39] and Canada.[40] U.S. based studies were conducted in various regions including those in warmer and cooler climates. Although search criteria included children ages 2-18 years old, the studies included in this review only provided gardening interventions to children ages 2-15 years old, with the majority of programs (86%) primarily targeting elementary aged children.[27,28,31,32,33,34,35,36,37,38,39,40]

Duration of gardening interventions ranged from 10 weeks to 18 months with most interventions lasting between 10-16 weeks. Nine of the studies were conducted in the school setting, utilizing classroom time and school curricula for program implementation.[32-40] In the remaining five studies, gardening programs were implemented in community, afterschool, and childcare settings.[27-31] Sample sizes in the reviewed studies ranged between 77-641 children with the majority of sample sizes between 100-300 children. The gardening interventions typically included the opportunity for children to plant, water, weed, harvest, and taste an assortment of FV. Several curricula were used in the studies included in this review with two studies that used the LA Sprouts curriculum.[29,30]

The identified studies used a variety of experimental designs. Ten of the 14 studies included in this review used a design that included a control or comparison group[27-29, 32-35, 37-39] and the other four studies conducted a pretest-posttest design [30,31,36,40] Convenience samples were commonly used, however, three studies[28,29,37] did randomize either the children or the schools in

the study. Only three studies followed students for a year or longer to evaluate long-term effects of the intervention.[35,37,40] FV consumption was operationalized in three ways: amounts, frequency, and variety of consumption. Diverse evaluation tools and techniques were used with a wide range in validity, reliability, and rigor. Evaluation tools used to determine changes in FV consumption included 24 hour dietary recalls,[31,32,39] food diaries,[35] the Block Kids Food Screener,[27,28,33] structured dietary observation,[29,34] Child and Diet Evaluation Tool,[37] Day in the Life Questionnaire,[38] and the Garden Vegetable Frequency Questionnaire.[36] Select studies also used instruments that had not been previously validated.[30,40]

Study Quality

Based on the EPHPP Quality Assessment Tool criteria, one study was considered strong[28], one study was considered moderate[38], and 12 studies were considered weak.[27,29-37,39-40] The most common study limitations were selection bias and external validity as a result of the use of convenience samples and small sample sizes, respectively. Among the individual studies, eight studies[27,28,31,32,36-38] used validated measurement tools and four studies reported reliability.[27,28,37,38] In the four studies that were randomized,[28,29,33,37] the nature of the intervention did not allow for blinding of participants or researchers. Twelve studies in this review[27,28,30-33,35,36-40] relied on self-reported measurements of FV consumption.

Randomized Controlled Trials

None of the three randomized controlled trials found statistically significant changes in FV consumption after children participated in gardening interventions.[28,29,37] Gatto & colleagues found that FV consumption did not significantly increase among children (3rd-5th graders) in the

intervention group (n=172), however, dietary fiber consumption increased by 0.4g/day among the intervention group as compared to a decrease of 2.0g/day among the control group (P=0.04, n=147).[28] In the study by Namenek Brouwer & Neelon, children (3-5 years old) in the intervention group (n=38) consumed a mean increase of 0.25 servings of vegetables per day as compared to mean decrease of -0.18 servings per day in the control group (n=38).[29] However, this paper did not include any significance testing so it is unclear if this finding is statistically significant or not.[29] Christian & colleagues found no significant changes in fruit or vegetable consumption among children (7-11 years old) in either the Royal Horticulture Society-led group (n=312) or the Teacher-led group (n=329), two intervention groups that received varying degrees of assistance with implementing school based gardening interventions.[37] When FV were combined in an unadjusted model, children in the Teacher-led group consumed significantly more FV (P=0.05) after the intervention as compared to the Royal Horticultural Society-led group.[37] However, significance was not maintained after adjusting for confounders such as age, gender, and ethnicity (P=0.06).[37]

Nonequivalent Groups Design Studies

Six studies in the sample used non-randomized intervention and control groups.[32-34,36,38,39] Four of these found increased intakes of either fruit or vegetables in the gardening intervention group.[32,34,36,38] McAleese & Rankin found a significant increase in fruit (P<0.001) and vegetable (P<0.001) consumption among children (6th graders) in the nutrition education and gardening group (n=45) with fruit increasing by 1.13 servings per day and vegetables increasing by 1.44 servings per day.[32] FV consumption did not significantly change in the control (n=25) or nutrition education only group (n=25).[32] Duncan & colleagues also found a significant increase

(P=0.01) in FV consumption among children (1st-5th graders) in the intervention group (n=46, mean±SD=1.4±1.5 portions per day) while no significant change (P>0.1) was found in the control group (n=31).[38] Parmer & colleagues determined vegetable consumption by visual inspections of plates before and after lunchtime at the pre and post assessment.[34] Consumption of vegetables significantly increased among the gardening and nutrition education group (n=39, 2nd graders) (P<0.01) from pre to post assessment.[34] No changes were found in the nutrition education only group and the control group ate significantly fewer vegetables at the post assessment (P<0.001).[34] Ratcliffe & colleagues found that although the variety of vegetables consumed during the school day significantly increased (P<0.01) when comparing the intervention group (n=170, 11-13 year olds) to the control group (n=150, 11-13 year olds), vegetable consumption at home did not significantly change (P=0.12).[36]

Two of the nonequivalent groups design studies found no significant change in FV consumption.[33,39] Morgan & colleagues found no significant difference in fruit (P=0.23) or vegetable (P=0.22) consumption in children (5th-6th graders) in either of the treatment groups or the control group over the intervention period.[39] Similarly, Meinen and colleagues did not find a significant change in FV consumption from pretest to posttest in either the intervention or control group among older children (n=801; 3rd-7th graders) who completed their own surveys.[33] The intervention group did see a significant increase in fruit (P<0.01) and vegetable (P<0.05) consumption as reported by parents of younger children (n=995, 2nd graders and younger).[33]

Pretest Posttest Studies

There were three studies that used a pretest posttest study design to compared FV consumption before and after receiving a gardening intervention.[27,30,31] Two studies found

significant increases in FV consumption.[30,31] Castro & colleagues found the average number of FV significantly (P<0.001) increased among children (n=120, 2-5 years old) after participating in Growing Healthy Kids Program (n=120) with fruits increasing by 28% and vegetables increasing by 33% each day.[30] Lautenschlager & Smith found a significant increase in fruit (P=0.029) and vegetable (P=0.007) consumption among boys (n=42, 8-15 years old) after participating in the gardening intervention.[31] Fruit (P=0.253) and vegetables (P=0.682) consumption did not significantly increase among girls (n=54, 8-15 years old).[31] However, girls in this study had higher intakes of FV at baseline as compared to boys.[31]

One study that used a pretest-posttest study design did not find a significant increase in FV consumption.[27] Davis & colleagues found that dietary fiber intake increased by 22% in the intervention group (n=34) compared to a 12% decrease in the control group (P=0.04, n=70) from pre to post intervention.[27] However, similar to the study conducted by Gatto & colleagues, FV consumption did not significantly change among either group so it is unlikely that the higher fiber intake resulted from increased FV consumption.[27,28]

Prospective Cohort Studies

Only two studies followed gardening intervention cohorts over time to determine long-term changes in FV consumption.[35,40] Hanbazaza & colleagues asked children (n=116, 1st-6th graders) at baseline, 7-month follow-up, and 18-month follow-up if they consumed certain vegetables at home during each data collection using yes/no questions.[40] There were no significant changes in the consumption of fruit or vegetables reported at any time point.[40] However, this study did not directly measure FV consumption. Wang & colleagues found that children (n=327, 4th-5th graders) with the greatest exposure to the intervention (gardening classes,

cooking classes, improved school meals and dining, and gardening/cooking lesson) increased FV consumption by roughly 0.5 cups/day while children with little to no intervention decreased FV consumption by 0.3 cups/day.[35] As a result of the multicomponent intervention used in this study, there is no way to determine specifically if the gardening component of the intervention influenced behavior change among participants.[35]

Discussion

This review of the impact of gardening interventions on FV consumption among children included 14 studies with considerable diversity in study design, sample size, and tools used to measure FV consumption. Ten studies found that participating in various gardening interventions was associated with significantly greater FV consumption .[27-35,38] However, four other studies indicated no significant changes in FV consumption.[36,37,39,40] Furthermore, minimal data regarding long-term changes in FV consumption has been collected therefore there is no way to determine if changes in FV consumption are sustained over time. In fact, the long-term benefits associated with implementing gardening programs for children remains in question suggesting a need for further research.

Although many studies have reported significant improvements in preferences, knowledge, and attitudes towards FV,[12,14-17] increases in FV consumption were not consistently found among studies presented in this review. While gardening interventions increase access to FV during the school day, it is possible that children have limited access to FV at home resulting in minimal changes in FV consumption over the intervention period.[36] Ratcliffe and colleagues[36]

and Namenek Brouwer and colleagues[29] found that although the variety of vegetables consumed at school increased, consumption of vegetables at home did not change. Gardening interventions for children may benefit from incorporating a parental component to increase the likelihood that FV are available for children at home to allow for increased consumption.[36,37] Future studies should compare the effectiveness of a traditional gardening intervention program to gardening interventions that incorporate resources and support for parents to encourage changes in FV consumption when children are not in school.

Three studies in this review supplemented gardening interventions with nutrition education to increase FV consumption by enhancing knowledge and increasing exposure of FV.[32, 34,39] When compared to children who did not receive an intervention and to those who received nutrition education only, children who received gardening and nutrition education combined were found to have greater increases in FV consumption over the intervention period in two out of three studies.[32,34] Multi-component interventions have been found to be more effective at changing nutrition-related behaviors than single-component interventions among children.[42] Although results are not conclusive, these studies suggest that the combination of gardening and nutrition education may be an effective intervention for increasing FV consumption. Future studies should be conducted to determine if interventions that incorporate hands-on gardening experiences, nutrition education, and parent involvement are more effective than interventions that provide gardening experiences only. Further research should also be done to determine which educational strategies actually contribute to behavior change among garden intervention participants.

Most studies in this review investigated changes in consumption of both FV even though only four studies reported planting fruit,[27,29,30,32] most commonly strawberries and melons, as

part of the gardening intervention. It is likely that the limited exposure to fruit through this intervention impacted the effectiveness of increasing fruit consumption among participants. Although most studies combine FV in general discussion about these food groups and in actual measurement of them, there has been evidence to suggest that nutrition-related interventions should target fruit and vegetables separately as a result of the different factors influencing consumption such as knowledge, barriers, and stages of change.[43] Furthermore, there is growing evidence that consumption of vegetables among children presents a much greater challenge than consumption of fruit.[44] Future studies in this area should report fruit and vegetable outcomes separately, and consider carefully whether or not they should include fruit consumption as an outcome.

The duration and intensity of the gardening interventions provided to children varied greatly among the studies in this review. Morgan and colleagues[39] conducted a high intensity 10 week gardening intervention of 45 minutes four times per week and found that participation in the gardening intervention was not associated with increased FV consumption. Two other high intensity gardening interventions that provided 90 minute weekly sessions of gardening for 12 weeks also concluded that FV consumption did not significantly change among participants.[27,28] Conflicting results were found in a study comparable in duration and intensity.[38] Furthermore, several studies did not indicate the intensity of the gardening interventions implemented[29,31-34,37,40] which makes it difficult to determine the dose-response of the change in FV consumption at varying levels of exposure to gardening interventions. Consequently, a direct comparison of study results was not possible in this review. The intensity and length of gardening interventions should be further investigated and compared to determine the most effective method for implementing gardening interventions for children.

The studies included in this review included widely different ages of children from 2-15 years. From the results presented here, there is no evidence that gardening interventions are more effective in certain age ranges. Ages of children should be considered when developing and implementing gardening based interventions to ensure program effectiveness. Children learn differently at every age resulting in the need for variation in learning objectives, educational strategies, and activities offered to each age group.[45] Although many studies in this review used age appropriate evaluation tools, there was no mention of consideration regarding age during program and curriculum development. Many studies offered the same gardening-based interventions to a large age range of children[31,37,38,40] with the largest age range spanning from 2-13 year old.[33] Authors of future studies should consider using evidence-based curricula that are age specific to ensure the intervention is tailored to the developmental stage of their intended audience. In addition, future studies should be conducted to determine if gardening interventions are more effective among certain age ranges of children. Results of studies should be stratified by age if they include wide age ranges and if sample size permits.

Although the results from studies presented in this review provide valuable insight into the effectiveness of gardening interventions on FV consumption among children, there are significant limitations. Most importantly, only three studies conducted randomization of either children or schools.[28,29,37] Without randomization, researchers increase the risk for selection bias, systematic differences among study groups, and less accurate interpretation of the effects of the intervention.[46] Cohort and quasi-experimental study designs were used for the remaining studies, which have numerous limitations including the lack of randomized control groups, influence of confounding variables, threats to internal validity, and overall weaker conclusions.[47] Other flaws in study design including the use of convenience samples and unblended experiments may have

resulted in multiple type of bias, therefore, limiting the generalizability of the results. Blinding researchers that implement the gardening interventions is not feasible, but future studies should consider blinding researchers whose role is limited to collecting dietary intake data from participants. RTCs with larger sample sizes should be used in future studies to limit potential bias and to determine if causality exists between participation in gardening-based interventions and changes in FV consumption.

FV consumption was measured using a variety of self-reported instruments, which may have influenced the results of this review. Self-reported measurement tools are susceptible to social approval bias and therefore may not accurately represent change in dietary intake.[48] Further, only half of studies reported validity and reliability of measurement tools, which may limit the accuracy of results in those studies. Most studies used 24-hour recalls[31,32,35,37,39] or the Block Kids Food Screener[27,28,33] to measure changes in FV consumption. Although 24 hour recalls are state of the art for measuring individual dietary intake, misreporting of dietary intake can occur especially among children 12 years of age and younger[49] which may have influenced the accuracy of results in numerous studies. Future studies should consider including more objective measures of FV consumption in addition to 24-hour recalls to give a more complete picture of changes in FV consumption. For example, skin carotenoid levels can be assessed using resonance Raman spectroscopy, a noninvasive alternative to measuring serum carotenoids that has been used as a valid objective indicator of FV consumption among children.[50,51]

Conclusion

Gardening-based interventions have been implemented around the country with an overall goal of improving health-related behaviors of children in school and community settings. Although the evidence is somewhat mixed, most available studies suggest a small but positive impact of gardening interventions on children's FV consumption. Recommendations for future research include investigating long term changes in FV consumption, the impact of parental components of gardening based interventions on FV consumption of participating children, the effects of duration and intensity of programs, and the use of age-specific curriculum on program outcomes. Additional research that addresses the limitations discussed here should be conducted and would strengthen the available evidence regarding the efficacy of gardening-based interventions to increase children’s FV consumption.

References

1. Bazzano LA, He J, Ogden LG, et al. Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr*. 2002;76(1):93-99.
2. Boffetta P, Couto E, Wichmann J, et al. Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). *J Natl Cancer Inst*. 2010;102(8):529-537.
3. Harding A-H, Wareham NJ, Bingham SA, et al. Plasma vitamin C level, fruit and vegetable consumption, and the risk of new-onset type 2 diabetes mellitus - The European Prospective Investigation of Cancer-Norfolk prospective study. *Arch Intern Med*. 2008;168(14):1493-1499. doi:10.1001/archinte.168.14.1493.
4. Ledoux TA, Hingle MD, Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obes Rev*. 2011;12(5):e143-e150.
5. Liu RH. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *Am J Clin Nutr*. 2003;78(3):517S - 520S.
6. Van Duyn MS, Pivonka E. Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: Selected literature. *J Am Diet Assoc*. 2000;100(12):1511-1521. doi:10.1016/S0002-8223(00)00420-X.
7. Slavin J, Lloyd B. Health benefits of fruit and vegetables. *Adv Nutr*. 2012; 3(4):506-516. doi: 10.3945/an.112.002154

8. Pandey KB, Rizvi SI. Plant polyphenols as dietary antioxidants in human health and disease. *Oxid Med Cell Longev*. 2009;5(2):270-278. doi: 10.4161/oxim.2.5.9498 doi:10.3945/jn.111.146092.

9. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc*. 2006;106(9):1371-1379. doi:10.1016/j.jada.2006.06.002.

10. Maynard M, Gunnell D, Ness AR, Abraham L, Bates CJ, Blane D. What influences diet in early old age? Prospective and cross-sectional analyses of the Boyd Orr cohort. *Eur J Public Health*. 2006;16(3):315-323. doi:10.1093/eurpub/cki167.

11. Berezowitz CK, Yoder ABB, Schoeller DA. School gardens enhance academic performance and dietary outcomes in children. *J Sch Health*. 2015;85(8):508-518. doi:10.1111/josh.12278.

12. Gatto NM, Ventura EE, Cook LT, Gyllenhammer LE, Davis JN. LA Sprouts: A garden-based nutrition intervention pilot program influences motivation and preferences for fruits and vegetables in Latino youth. *J Acad Nutr Diet*. 2012;112(6):913-920. doi:10.1016/j.jand.2012.01.014.

13. Heim S, Stang J, Ireland M. A garden pilot project enhances fruit and vegetable consumption among children. *J Am Diet Assoc*. 2009;109(7):1220-1226. doi:10.1016/j.jada.2009.04.009.

14. Hutchinson J, Christian MS, Evans CEL, Nykjaer C, Hancock N, Cade JE. Evaluation of the impact of school gardening interventions on children's knowledge of and attitudes towards fruit and vegetables. A cluster randomised controlled trial. *Appetite*. 2015;91:405-414. doi:10.1016/j.appet.2015.04.076.

15. Nolan GA, McFarland AL, Zajicek JM, Waliczek TM. The effects of nutrition education and gardening on attitudes, preferences, and knowledge of minority second to fifth graders in the Rio Grande Valley toward fruit and vegetables. *Horttechnology*. 2012;22(3):299-304.
16. Davis JN, Martinez LC, Spruijt-Metz D, Gatto NM. LA Sprouts: A 12-week gardening, nutrition, and cooking randomized control trial improves determinants of dietary behaviors. *J Nutr Educ Behav*. October 2015. doi:10.1016/j.jneb.2015.08.009.
17. Triador L, Farmer A, Maximova K, Willows N, Kootenay J. A school gardening and healthy snack program increased Aboriginal First Nations children's preferences toward vegetables and fruit. *J Nutr Educ Behav*. 2015;47(2):176-180. doi:10.1016/j.jneb.2014.09.002.
18. Robinson-O'Brien R, Story M, Heim S. Impact of garden-based youth nutrition intervention programs: A review. *J Am Diet Assoc*. 2009;109(2):273-280. doi:10.1016/j.jada.2008.10.051.
19. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption. *J Hum Nutr Diet*. 2005;18(6):431-443. doi:10.1111/j.1365-277X.2005.00648.x.
20. Rutishauser IHE. Dietary intake measurements. *Public Health Nutr*. 2005;8(7A):1100-1107. doi:10.1079/PHN2005798.
21. Patrick H, Nicklas TA. A review of family and social determinants of children's eating patterns and diet quality. *J Am Coll Nutr*. 2005;24(2):83-92.
22. Koch S, Waliczek TM, Zajicek JM. The effect of a summer garden program on the nutritional knowledge, attitudes, and behaviors of children. *Horttechnology*. 2006;16(4):620-625.

23. Langellotto GA, Gupta A. Gardening increases vegetable consumption in school-aged children: A meta-analytical synthesis. *Horttechnology*. 2012;22(4):430-445.

24. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA statement. *J Clin Epidemiol*. 2009;62(10):1006-1012. doi:10.1016/j.jclinepi.2009.06.005.

25. Armijo-Olivo S, Stiles CR, Hagen NA, Biondo PD, Cummings GG. Assessment of study quality for systematic reviews: a comparison of the Cochrane Collaboration Risk of Bias Tool and the Effective Public Health Practice Project Quality Assessment Tool: methodological research. *J Eval Clin Pract*. 2012;18(1):12-18.

26. Thomas BH, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews Evid Based Nurs*. 2004;1(3):176-184.

27. Davis JN, Ventura EE, Cook LT, Gyllenhammer LE, Gatto NM. LA Sprouts: A gardening, nutrition, and cooking intervention for Latino youth improves diet and reduces obesity. *J Am Diet Assoc*. 2011;111(8):1224-1230. doi:10.1016/j.jada.2011.05.009.

28. Gatto NM, Martinez LC, Spruijt-Metz D, Davis JN. LA sprouts randomized controlled nutrition and gardening program reduces obesity and metabolic risk in Latino youth. *Obesity*. 2015;23(6):1244-1251. doi:10.1002/oby.21077.

29. Namenek Brouwer RJN, Neelon SEB. Watch Me Grow: A garden-based pilot intervention to increase vegetable and fruit intake in preschoolers. *Bmc Public Health*. 2013;13:363. doi:10.1186/1471-2458-13-363.

30. Castro DC, Samuels M, Harman AE. Growing Healthy Kids A community garden-based obesity prevention program. *Am J Prev Med*. 2013;44(3):S193-S199. doi:10.1016/j.amepre.2012.11.024.

31. Lautenschlager L, Smith C. Understanding gardening and dietary habits among youth garden program participants using the Theory of Planned Behavior. *Appetite*. 2007;49(1):122-130. doi:10.1016/j.appet.2007.01.002.

32. McAleese JD, Rankin LL. Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. *J Am Diet Assoc*. 2007;107(4):662-665. doi:10.1016/j.jada.2007.01.015.

33. Meinen A, Friese B, Wright W, Carrel A. Youth gardens increase healthy behaviors in young children. *J Hunger Environ Nutr*. 2012;7(2-3):192-204.

34. Parmer SM, Salisbury-Glennon J, Shannon D, Struempler B. School gardens: An experiential learning approach for a nutrition education program to increase fruit and begetable knowledge, preference, and consumption among second-grade students. *J Nutr Educ Behav*. 2009;41(3):212-217. doi:10.1016/j.jneb.2008.06.002.

35. Wang MC, Rauzon S, Studer N, et al. Exposure to a comprehensive school intervention increases vegetable consumption. *J Adolesc Health*. 2010;47(1):74-82. doi:10.1016/j.jadohealth.2009.12.014.

36. Ratcliffe MM, Merrigan KA, Rogers BL, Goldberg JP. The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promot Pract*. 2011;12(1):36-43. doi:10.1177/1524839909349182.

37. Christian MS, El Evans C, Nykjaer C, Hancock N, Cade JE. Evaluation of the impact of a school gardening intervention on children's fruit and vegetable intake: a randomised controlled trial. *Int J Behav Nutr Phys Act*. 2014;11:99. doi:10.1186/s12966-014-0099-7.

38. Duncan MJ, Eyre E, Bryant E, et al. The impact of a school-based gardening intervention on intentions and behaviour related to fruit and vegetable consumption in children. *J Health Psychol*. 2015;20(6):765-773. doi:10.1177/1359105315573445.

39. Morgan PJ, Warren JM, Lubans DR, Saunders KL, Quick GI, Collins CE. The impact of nutrition education with and without a school garden on knowledge, vegetable intake and preferences and quality of school life among primary-school students. *Public Health Nutr*. 2010;13(11):1931-1940. doi:10.1017/S1368980010000959.

40. Hanbazaza MA, Triador L, Ball GDC, et al. The impact of school gardening on Cree children's knowledge and attitudes toward vegetables and fruit. *Can J Diet Pract Res*. 2015;76(3):133-139. doi:10.3148/cjdpr-2015-007.

41. Schulz KF, Grimes DA. Blinding in randomised trials: hiding who got what. *The Lancet*. 2002;359(9307):696-700.

42. Hoelscher DM, Kirk S, Ritchie L, Cunningham-Sabo L. Position of the Academy of Nutrition and Dietetics: Interventions for the prevention and treatment of pediatric overweight and obesity. *J Acad Nutr Diet.* 2013; 113(10):1375-1394. doi: 10.1016/j.jand.2013.08.004

43. Glasson C, Chapman K, James E. Fruit and vegetables should be targeted separately in health promotion programmes: differences in consumption levels, barriers, knowledge and stages or readiness for change. *Public Health Nutr.* 2010; 14(4):694-701. doi:10.1017/S1368980010001643

44. Kim S, Moore L, Galuska D et al. Vital signs: Fruit and vegetable intake among children-United States, 2003-2010. *Morb Mortal Wkly Rep*. 2014; 63(31); 671-676.

45. Nasir Jalbani L. The impact of effective teaching strategies on the students' academic performance and learning outcomes. Pedagogy-Common Didactics, Educational Objectives, Methods. 2014. http://www.grin.com/en/e-book/300046/the-impact-of-effective-teaching-strategies-on-the-students-academic-performance

46. Suresh K. An overview of randomization techniques: An unbiased assessment of outcome in clinical research. *J Hum Reprod Sci*. 2011;4(1):8-11. doi:10.4103/0974-1208.82352.

47. Harris AD, McGregor JC, Perencevich EN, Furuno JP, Zhu J, Peterson DE, Finkelsein J. The use and interpretation of quasi-experimental studies in medical informatics. *J Am Med Inform Assoc.2006;13(1):16-23.* doi: 10.1197/jamia.M1749

48. Miller TM, Abdel-Maksoud MF, Crane LA, Marcus AC, Byers TE. Effects of social approval bias on self-reported fruit and vegetable consumption: a randomized controlled trial. *Nutr J*. 2008;7(18):18588696.

49. Livingstone MBE, Robson PJ, Wallace JMW. Issues in dietary intake assessment of children and adolescents. *Br J Nutr*. 2004;92(Supplement S2):S213-S222. doi:10.1079/BJN20041169.

50. Aguilar SS, Wengreen HJ, Lefevre M, Madden GJ, Gast J. Skin carotenoids: A biomarker of fruit and vegetable intake in children. *J Acad Nutr Diet*. 2014;114(8):1174-1180. doi:10.1016/j.jand.2014.04.026.

51. Wengreen HJ, Madden GJ, Aguilar SS, Smits RR, Jones BA. Incentivizing children's fruit and vegetable consumption: Results of a United States pilot study of the Food Dudes Program. *J Nutr Educ Behav*. 2013;45(1):54-59. doi:10.1016/j.jneb.2012.06.001.

550