THESIS

ASSOCIATION BETWEEN YOUTH INVOLVEMENT IN HOME/COMMUNITY GARDENING AND HEALTH BEHAVIORS

Submitted by

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ABSTRACT

ASSOCIATION BETWEEN YOUTH INVOLVEMENT IN HOME/COMMUNITY GARDENING AND HEALTH BEHAVIORS

American youth are developing risk factors for historically “adult diseases” at increasingly high rates. These risk factors, such as obesity, elevated blood lipid, blood pressure and insulin resistance, put children at a high risk for developing chronic disease early in life, including before reaching adulthood. School gardening programs are effective at improving dietary intake, physical activity levels and BMI of youth. Despite the success of such programs, there is a need for interventions that effectively target child behaviors while at home. Family-based home and/or community gardens may promote child health behaviors similar to those that occur in school-based gardening programs. A home and/or community garden has the added benefit of parental involvement, which has been shown to be essential for effective child health interventions. The current study examined the relationship between youth involvement in a home and/or community garden and various health behaviors.

A convenience sample of 124 adults participated in a cross-sectional survey from June – October 2023. Participants answered questions about family and child involvement in a home/community garden, child health behaviors and parent health behaviors. Health behaviors assessed were physical activity minutes, sedentary behavior, frequency of fruit and vegetable intake and mental health symptoms.

Independent sample t-tests indicated that gardening youth had lower sedentary time ($t(112) = -1.95$, $p = 0.03$), as well as higher frequency of fruit ($t(110) = 2.14$, $p = 0.02$) and vegetable intake ($t(109) = 2.67$, $p = 0.004$). Parent fruit intake had a positive linear association with child fruit intake ($\beta = 0.51$, $p = <0.001$), as did parent gardening belief ($\beta = 4.04$, $p = 0.01$). Mediation analysis indicated a positive association between path a (gardening status and parent

fruit intake: β=3.06, 95% CI: 0.08, 6.03, p = 0.04) and path b (parent fruit intake and child fruit intake: β = 0.48, 95% CI: 0.30, 0.65, p = <0.001). Gardening status was no longer associated with child fruit intake after the inclusion of parent intake (c': β = 1.64, 95% CI: -1.06, 4.35, p = 0.23), suggesting that parental fruit intake fully mediated the relationship between gardening status and child fruit intake. Gardening status had a positive linear association with child vegetable intake (β = 3.4, p = 0.02), as did parent vegetable intake (β = 0.21, p = 0.004). These findings indicate that youth involvement in a family-based home and/or community garden may be associated with positive health outcomes, especially regarding dietary intake. Parental influence was also associated with positive youth health outcomes. Our findings suggest that home and/or community gardens may provide an effective technique for child health interventions.

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CHAPTER 1: INTRODUCTION

1.1 Health During Childhood

Childhood is composed of the foundational years between birth and adulthood where growth and development occur at a rate unparalleled to any other period of life. The changes that a child progresses through are magnificent and often occur instinctively if the social, emotional and physical needs of the child are met.[1] Although typical development is hardwired into a child, failure to meet these needs puts a child at risk for suboptimal development.

A child's health plays a central role in this development. Despite advances in disease prevention and treatment, today's children face significant health issues. Children do not often develop chronic diseases such as heart disease, hypertension or type 2 diabetes; however, youth are developing risk factors for these traditionally "adulthood diseases" at higher rates.[2,3] Obesity, elevated blood lipid, blood pressure and insulin resistance are increasingly appearing in children and increase the risk of developing chronic disease later in life, even as soon as teenage years.[2,3] Additionally, an individual's physical health has a complex relationship with other dimensions of health, such as mental health.[4,5] As such, poor physical health has the potential to influence many areas of a child's life.

One of the most prevalent and harmful health risks is obesity. Obesity is a complex disease that is believed to be influenced by behaviors, genetics and certain medications or conditions.[6] Worldwide, over 340 million youth are overweight or obese and the rate of obesity continues to grow.[7] Not exempt from this trend, in the United States it is estimated that 1 out of 5 youth are overweight or obese,[6] with some estimates higher than 1 out of 3 youth.[3,8]

1.2 Childhood Health Guidelines

Despite the complexity around childhood obesity and other related risk factors, researchers and health authorities have consistently suggested similar strategies for prevention,

management and treatment: offer children healthy dietary options, help children to be more physically active, set consistent sleep routines, limit screen time, and encourage adult modeling of these same health behaviors.[9,10]

Health guidelines, such as for dietary and physical activity behaviors, provide clear guidance about implementing healthy behaviors throughout childhood. Adherence to these guidelines promotes a healthy body weight by targeting energy balance[11] and improves child health in other areas including fitness, improved cognition and reduced risk for chronic diseases.[3,12,13] Furthermore, childhood behaviors often persist into adulthood,[2,3] making the development of appropriate habits early on especially crucial.

1.2.1 Physical Activity Guidelines

Youth ages 6-17 are recommended by the "Physical Activity Guidelines for Americans" to complete at least 60 minutes of moderate-vigorous physical activity per day, as well as muscle and bone strengthening activities.[2] It was estimated that only 23% of American youth meet these guidelines in 2019.[14]

1.2.2 Dietary Guidelines

Robust dietary guidelines have been established in the "Dietary Guidelines for Americans." Youth are encouraged to eat nutrient-dense foods that provide adequate calories for appropriate development but avoid excess weight gain.[3] The specific caloric recommendations and serving sizes of specific food groups change as the energy requirements increase with age. Youth of all ages are not meeting the dietary recommendations, and diet quality declines as a child progresses towards teenage years and early adulthood.[3] Children between ages 5-14 years old are recommended a daily consumption of 1.5-2 servings of fruit and 1.5-3.5 servings of vegetables. Nationally, children this age have a weighted diet quality index score of between 52-55 out of 100, with daily intakes about 1 cup of each fruits and vegetables for both males and females, which are well below the recommended intakes.[3]

1.2.3 Sedentary Behaviors

Sedentary behaviors (e.g., watching television, sitting in the car) may have an effect similar to inadequate PA levels, yet independent of PA, in the development of cardiovascular disease and all-cause mortality in adults.[2] Both the "World Health Organization Guidelines on Physical Activity and Sedentary Behavior" and the "Physical Activity Guidelines for Americans" report that there is insufficient evidence to develop threshold guidelines for sedentary behavior in adults or children; however, it is strongly encouraged that youth limit sedentary time, especially from screens.[2,15]

Youth spend an estimated 41-51% of their after-school time in sedentary behavior, with a large proportion in television viewing.[16] This rate also grows as children reach adolescence,[16,17] and higher sedentary time is consistently associated with lower diet quality.[18] School sedentary time may also be a valuable target for interventions. Decreased sedentary time at school is associated with improved quality of life, cognition and mental health, as well as increased physical activity,[19] suggesting value in minimizing child sedentary time in both leisure and educational settings.

1.3 Effectiveness of Childhood Health Interventions

Many interventions for childhood obesity target at least one of the above listed health behaviors, with the most successful strategies targeting several behaviors simultaneously.[20] Most childhood obesity prevention studies are school-based and have been found to be moderately effective at improving body mass index (BMI) scores, especially when home involvement is incorporated.[20,21] Although there are relatively fewer home-based interventions, the related studies have likewise reported positive changes in youth health outcomes. Interventions that are only home-based interventions have an impact on both short-term and long-term BMI reduction[22] but may be difficult to implement and monitor. Although intervention procedures of these studies can vary widely, home-based interventions increase physical activity, reduce sedentary time and improve diet quality.[22] One limitation of the available home-

based obesity intervention studies is that those available is underrepresentation of non-traditional families, older children and racial minorities.[23] Community-based interventions also seem to have a moderate effect on preventing obesity; however methods vary greatly between studies and are less studied compared to school-based interventions.[24]

1.4 Gardening-Based Health Interventions

A health intervention strategy that has grown in popularity for individuals of many ages is gardening. Robust evidence suggests that gardening can improve various aspects of physical and emotional well-being, such as nutritional intake, anthropometrics and physical activity outcomes[25,26] and mental and social health[27] in adults. Health benefits are also seen in specifically youth populations, especially for improved fruit/vegetable (FV) consumption,[28–30] as well as improvements in physical activity (PA)[29,31,32] and BMI.[33–35] Few studies have analyzed changes in child sedentary time; however, those available have found non-significant differences in sedentary behavior after a gardening intervention.[31,32]

1.4.1 School-Based Gardening Interventions

Most gardening studies and programs in youth have been done in a school setting, sometimes with a minor home component, due to the strong evidence for the effectiveness of school-based obesity programs.[21] There is great variability in the structuring of school-based gardening programs, such as type of garden, length of gardening season, and other components incorporated into the program, making it unclear which qualities of a school-based gardening program have the greatest impact on reported child health outcomes.[36] Other potential settings for gardening-based interventions are at home or in the community. To date, few studies have evaluated the effects of youth involvement in a community-based garden, and none have been conducted in a home or family-led community gardening setting.

Several mechanisms may be proposed to explain the improved dietary and physical activity outcomes seen in youth involved in school-based gardens. Increases in youth physical activity during gardening interventions or studies may be due to the specific gardening tasks

being performed and/or increased outdoor time. Gardening studies reporting increases in youth PA vary greatly in how PA was measured and the types, duration and categorization of gardening activities performed. This makes it difficult to elucidate factors that may be driving the increase in PA reported in the literature. One study attempted to estimate the metabolic costs of various gardening tasks in youth[37]; however, no studies were found to measure the type or duration of gardening tasks that youth typically perform during a gardening session. Another factor that may influence PA during gardening interventions is that activities in an outdoor setting may encourage greater child PA.[38] Extended time spent outdoors is positively related to increased PA and reduced sedentary behavior in children across various demographics.[39–41] This may be attributed to differing social expectations in indoor settings compared to outdoor; for instance, children more frequently prompt each other to be more active in an outdoor setting, while prompting each other to be more sedentary in an indoor setting.[42] Socioecological factors are also associated with the amount of physical activity that occurs during outdoor time, such as the availability of greenspace[43] independent of its size,[44] seasonality, low personal activity levels, and parent attitudes and modeling.[45] Dietary changes may also be attributable to many factors. Simply increasing the availability and physical presence of FV has been shown to increase consumption in children.[46–48] Children with gardening experience have greater vegetable consumption, with the highest levels of preference and consumption among children who reported enjoying gardening.[49] The impact of exposure on FV consumption may be mediated by improved knowledge of foods,[50] and increases in positive attitudes, norms and perceived control.[51]

A substantial amount of qualitative evidence exists about the relationship between youth involvement in gardening and well-being, with reports of improved social and personal outcomes.[29] Increased well-being may be due to the strong relationship between nature contact and child well-being, behavioral or mental health.[52–54] Very few gardening-related studies have reported quantitative measures of well-being, and of these studies, no significant difference has

been found. It is unclear whether a failure to find significance via quantitative measures is due to a true non-significance or to study design limitations.[29] More quantitative studies are needed to support the qualitative findings about the relationship between youth gardening and mental health outcomes.

1.4.2 Gardening in Other Settings

Although the positive findings from school-based gardening interventions and programs are valuable, there is a lack of research about the impact of gardening in other settings. This gap is significant because the many hours after school and during school breaks also contribute towards the development of appropriate health behaviors. Furthermore, although school-based gardening programs promote positive health behaviors during school hours, it is also not clear whether the health changes carry over to the hours outside of the school day.[28,55,56]

Non-school gardening activities may take place in home or community-based settings. Few community-based youth gardening studies have been conducted, but those available have reported positive outcomes. One such benefit is an improved home food environment, which may increase child dietary quality.[57] To the best of our knowledge, no studies have studied youth involvement in family-based gardening and its potential influence on health outcomes.

1.5 Parental Influence on Child Health Outcomes

Gardening that takes place in a home setting or community garden with individually maintained plots may positively influence child health outcomes, especially because parental involvement is central to the activity. It is clear that parental behaviors and family culture powerfully influence youth health outcomes. Several reviews have concluded that including parental involvement in obesity prevention programs resulted in improved weight and BMI across many demographics and diverse populations.[58,59] This beneficial effect is seen in both prevention and treatment interventions and has a pronounced impact on interventions with multi-level outcomes, such as diet and physical activity.[59]

The effect of parents on child health outcomes may be due to various factors, including the concept of positive parental influence. Positive parental influences encompass many dimensions, such as the parent's own beliefs, habits and attitudes towards health behaviors and the consequential supportive actions that the parent takes.[58]

1.5.1 Parental Influence on Child PA

Physical activity parenting practices frameworks have been developed to explain different parenting behaviors that may positively or negatively influence child PA levels. One dimension within many physical activity parenting practices framework is structuring, where parents create more structure in order to promote PA. Structuring behaviors might manifest as participating in PA with the child, modeling appropriate behavior, and providing tangible support by enrolling the child in active extra-curriculars and providing transportation. Another main dimension is autonomy, where parents support child motivation to be active through praise or encouragement and allow child input about activities.[60] Positive parental influence is positively associated with greater child PA across many populations.[58] Furthermore, child and adolescent PA is higher when they receive approval, support/assistance, and recognition/reward from their parents.[58]

Parent and child PA levels are also positively correlated; as parent PA increases, so does child PA.[61] This is also true specifically for leisure-time PA.[40,62] Parents influence the family culture around leisure-time activities, such as the types of activities and durations that frequently occur within the family.

There is currently no literature analyzing common or effective parenting practices during gardening activities; however it is plausible that many of the general physical activity parenting practices are likely to be effective in these settings. Parents who maintain a home-based garden may be likely to encourage their child to participate in gardening activities and then positively reinforce behaviors when child involvement does occur. Additionally, the decision to maintain a home or community garden results in a series of regular responsibilities necessary to maintain

the garden, with a wide variety of tasks that vary in duration and intensity. The potential for increased adult PA due to gardening activities[63] may indirectly influence child PA through role modeling opportunities, given that parental role modeling of PA has been found to independently affect child PA and sedentary time.[61,64] Finally, maintaining a home or community garden may impact how leisure-time is utilized both for parent and child, potentially replacing time that might have otherwise been spent in sedentary behavior, such as on screens.

1.5.2 Parental Influence on Child Diet Quality

Parents who maintain a home or community garden may also influence child dietary intake. Involving parents in obesity interventions improves child dietary intake.[59,64] This effect may be due to how parents influence the social environment around food; when parents care about health eating and encourage the child to eat healthy foods, the child has a better diet quality and is less likely to be overweight.[59,64] Furthermore, parental practices determine the home food environment. Home food environments where parents model healthy eating and have healthful foods available are positively associated with child dietary intake and/or weight status, and may be an important factor contributing to overall diet quality.[65]

The relationship between parent and child diet can vary depending on the parent-child dyad, foods analyzed and demographics.[66] However, parents and children have similar diet quality, and parent diet quality may be a strong predictor of child diet qualtiy[67] for all food groups, including in children with obesity/overweight.[68] Adults who participate in home or community gardening have higher fruit and vegetable intake,[63,69,70] but it is not clear whether the increase in intake is from greater availability and/or increased exposure to fruits and vegetables. Regardless, if parental intake is increased as a result of garden participation, child diet may also be positively influenced.

1.6 Summary

Childhood is a critical period for physical and mental growth and development. Unfortunately, youth are developing markers of health issues and chronic diseases, such as

obesity, hypertension and type 2 diabetes at higher rates than previous generations, creating an elevated need for effective interventions. Gardening has emerged as a potential intervention that has been found to improve youth health outcomes of BMI, physical activity and diet quality. While most existing studies focus on school-based gardening programs, the effectiveness of interventions in other settings such as home and/or community gardens, remains underexplored. Additionally, parental involvement is crucial in shaping children's health behaviors. Home and/or community-based gardening may provide additional opportunities for positive parental influences. Research is needed to uncover the mechanisms through which home and/or community-based gardening may impact youth health outcomes.

1.7 Statement of Purpose

This study aimed to (1) examine the association between youth involvement in home and/or community gardening (HCG) and positive health behaviors using a regional sample from Colorado and (2) investigate if positive association between child health behaviors and gardening status is mediated by parental behaviors. Specific research questions (RQ) and hypotheses (H) are outlined below.

RQ1: When families have a home and/or community garden, how are children involved in the gardening tasks?

H1: Children whose families have a home/community garden will be involved with various gardening tasks that will contribute to improvements in health behaviors.

RQ2: Do youth who are involved in a HCG have more positive health outcomes and behaviors compared to youth who are not involved in a HCG?

H2: Youth who are involved in a HCG with engage in more moderate-vigorous physical activity, spend less time in sedentary behavior, consume fruits and vegetables more frequently, experience fewer mental health symptoms, and maintain a healthier BMI compared to those who are not.

RQ3: Do youth who are involved in a HCG reach the recommended health guidelines?

H3: Youth that are involved in a HCG will be more likely to reach the recommended PA and dietary guidelines compared to youth who do not have a HCG.

RQ4: Do parents who participate in a HCG have more positive health outcomes? If so, do these positive health outcomes mediate the association with an improvement in child health outcomes?

H4: Parent participation in HCG will result in more positive health outcomes and will mediate positive child health outcomes.

CHAPTER 2: METHODS AND PROCEDURES

2.1 Survey Design

2.1.1 Recruitment and Participants

Our research team from Colorado State University used community contacts, email, social media and an advertisement in a regional parenting magazine to recruit a sample of adults. (Appendix: Recruitment Materials) A variety of organizations, schools and businesses in Northern Colorado were also contacted and asked to disseminate information about the study (Table 1). Overall response rate from organizations contacted was 57%. We were unable to track the number of participants that each organization contacted, so the overall participant response rate is unknown. Participants who completed the entire survey were eligible to opt into a randomized drawing for one of five $50 Amazon gift cards as compensation.

Eligible participants were parents of youth aged 6-14 years old, able to speak and read English, and lived in Colorado. The Institutional Review Boards (IRB) of CSU (Protocol #4485) approved the study protocol. (Appendix: IRB Approval Letter)

2.1.2 Procedures

Participants completed a 15-minute electronic survey via Qualtrics that included questions about family gardening activities, child health behaviors, parent health behaviors and demographic questions (Appendix: Survey). Participants were recruited on a rolling basis between June 2023 and October 2023. In order to minimize the effects of participant drop out, survey flow was laid out in the following order: gardening involvement questions, child health outcomes, child demographics, parent health outcomes, and parent demographics.

Table 1: Study recruitment efforts and response rates

Recruitment Type	Organizations Contacted (N)	Organizations that Disseminated Information (N)	Participant Responses Included in Study (N)	Organization Name
Youth Organizations	6	1	111	CSU Youth Sports Camps (111); Youth Health Behaviors Project; Poudre Global Academy; Colorado Youth Outdoors; Mountain Youth; B/G Club of Larimer County
Businesses	4	1	1	Fort Collins Nursery(1); FC Museum of Discovery; FC United Way; Gardens Sweet Farm Share
Local School Administration	2	1	0	Sage Mountain School PDS
Youth Gardening Organizations	1	1	2	Loveland Youth Gardeners
Local Gardening/ Community Gardening Organizations	9	1	1	Denver Urban Gardens (1); Gardens at Spring Creek; Fort Collins Community Gardens; Community Gardens at Council Tree; Hope Cultivate Community Gardens; The Vegetable Connection; Homegrown Food Organization; The Growing Project; SpourtinUp Organization
Apartment Complexes	4	2	0	Catalyst Housing; Care Housing; Revive Housing FC
Other *(Local Parenting Magazine Ad, Word of Mouth, Social Media, Event)*	5	5	7	RM Parenting Ad (1); Word of Mouth (5); FC United Way; Social Media: Chinese Webchat (1); Social Medial: Other; Author Event
Unspecified	N/A	N/A	2	
TOTAL	**21**	**12**	**124**	

2.2 Measures

2.2.1 Demographic Variables

Participants reported demographic information about both the parent and child. Parent demographics included ethnicity, race, education level, age, gender, marital status, employment status, relationship to the child and zip code. Child demographics included child birth month and year, ethnicity, race and biological sex.

Parent demographics questions were taken directly from 2022 National Health and Nutrition Examination Survey (NHANES)[71] and 2021 Behavioral Risk Factor Surveillance System (BRFSS)[72] survey. Ethnicity was indicated as negative (0) or affirmative (1) to being of Hispanic, Latino or Spanish origin (2022 NHANES DMQ.241). Race categories allowed multi-choice selection and were grouped into categories: White ("White"), Asian or Asian/White (selected "Asian" with/without "White"), Black or Black/White (selected "Black or African American with/without "White"), Other ("American Indian or Alaskan Native", "Native Hawaiian or Pacific Islander" and/or "Other (please specify)") (2022 NHANES DMQ.263). For regression analyses, race was further collapsed into categories of white (ref.) versus other due to very low response rate for other races.

Age was reported as an integer (2022 NSCH J3). Gender choices were "male" (1), "female" (2), and "I do not identify as either" (not included in analyses due to zero response rate) (2022 NHANES 4.4.6). Marital status was categorized into groups of married ("married"), divorced ("divorced"), or other ("widowed", "separated", "never married", "living with a partner", "prefer not to answer", and "don't know") (2022 NHANES DMQ.380). For regression analyses, marital status was further collapsed into categories of married (ref.) vs other due to low response rate for other marital statuses.

Education was reported as the highest level of school or degree completed using question wording was directly taken from NHANES 2022 (2022 NHANES DMQ.141). Responses were grouped and reported under main categories with the following response

options under each category: some college (“some college, no degree”), associate degree (AD)(“associate degree: occupational, technical, or vocational program”, “associate degree: academic program”), bachelor’s degree (BD) (“bachelor's degree (Example: BA, AB, BS, BBA)”) and master’s/professional/doctoral degree (M/P/D D) (“master's degree (Example: MA, MS, MEng, MEd, MBA)”, “professional school degree (Example: MD, DDS, DVM, JD)”, “doctoral degree (Example: PhD, EdD)”). Additionally, “No degree (“high school graduate”, “GED or equivalent”)”, “prefer not to answer” and “don’t know” were response options but were not reported by any participants. For statistical analyses, the responses were further grouped into categories of ≤ bachelor’s degree (B.D.) by combining previous groupings of some college, A.D. and B.D., compared to > B.D. (utilizing the M/P/D D. category).

Employment option were: “employed for wages full-time”, “employed for wages part-time”, “self-employed”, “out of work for less than 1 year’, “out of work for more than 1 year”, “homemaker”, “student”, “retired”, “unable to work”, “other (please specify)” (2022 BRFSS CDEM.14). For sample demographics, full-time employed, part-time employed, self-employed were reported. All other responses were grouped into “other.” For further statistical analyses, employment was collapsed into full-time (ref.) versus other due to low response rate for other options. Relationship to the child was reported as mother, father, grandparent, other Legal Guardian (please specify) but was not used in analyses. Zip code was reported as open response (2022 BRFSS CDEM.09) and further collapsed into categories of Larimer County versus other.

Where possible, child demographic questions were also taken from 2022 NHANES.[71] Questions about ethnicity and race were identical to parent demographic questions and utilized the same coding. Per 2022 NHANES screening question to determine sex of household members (2022 NHANES SCQ.131) and YRBS questions for middle school age children (2023 SMS YRBS Q2),[73] child sex was reported and categorized as male (1), female (2), other (“prefer

not to answer", "don't know") (excluded from analyses due to very low response rate). Age was reported by birth month and year.

2.2.3 Dependent Variables

2.2.3.1 Child Measures of Health and Health Behaviors

Body Mass Index (BMI) and Health Perception: **BMI** (kg/m^2) was calculated from self-reported height and weight (2022 NHANES WHQ.025). Responses were excluded if they did not include both height and weight. Parents rated their child health using a 5-point Likert scale ranging from "excellent" (5) to "poor" (1) (2022 NSCH-T2 A1)[74] to create the **Health Perception** variable. Finally, participants were asked to describe their child's weight using a 5-point Likert scale ranging from "very underweight" (1) to "very overweight" (5) (NHANES 2012 WHQ030E) to create the **Weight Perception** variable. Parent perception of their child's weight was included to provide context to reports of child height and weight. Context is important because some studies have found that parents underestimate child weight, resulting in an underestimation of the number of children classified as obese.[75] Furthermore, parents who inaccurately categorize their child's weight are less likely to initiate positive lifestyle change.[75,76]

Physical-Activity Frequency, Intensity, and Duration: The PA section began with an introduction explaining how to categorize PA as moderate or vigorous using wording from Center of Disease Control (CDC) online recommendations[77] and current Physical Activity Guidelines – 2nd Edition (PAG).[2] Moderate PA (MPA) was defined activities that cause a moderate increase in breathing or heart rate, whereas vigorous PA (VPA) was defined as activities that cause large increases in breathing or heart rate. Examples of potential MPA and VPA sources were given. Parents were instructed to not include PA from gardening activities or PA that occurred while family members were gardening, and to include PA from all other sources.

Parents then separately reported the MPA and VPA that occurred during each day of the previous week using the open-response question, "During the past week, how many minutes did

your child participate in moderate and vigorous-intensity physical activity". Many national surveys utilize dichotomous reporting of PA (e.g. responding negative or affirmative to if their child met the PA guidelines of 60 minutes per day); however, our survey requested PA to be reported as integer in order to provide greater detail into the PA differences between the two groups. Thus, survey questions were modeled after national surveys but adapted to fit the specific research questions of this project (Appendix: Survey, Question 16). MPA and VPA were combined to create the MVPA variable.

Child MVPA variable was calculated from reports of MPA, VPA, time spent in gardening tasks, and time spent playing outside. MPA was incorporated directly into the MVPA variable. VPA values were multiplied by 2 to create a MVPA equivalent.[78] This method of calculating weekly minutes of MVPA has been used in previous population-based studies. Time spent doing specific gardening tasks was converted to moderate or vigorous minutes using MET equivalents.[37] Time spent playing outside during gardening tasks was multiplied by 0.14[79] and added to total moderate PA minutes. If the participant input minutes for at least one of the days but left other days blank, it was assumed that days without a response were intended to report zero minutes. Physical activity levels were also compared using physical activity guideline adherence. A dichotomous variable, **MVPA Guidelines**, was created that indicated whether the participant met (1) or failed to meet (0) the 420 minutes/week guidelines.

Sedentary Behaviors: Child sedentary time (hours/day) was measured using the multiple-choice question, "On most days, about how much time per day does your child spend in front of a TV, computer, cellphone or other electronic device watching programs, playing games, accessing the internet or using social media? (Do not include time spent doing schoolwork)" with options: none at all, about half an hour a day, about 1 hour a day, about 2 hours a day, about 3 hours a day, about 4 hours a day, about 5 hours a day, about 6 hours a day, about 7 or more hours a day. Question wording was taken directly from the 2022 National Survey of Children's Health (NSCH)[74] (2022 NSCH H6). The original question provided options of less

than 1 hour to 4 or more hours. The list of responses was adapted to include a broader range of hours in order to reflect the greater autonomy of time that children have during school breaks. Parents reported hours of sedentary time for a typical weekday and for a typical weekend day. Sedentary time was converted into numeric hours based directly on participants' responses. Weekday and weekend sedentary hours were combined and averaged to make a combined **Sedentary Time** variable. Currently, there are not evidence-based guidelines established for sedentary time limits by age group. Thus, a dichotomous variable regarding meeting sedentary health guidelines was not created.

Diet: Diet was reported using the multiple choice question, "During the past week, how often did your child:" with the following responses: "eat fruit (do not include juice)", "drink 100% fruit juice such as orange juice or apple juice (do not include fruit-flavored drinks or fruit juices with added sugar.)", "eat a green leafy or lettuce salad, with or without other vegetables", "eat any kind of fried potatoes, including French fries, home fries or hash browns", "eat any other kind of potatoes, or sweet potatoes, such as baked, boiled, mashed potatoes, or potato salad", "not including lettuce salads and potatoes, how often did your child eat other vegetables", and "consume foods that were grown in your garden". Reponses included: "not at all", "1-3 days", "4-6 days", "1 time per day", "2 times per day" or "3 or more times per day". Question wording came from the 2021 National Behavioral Risk Factor Surveillance System Survey (BRFSS 2021 CFV.01-06)[80] and 2023 National High School Youth Risk Behavior Survey (YRBS 2023 Q75-Q78, Q80).[73] The 2021 BRFSS was utilized because the 2022 version did not include dietary questions. Although our target population was ages 6-14, which is elementary school and middle school age, the Middle School YRBS has not asked F/V consumption questions since 1997. As such, the current F/V consumption questions included in the High School YRBS were utilized. Questions from both the 2021 BRFSS and 2023 HS YRBS surveys that reported fruit and vegetable consumption were selected. Other dietary questions about sugar-sweetened

beverages, dairy intake and breakfast consumption were not included due to the focus of our research questions specifically on F/V intake.

Although the BRFSS dietary questions asks the participant to report frequency of food consumption by day, week and month, frequency scaling for this survey was adapted to match the 7-day recall pattern utilized in the YRBS. Asking frequency per week was justifiable so that the recall pattern for the survey fit the recall frequency of earlier physical activity questions.

It is important to note that the BRFSS wording of weekly frequencies is not equivalent to weekly servings, since frequency may be interpreted slightly differently between participants. As such, weekly frequencies between the Gardening and Non-gardening groups were compared to each other, but were not compared to nationally set guidelines, which recommend specific serving quantities. The survey instructions do include some information on classification of very low intake of specific food categories, such as less than one fruit frequency per day, less than one vegetable frequency per day, and less than one fruit and one vegetable frequency per day.[81]

Dietary outcome variables were calculated by creating weekly quantities from the participant responses. Survey responses for each dietary question were coded into weekly frequencies as follows: never (0); 1-3 days a week (2); 4-6 days a week (5); 1 time per day (7); 2 times per day (14); 3 or more times per day (21).

Several of the dietary questions were combined to create weekly frequencies of vegetables and fruit variables. Fruit and 100% fruit juice were combined to create the **Fruit Intake** variable. The **Vegetable Intake** variable was created by combining frequencies reported for leafy or lettuce salad, other kinds of potatoes and other vegetables. The category of fried potatoes ultimately was not included in any of the dietary analyses.[81,82]

Additionally, the BRFS recommends comparing groups based on meeting dietary guidelines of ≥1 fruit intake per day (**Fruit Intake Guideline** variable), ≥1 vegetable intake per day (**Vegetable Intake Guidelines** variable), and a combined fruit and vegetable guideline of

≥1 each per day (**Combined F/V Intake** Guidelines variable) in order to screen for very low intake levels. Participants were compared to the guidelines to create dichotomous variables of meeting or not meeting the guidelines. As such, frequencies of “not at all”, “1-3 days” and “4-6 days” were coded as 0 (inadequate intake), whereas “1 time per day”, “2 times per day”, and “3 or more times per day” were coded as 1 (adequate intake).

The research team also added a question asking how often the child consumes foods that were grown in the family garden to create the **Garden Consumption** variable. This variable informed whether a proportion of the reported fruit and vegetable intake came directly from the garden.

Mental Health Status: Mental health symptoms were assessed using questions from the 2023 National Health Interview Survey (NHIS)[83], intended for children ages 5-17 years old. Depressive symptoms frequency were estimated by parent reports of the frequency that the child seems sad or depressed (2023 NHIS DEP.001). Anxiety symptoms frequency was estimated by reports of the frequency that the child seems anxious, nervous or worried (2023 NHIS ANX.001). Frequency options were daily, weekly, monthly, a few times a year, or never. Child mental health was coded into separate dichotomous groups of “daily”, “weekly” and “monthly” symptoms (1) compared to “a few times a year” and “never” (0)[84–86] to create the **Depression** and **Anxiety** variables.

2.2.2 Independent Variables

2.2.2.1 Gardening Involvement

Parents were asked to report if the family currently has a garden. A garden was defined as growing produce, herbs or other edible plants, which follows the wording used in a recent gardening study.[63] Accordingly, both parent and child were categorized into **Gardening** vs **Non-gardening** groups. If parents indicated non-gardening status, gardening question were skipped.

There have not been previous studies about youth involvement in home/community gardening, therefore all gardening-related questions were created by the research team. Parents were asked to indicate the garden type (outdoor home garden; community garden; other - please specify), weeks spent gardening since the beginning of the year, if the parent participates in at least half of the family gardening activities, and if the child helps with gardening tasks or plays outside while family members are gardening.

Participants were asked to quantify the number of minutes over the past seven days that their child helped with gardening tasks. Next, participants were asked to quantify the total number of minutes during the past week that their child spent doing specific gardening tasks: digging, raking, weeding, mulching, hoeing, sowing seeds, harvesting, watering, mixing soil, planting transplants, or other (please specify). Minutes helping a family member with gardening tasks was used to cross validate the reported minutes spent doing specific gardening tasks and was not incorporated into the overall MVPA minutes variable. Minutes spent doing specific gardening tasks was incorporated into total MVPA minutes variable by using MET equivalents to convert task minutes into relative MVPA.[37]

Additionally, participants reported the total minutes the child played outside while a family member was gardening during the past 7 days, with a specification to not including time spent doing gardening tasks. Minutes the child played outside while a family member gardened was incorporated into the overall MPVA value after the transformation detailed below. Outdoor play time often includes a mix of sedentary time, low physical activity, and MVPA; however total outdoor play time is still strongly associated with improved BMI.[79] It is estimated that of total outdoor play time, 53% is spent in sedentary time, 14% in MVPA and 44% in total physical activity.[73] As such, total outdoor play time while parents were gardening was multiplied by 0.14 to create a MVPA equivalent and added into the child's total MVPA value.

For all open response questions where minutes of activity were reported, if the participant input minutes for at least one of the days but left other days blank, it was assumed that days without a response were intended to report zero minutes.

The variable **Gardening Encouragement** and **Parent Gardening Belief** variables were measured using a 5-point Likert scale ranging from “disagree” to “agree” to rank the statements, “I encourage my child to garden with me” and “Gardening makes it easier for my child to be active,” respectively. Responses were collapsed into categories of disagree/somewhat disagree (0) and neutral/somewhat agree/agree (1).

2.2.4 Potential Mediators

2.2.4.1 Parent Health Behaviors

Parent health behaviors were collected so that relationships between parent behavior and child behavior could be evaluated.

Physical-Activity Frequency, Intensity, and Duration: Parent PA levels were also self-reported using similar methods as child PA (MPA and VPA reported for each day of the previous week). The introduction was adapted in order to reflect MPA/VPA classification examples that are more relevant to an adult population. Examples from the PAG[2] for health adults were also provided to aid participant classification of PA intensity. MPA and VPA was reported using the open-response question, “During the past week, how many minutes did you participate in moderate and vigorous-intensity leisure-time physical activities, which means activities that were NOT part of housework, job duties or transportation?” Parents then reported MPA and VPA minutes for each day of the previous week. Direct wording from the NHANES physical activity questionnaire for adults (2022 NHANES PAQ.790)[88] was used. For adults, reported moderate PA and vigorous PA were incorporated into the **Parent MVPA** variable using the same methods utilized for the Child MVPA variable. Physical activity levels were also compared using physical activity guideline adherence. A dichotomous variable, **MVPA**

Guidelines, was created that indicated whether the participant met (1) or failed to meet (0) the guidelines of 150 minutes of MVPA per week.

Sedentary Behaviors: Parent sedentary behavior was reported using the question, “The following question is about sitting at work, at home, getting to and from places, or with friends, including time spent sitting at a desk, traveling in a car or bus, reading, playing cards, watching television, or using a computer. Do not include time spent sleeping.” Multiple choice responses and coding included: “about 4 hours a day or less” (4), “about 5 hours a day” (5), “about 6 hours a day” (6), “about 7 hours a day” (7), “about 8 hours a day” (8), “about 9 hours a day” (9), “about 10 or more hours a day” (10). Parents reported both weekday and weekend sedentary time. Weekday and weekend values were combined and averaged to create the **Parent Sedentary Time** variable. Wording for the questions on sedentary behavior were taken from NHANES sedentary behavior question for adults (2022 NHANES PAQ.680). The NHANES question is free response, so the multiple choice options were provided that mirrored responses used for children questions.

Diet: Parent diet was reported using the same questions used for child diet to ease participant survey burden and to allow comparison between dietary patterns reported for the child and parent. **Parent Fruit Intake** and **Parent Vegetable Intake** variables were created using the same methods used for child dietary variables. As was done with child dietary outcomes, parent dietary outcomes were compared to the guidelines to create dichotomous variables of meeting or not meeting the guidelines to create the **Parent Fruit Intake Guidelines**, **Parent Vegetable Intake Guidelines and Parent Combined F/V Intake Guidelines** variables.

2.3 Statistical Analysis

Descriptive statistics (i.e., mean, standard deviation, frequency, and proportion) were calculated to describe the demographic information. The assumptions of t-test and linear regression were tested before corresponding statistical tests were conducted. Outliers were

removed for tests that compared mean or median values (i.e. difference in mean vegetable intake between groups). One Non-gardening case was excluded from the child MVPA analysis due to an abnormally high reported PA level of 3840 minutes/week, equating to 9.1 hours of MVPA per day (See Appendix: Figure A1 for boxplot and histogram displays used to determine child MVPA outliers). Two parent MVPA values were excluded as outliers using by boxplot diagnosis. One child vegetable intake value was excluded from the comparison of mean and median intake due to boxplot indication as an outlier. If Levene's test indicated unequal variance on a t-test, the appropriate t and p-values were reported.

Independent sample t-tests were carried out to determine whether differences existed between the Gardening and Non-gardening groups utilizing the corresponding variables described previously: child health outcomes of BMI, MVPA minutes, meeting MVPA guidelines, sedentary time, fruit intake, vegetable intake, meeting dietary guidelines, anxiety and depression symptoms, and parent health outcomes of MVPA minutes, sedentary time, fruit intake and vegetable intake, meeting MVPA guidelines and meeting dietary guidelines.

Fisher's exact test was conducted to assess for differences between groups in median values for the variables of child health perception, weight perception, fruit intake and vegetable intake. Interquartile ranges (IQR) were provided for each variable tested.

Regressions were conducted to provide greater insight into the relationship between child health outcomes and related independent variables. Hierarchical multiple regression analyses were conducted to examine the relationship between parent outcomes and demographics on child outcomes of sedentary time, fruit intake and vegetable intake. Each independent variable was entered into the regression equation in a stepwise fashion. Independent variables selected for regressions were chosen based statistical significance determined by bivariate analyses (Appendix: Tables 1-2;4-5) or by practical significance, where previous literature has shown that the included covariate is associated with the analyzed child health outcome. All potential covariates were checked for collinearity (Appendix: Tables A2 &

A4). If several covariates displayed both statistical significance with the outcome variable and significant collinearity with another covariate, only one covariate was selected for the regression analysis based on practical significance. When multiple statistically significant covariates were included in a regression, order of covariate was determined by descending p-value. If statistically and practically significant covariates were included in a regression, the researchers' best judgement determined the order of covariate inclusion into the regression. When variables were coded into related dummy variables, the category with the highest number of responses was utilized as the reference variable (i.e., for race, most respondents reported "white" compared to "other." As such, "white" was coded as the reference variable). Reference variables are indicated on associated tables.

Mediation analyses are used to explore the direct effect between an independent and dependent variable, as well as the indirect effect through a mediator variable.[89] These analyses were used to investigate if parental health behaviors (i.e., parent fruit intake, vegetable intake and sedentary time on corresponding child outcomes) mediate the association between gardening status and child health outcomes. Total direct effect of the relationship between the dependent and independent variables are indicated by the "c." When the mediating variable is introduced, the path between the independent and mediating variable is indicated by "a", the path between the mediating variable and dependent variable is indicated by "b", and the path between the independent and dependent variable is indicated by the "c", path. Results suggesting that path a and path b are both significant, and c' is non-significant indicate a full mediation by the mediating variable. Indirect effect of the relationship is indicated by the effect of X on Y via the mediating variable. PROCESS macro for SPSS v4.1 was utilized for mediation analyses.

P-value significance level was set at $\alpha = 0.05$ for all hypotheses. The only variables that utilized multiple tests to determined hypothesis conclusion was for dietary intake (fruit intake variable and vegetable intake variable) and meeting dietary guidelines (fruit guidelines,

vegetable guidelines, and combined fruit and vegetable guidelines). As such, Bonferroni adjustment was used to generate an adjusted significance level of 0.025 to reduce the instance of a false positive for these outcomes and the related hypotheses.

The data were processed and analyzed using SPSS (version 28.0.1). Listwise deletion was applied to handle missing data. In other words, analyses for specific outcomes only included complete responses for the related survey question(s).

CHAPTER 3: RESULTS

3.1 Demographics and Characteristics

Between June 2023 and October 2023, 171 survey responses were recorded, of whom 124 (73%) completed the survey at least through the gardening involvement section, 112 (63%) completed through child health questions and 108 (63%) completed the entire survey. Of those that completed through child health questions, 84 (75%) indicated having a home/community garden and 28 (25%) indicated not (Figure 1).

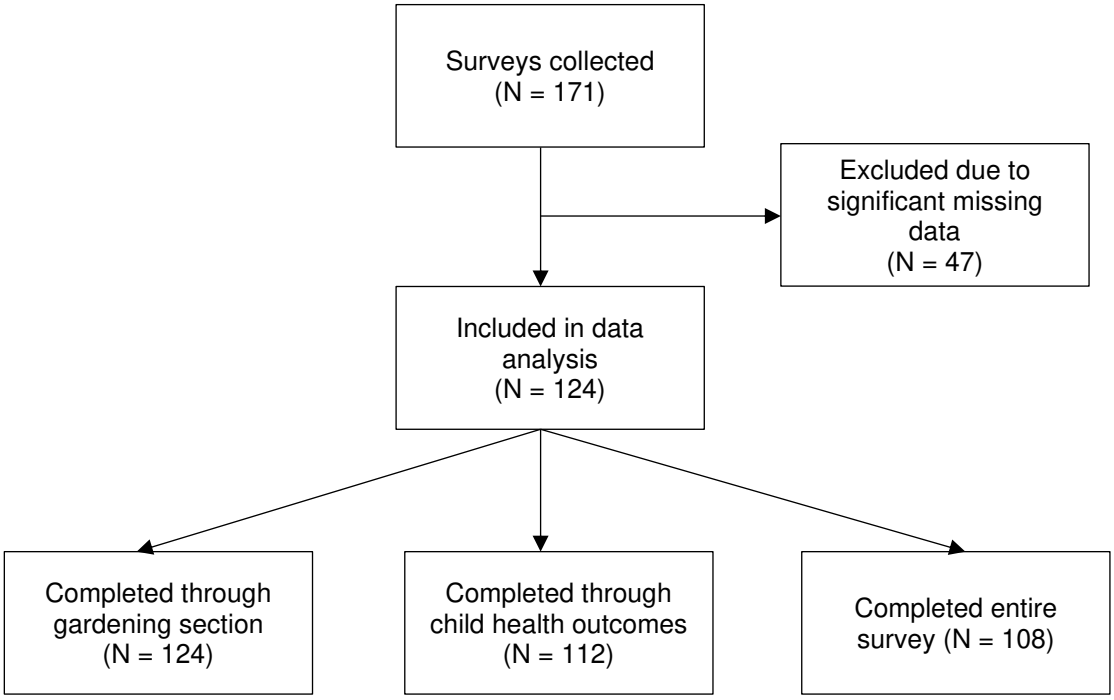

Figure 1. Flow diagram of survey respondents and inclusion in data analysis

Table 2 shows participant demographics for our final sample which included 124 total participants. Our sample included predominately non-Hispanic (97.2%), White (92%) females with mean age of 42.2 ± 6.2 years. Additionally, most held a college degree or higher (95.3%) and were employed full time (68.5%). Children were predominately non-Hispanic (90.1%) and white (92.0%), with 60.7% males and mean age of 8.4 (± 2.1) years.

Table 2. Demographics by Whole Sample and Gardening Status

		Overall		Gardening		Non-Gardening	
		N	Mean or %	N	Mean or %	N	Mean or %
Child	Age in years (Mean ± SD)	122	8.42±2.05	82	8.3±2.0	29	8.8±2.2
	Sex	112		83		29	
	Female		39.29		42.17		31.03
	Male		58.93		55.42		68.97
	Prefer not to answer		1.79		2.40		0.00
	Non-Hispanic (vs. Hispanic)	111	90.18	83	92.77	28	85.71
	Race/Ethnicity	112		83		29	
	White		91.96		91.57		93.10
	Black or Black/White		3.57		3.40		3.45
	Asian or Asian/White		2.68		3.40		0.00
	Other		1.78		1.63		3.45
Parent	Age in years (Mean ± SD)	106	42.2±6.2	79	41.6±5.2	27	43.7±8.3
	Sex	108					
	Female		91.66	80	93.75	28	85.75
	Male				6.25		14.25
	Non-Hispanic (vs. Hispanic)	108	95.37	80	96.25	29	92.85
	Race/Ethnicity	108		80		29	
	White		97.22		96.25		100
	Asian or Asian/White		2.78		3.75		0.00
	Other		0.00		0.00		0.00
	Education	108		80		28	
	Some college		4.63		3.75		7.10
	≥ College graduate		95.37		96.25		92.90
	A.D.		*5.56*		*6.25*		*3.57*
	B.D.		*32.41*		*35.0*		*25.00*
	M/P/DD		*57.41*		*55.0*		*64.33*
	Marital Status	108		80		28	
	Married		86.11		88.75		78.57
	Divorced		8.33		6.25		14.29
	Other		5.56		5.00		7.14
	Employment	108		80		28	
	Full-time		68.52		66.25		75.00
	Part-time		7.41		7.50		7.14
	Self-Employed		14.81		18.75		3.57
	Other		9.26		7.50		14.28
	County of Residence	101		76		25	
	Larimer County		78.22		76.32		84.00
	Denver County		15.84		15.79		16.00
	Other		5.94		7.89		0.00

Notes: Demographic questions were asked at the end of the survey. Thus overall survey N = 124, however only N = 112 completed enough of the survey to answered some or all demographic questions.

Demographics by gardening status did not differ greatly from whole sample demographics (Table 2). Notable differences include a slightly higher proportion of female and

non-Hispanics children from the Gardening group. Gardening parents had a slightly higher proportion female, married and self-employed individuals.

3.3 Dependent Variables

3.3.1 Child Health Outcomes

3.3.1.1 BMI and Health Perception

Fisher's exact tests indicated non-significant difference in parent perception of child health ($z(112) = 1.56$, $p = 0.87$) and weight ($z(113) = 5.14$, $p = 0.14$) between Gardening and Non-Gardening groups. (Table 4) Both groups reported a median heath perception of "excellent" and median weight perception of "about the right weight." Fisher's exact tests likewise indicated a non-significant difference in health and weight perception between the groups ($t(109) = -0.23$, $p = 0.40$) (Table 4). Mean BMI was 16.53 (SD = 2.74) and 16.58 (SD = 2.70) for the Gardening and Non-gardening group respectively (Table 3). Healthy BMI is interpreted as being between the 5th percentile to < 85th percentile,[90] however a BMI of 16.4-16.6 falls within the healthy range for children ages 6-14 for both sexes.

3.3.1.2 Physical Activity

Results of independent samples t-test indicate that minutes of MVPA did not differ between Gardening and Non-Gardening groups. Mean MVPA minutes were 988.50 (SD = 573.80) for the Gardening group and 1148.36 (SD = 787.86) for the Non-gardening group (Table 3). Both groups had mean MVPA minutes above the recommended guidelines (420 minutes per week) and 90.4% of Gardening children and 82.8% of Non-gardening children met the MVPA minutes guidelines. Similar to the mean MVPA minutes, an independent samples t-test indicated that the difference in proportions between the two groups was non-significant ($t(112) = -0.33$, $p = 0.37$) (Table 5).

Table 3. Reports of Child Health Outcomes by Gardening Status (mean values)

Health Outcome	**Gardening**		**Non-Gardening**		***Statistical Method***	***t-statistic***	***p***
	N	Mean (SD)	N	Mean (SD)			
General Health							
BMI (kg/m^2)	83	16.53 (2.74)	28	16.58 (2.70)	T-Test	-0.23	0.40
Physical Activity (minutes MVPA/week)	83	988.50 (573.80)	28	1148.36 (787.86)	T-Test	-0.99	0.17
Sedentary Time (hours/day)	83	1.70 (1.00)	29	2.13 (1.20)	T-Test	-1.95	0.03
Diet							
Fruit Intake (frequency/wk)	83	14.71 (6.57)	29	11.55 (7.60)	T-Test	2.14	0.02
Vegetable Intake (frequency/wk)	82	12.44 (6.38)	29	8.76 (6.36)	T-Test	2.67	0.004
Mental Health							
Anxiety (<1 time per month)	83	0.36 (0.48)	29	0.24(0.44)	T-Test	1.24	0.11
Depression (<1 time per month)	83	0.06 (0.24)	29	0.07 (0.26)	T-Test	-0.17	0.43

Table 4. Child Health Outcomes by Gardening Status (median values)

Health Outcome	**Gardening**		**Non-Gardening**		***Statistical Method***	***Z score***	***p***
	N	Median (IQR)	N	Median (IQR)			
General Health							
Health Perception	83	5.0 (4.0, 5.0)	29	5.0 (4.0, 5.0)	Fisher's Exact	1.56	0.87
Weight Perception	84	3.0 (3.0, 3.0)	29	3.0 (3.0, 3.0)	Fisher's Exact	5.14	0.14
Diet							
Fruit Intake (frequency/wk)	83	16.0 (7.0, 21.0)	29	9 (7.0, 16.0)	Fisher's Exact	19.04	0.07
Vegetable Intake (frequency/wk)	82	11.5 (7.0, 18.0)	29	7 (5.0, 12.0)	Fisher's Exact	24.84	0.05

Table 5: Child percentages (weighted) for meeting recommended guidelines

Health Outcome	Gardening			Non-Gardening			*T*	*p*
	N	Mean (SD)	% Below Guidelines	N	Mean (SD)	% Below Guidelines		
MVPA Guideline	83	0.90 (0.40)	9.6%	29	0.83 (0.38)	17.2%	-0.33	0.37
Fruit Intake Guideline	83	0.87 (0.33)	12.0%	29	0.79 (0.41)	20.7%	1.02	0.16
Vegetable Intake Guideline	83	0.82 (0.39)	18.1%	29	0.66 (0.48)	34.5%	1.84	0.05
Combined F/V Intake Guideline	83	0.77 (0.42)	22.9%	29	0.55(0.51)	44.8%	2.09	0.02

3.3.1.3 Sedentary Behavior

Based on independent samples t-test, there was a difference in overall sedentary hours between Gardening children (M = 1.70 hours, SD = 1.00) and Non-gardening children (M = 2.13 hours, SD = 1.20, t(112) = -1.95, p = 0.03)) (Table 3). When sedentary time was divided into weekday and weekend categories, Gardening youth had lower weekend sedentary time (M = 2.0, SD = 1.2) compared to Non-gardening youth (M = 2.6, SD = 1.3, t(112) = -1.97, p = 0.03) (Appendix: Table A5). The difference in weekday sedentary time was non-significant between groups.

3.3.3.4 Diet

Intake of fruits and vegetables were reported by both mean and median (Tables 3-4). Mean weekly fruit intake was 14.71 (SD = 6.57) frequencies per week for Gardening youth and 11.55 (SD = 7.60) frequencies for Non-gardening youth. Median intake was 16 frequencies (IQR = 7.0, 12.0) for Gardening youth and 9 frequencies (IQR = 7.0, 16.0) for Non-gardening youth. Mean vegetable intake was 12.44 frequencies (SD = 6.38) and 8.76 frequencies (SD = 6.36) for Gardening and Non-gardening youth respectively. Median vegetable intake was 16 (IQR = 7.0, 21.0) and 12 (IQR = 7.0, 18.0) for Gardening and Non-gardening groups respectively. Independent sample t-tests indicated that there was a difference in mean fruit intake between the Gardening and Non-gardening groups (t(110) = 2.14, p = 0.02). Fisher's exact tests indicated that median fruit intake did not differ. Mean vegetable intake was different (t(109) = 2.67, p = 0.004), as well as median vegetable intake (z(109) = 24.8, p = 0.05).

Groups were compared using the Fruit Intake Guidelines variable, Vegetable Intake Guideline variable and Combined F/V Intake Guideline variable to test for differences in very low consumption of a dietary category. Utilizing Bonferroni adjusted p value of 0.017 (0.05 divided by 3 associated variables), independent samples t-test indicated that there was a non-significant difference between the proportion of youth that met the fruit dietary guidelines ($t(112) = 1.02$, $p = 0.16$), that met the vegetable intake guidelines ($t(112) = 1.84$, $p = 0.05$) and that met the combined F/V intake guidelines ($t(112) = 2.09$, $p = 0.02$) (Table 5).

3.3.3.5 Mental Health

Independent sample t-tests indicated that anxiety and depression symptoms did not significantly differ between Gardening and Non-Gardening groups. Mean anxiety frequency for the Gardening group was 0.36 (SD = 0.48) and 0.24 (SD = 0.44) for the Non-gardening group ($t(112) = 1.24$, $p = 0.11$). Mean score of depression symptom was 0.06 (0.24) for the Gardening group and 0.07 (0.26) for the Non-gardening group ($t(112) = -0.17$, $p = 0.43$) (Table 3).

3.2 Independent Variables

3.2.1 Gardening Involvement

Of the responses completed at least through the gardening involvement section (N = 124), 76.6% (N = 95) indicated having a home and/or community garden, with 98% indicating an outdoor home garden or qualifying other garden, and 2% indicating having both a home and community garden. Children spent an average of 49.8 minutes helping with gardening tasks per week and 130.5 minutes additional minutes playing outside while a family member gardened. The time spent doing specific gardening tasks varied, with the watering and weeding as most frequent activities, with 20.3 and 20.2 mean minutes respectively (Appendix: Table A6)

Ninety percent of gardening parents agreed or somewhat agreed that they encourage their child to garden. Parents were also asked how strongly they agree with the statement that gardening makes it easier for their child to be active. Although this question was intended for only gardening parents, it was discovered after data collection that flawed display logic coding

caused the question to be displayed to all participants. Despite the error, the inclusion of gardening-based health benefit beliefs of both Gardening and Mon-gardening parents provides interesting insight into between group belief differences. Of the Gardening parents, 56% agreed/somewhat agreed, 33% were neutral and 11% disagreed/somewhat disagreed that gardening involvement makes it easier for the child to be active. Of the Non-gardening parents, 24% agreed/somewhat agreed, 31% were neutral and 45% disagreed/somewhat disagreed (Appendix: Table A7). Most gardening parents and children reported consuming produce from their garden at least weekly (70.8% and 73.2% respectively) (Appendix: Table A8).

3.2.2 Parent Health Behaviors

3.2.2.1 Physical Activity

Results of independent samples t-test indicate that minutes of MVPA did not differ significantly between Gardening and Non-Gardening groups. Mean MVPA minutes were 532.66 (SD = 367.72) for the gardening group and 544.62 (SD = 467.60) for the Non-gardening group (Table 6). Both groups had mean MVPA minutes above the recommended guidelines (420 minutes per week) and 92.2% of gardening parents and 92.3% of Non-gardening parents met the MVPA minutes guidelines. Similar to the mean MVPA minutes, an independent samples t-test indicated that the difference in proportions between the two groups was non-significant ($t(103) = -0.02$, $p = 0.50$) (Table 8).

3.2.2.2 Sedentary Behavior

Based on independent samples t-test, there was not a significant difference in overall sedentary hours between gardening parents (M = 5.18 hours, SD = 1.29) and Non-gardening parents (M = 4.88 hours, SD = 0.90, $t(108) = 1.14$, $p = 0.13$)) (Table 6).

Table 6. Parent health outcomes by gardening status (mean values)

Health Outcome	Gardening		Non-Gardening		*Statistical Method*	*t-statistic*	*p*
	N	Mean (SD)	N	Mean (SD)			
Physical Activity (minutes MVPA/week)	77	532.66 (367.72)	26	544.62 (467.60)	T-Test	-0.13	0.45
Sedentary Time (hours/day)	80	5.18 (1.29)	28	4.88 (0.90)	T-Test	1.14	0.13
Diet							
Fruit Intake (frequency/wk)	80	11.45 (7.29)	28	8.39 (5.25)	T-Test	2.38	0.01
Vegetable Intake (frequency/wk)	79	17.65 (8.71)	27	14.15 (9.30)	T-Test	1.77	0.04

Table 7. Parent dietary categories by gardening status (median values)

Health Outcome	Gardening		Non-Gardening		*Statistical Method*	*Z score*	*p*
	N	Median (IQR)	N	Median (IQR)			
Diet							
Fruit Intake (frequency/wk)	80	13.00 (5.00, 14.00)	28	7 (5.00, 14.00)	Fisher's Exact	11.61	0.64
Vegetable Intake (frequency/wk)	79	17 (11.00, 23.00)	27	12 (7.00, 21.00)	Fisher's Exact	27.31	0.16

Table 8. Parent percentages (weighted) for meeting recommended guidelines by gardening status

Health Outcome	Gardening			Non-Gardening			*T statistic*	*p-value*
	N	Mean (SD)	% Below Guidelines	N	Mean(SD)	% Below Guidelines		
MVPA Guideline	77	0.92 (0.27)	7.8%	26	0.92 (0.27)	7.7%	-0.02	0.50
Fruit Intake Guideline	80	0.75 (0.44)	25.0%	28	0.68 (0.48)	32.1%	0.73	0.23
Vegetable Intake Guideline	79	0.94 (0.25)	6.3%	27	0.89 (0.32)	11.1%	0.81	0.21
Combined F/V Intake Guideline	79	0.73 (0.44)	26.6%	27	0.63 (0.49)	37.0%	1.03	0.15

3.2.2.3 Diet

Intake of fruits and vegetables were reported by both mean and median (Tables 6-7). Mean weekly fruit intake was 11.45 (SD = 7.29) frequencies per week for gardening parents and 8.39 (SD = 5.25) frequencies for Non-gardening parents. Median intake was 13.0 frequencies (IQR = 5.00, 14.00) for gardening parents and 7.00 frequencies (IQR = 5.00, 14.00) for Non-gardening parents. Mean vegetable intake was 17.65 frequencies (SD = 8.71) and 14.15 frequencies (SD = 9.30) for Gardening and Non-gardening parents respectively. Median vegetable frequency was 17.00 (IQR = 11.00, 23.00) and 12.00 (IQR = 7.00, 21.00) for Gardening and Non-gardening groups respectively. Independent sample t-tests utilizing a Bonferroni adjusted p value of 0.025 indicated that there was a difference between the Gardening and Non-gardening groups in mean fruit intake, $t(80) = 2.38$, $p = 0.01$, but not in mean vegetable intake, $t(78) = 1.77$, $p = 0.04$. Fisher's exact tests indicated that median fruit and vegetable intake did not differ significantly. The Gardening and Non-gardening groups were also compared based on proportion meeting the dietary guidelines; however, no significant difference was found between groups (Table 8).

3.2 Mediating Variables

Child sedentary and dietary outcomes were analyzed using regressions and mediation analyses to investigate the potential relationship between independent variables and child health outcomes that were found to differ based on gardening status.

3.2.1 Child Sedentary Outcomes

Simple bivariate linear regression (unadjusted) revealed that child sedentary time had a linearly association with child gardening-status ($\beta = 0.44$, $p = 0.05$), sex ($\beta = -0.41$, $p = 0.05$), and age ($\beta = 0.12$, $p = 0.01$), suggesting that attributes of older age, non-gardening and male sex were associated with higher sedentary time (Appendix: Table A1). Hierarchical linear

Table 9. Ascending hierarchical multiple-linear regressions of child demographic covariates on child sedentary time.

	Model 1: Gardening status			**Model 2: Gardening status, sex**			**Model 3: Gardening status, sex, age**		
	B	95% CI	p	B	95% CI	p	B	95% CI	p
Gardening									
Gardening (ref.)	-	-	-	-	-	-	-	-	-
Non-gardening	0.46	(0.02, 0.91)	0.04	0.42	(0.97, 2.67)	0.06	0.37	(-0.70, 0.80)	0.10
Child sex									
Male (ref.)				-	-	-	-	-	-
Female				-0.40	(-0.80, 0.00)	0.05	-0.39	(-0.79, 0.00)	0.05
Child age							0.105	(0.009, 0.20)	0.03
R^2		0.04			0.07			0.11	

Table 10. Ascending hierarchical linear regressions of parent covariates on child sedentary time.

	Model 1: Gardening status			**Model 2: Gardening status, parent sedentary time**			**Model 3: Gardening status, parent sedentary time, parent age**		
	B	95% CI	p	B	95% CI	p	B	95% CI	p
Gardening									
Gardening (ref.)	-	-	-	-	-	-	-	-	-
Non-gardening	0.45	(-0.02, 0.91)	0.06	0.47	(0.01, 0.94)	0.05	0.40	(-0.06, 0.86)	0.09
Parent sedentary time				0.12	(-0.05, 0.29)	0.18	0.12	(-0.05, 0.28)	0.18
Parent age							0.04	(0.003, 0.07)	0.03
R^2		0.03			0.05			0.09	

regression incorporating these variables indicated that these variables explained 11.3% of the variance (R^2 = 0.11, F(3,105) = 4.45, p = 0.006). It was found that sex predicted sedentary time (β = -0.39, p = 0.05), as did age (β = 0.11, p = 0.03). These results indicate that sex and age are more likely to be associated with sedentary time than gardening status (Table 9).

Parent demographics and health outcomes were also checked for bivariate association with child sedentary time (Appendix: Table A3). A hierarchical linear regression was conducted of child sedentary time with covariates of gardening status, parent sedentary time, and parent age. Parent age and gardening status were chosen due to statistical significance in bivariate linear regression. Although bivariate analysis indicated that parent sedentary time was not significantly related to child sedentary time, this variable was chosen based on practical significance. The regression indicated that 9.2% of the variance was explained by these variables (R^2 = 0.09, F(3,102) = 3.44, p = 0.02). It was found that gardening status had a positive linear association with sedentary time when parent sedentary time and garden status were included as covariates (β = 0.47, p = 0.05) and (β = 0.12, p = 0.18) respectively. However, when parent age was introduced into the regression, only parent age had a linear association with child sedentary time (β = 0.04, p = 0.03). (Table 10)

Mediation analysis was also performed to examine the mediation effect of parent sedentary time on the association between gardening status and child sedentary time. Status as a Gardener was negatively associated with child sedentary time (c: β = -0.44, 95% CI: 0.01, 0.88, p = 0.05). Gardener status was not associated with parent sedentary time (a: β= -0.3, 95% CI: -0.82, 0.22, p = 0.23), nor was parent sedentary time associated with child sedentary time (b: β = 0.13, 95% CI: -0.04, 0.29, p = 0.14). Gardening status was still associated with child sedentary time after the inclusion of parent sedentary time (c': β = -0.48, 95% CI: -0.94, -0.02, p = 0.04), suggesting that the relationship between gardening status and child sedentary time was not mediated by parent sedentary time (Appendix: Figure A2). Indirect effect of gardening status on child sedentary time was β = 0.04, 95% CI: -0.02, 0.12.

3.2.1 Child Dietary Outcomes

Bivariate linear regressions did not demonstrate associations between child demographics and child mean fruit or vegetable intake (Appendix: Table A1); however, regressions using parent health outcomes and demographics as bivariates showed several statistically significant linear associations with child dietary outcomes (Appendix: Table A3). A hierarchical regression of the effect of gardening status, parent fruit intake and gardening belief on child fruit intake was conducted (Table 11). Although many parent health outcomes demonstrated a positive linear relationship with child fruit intake, only one parent health outcome covariate was included in the regression due to collinearity between parent health outcomes (Appendix: Table A4). The regression indicated that 28% of the variance was explained by these variables (R^2 = 0.28, F(3, 104) = 14.7, p <0.001). After adding parent covariates, gardening status no longer had an effect on child fruit intake. Parent fruit intake had a positive linear effect on child fruit intake (β = 0.51, p <0.001), as did parent gardening belief (β = 4.04, p = 0.01). Incorporating an interaction effect into the regression revealed non-significant results, suggesting that parent fruit intake and parent gardening belief act independently in the regression.

Bivariate analysis reveals that parent fruit intake was associated with gardening status and child fruit intake. Mediation analysis was also performed to examine the mediation effect of parent fruit intake on the association between gardening status and child fruit intake (Figure 2). Status as a Gardener was positively associated with child fruit intake (c: β = 3.16, 95% CI: 0.23, 6.09, p = 0.04). Gardener status was positively associated with parent fruit intake (a: β= 3.06, 95% CI: 0.08, 6.03, p = 0.04) and parent fruit intake was positively associated with child fruit intake (b: β = 0.48, 95% CI: 0.30, 0.65, p = <0.001). Gardening status was no longer significantly associated with child fruit intake after the inclusion of parent intake (c': β = 1.64,

Table 11. Ascending hierarchical linear regressions of parent covariates on child fruit intake.

	Model 1: Gardening status			**Model 2: Parent fruit intake + M1 variable**			**Model 3: Parent gardening belief + M2 variables**			**Model 4: M3 variables + Interaction**		
	B	95% CI	p	B	95% CI	p	B	95% CI	p	B	95% CI	p
Gardening												
Gardening (ref.)	-	-	-	-	-	-	-	-	-	-	-	-
Non-gardening	-3.10	(-6.09, -0.10)	0.04	-1.64	(-4.35, 1.06)	0.23	-0.25	(-3.09, 2.59)	0.86	-0.19	(-3.10, 2.72)	0.90
Parent fruit intake				0.48	(0.30, 0.65)	<0.001	0.51	(0.34, 0.68)	<0.001	0.55	(0.14, 0.97)	0.01
Parent gardening belief							4.04	(0.95, 7.14)	0.01	4.65	(-1.59, 10.89)	0.14
Interaction (Parent fruit intake × Parent gardening belief)										-0.05	(-0.50, 0.40)	0.82
R^2		0.04			0.24			0.28			0.27	

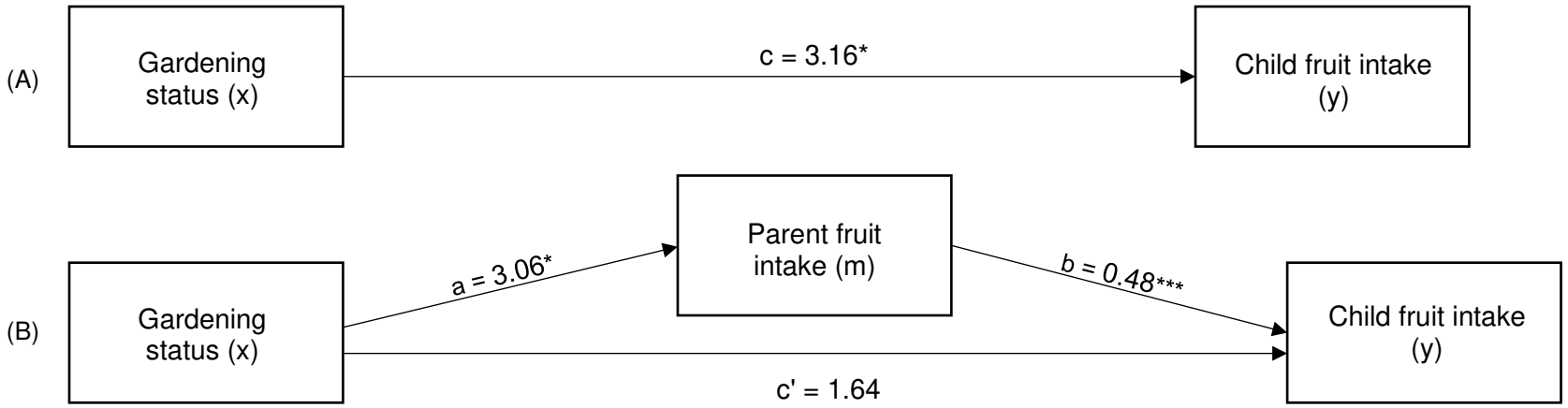

Figure 2. Mediation analysis for the influence of parent fruit intake on the relationship between gardening status and child fruit intake.

*Notes: (A) Illustration of total effect; (B) Illustration of a mediation effects; Path c: Total Effect; Path c': Direct effect; a Path ab: Indirect effect; * = p<0.05; ** = p<0.01, *** = P<0.001*

95% CI: -1.06, 4.34, p = 0.23), suggesting that parental fruit intake fully mediated the relationship between gardening status and child fruit intake. The indirect effect of gardening status on child fruit intake via parent fruit intake was β = 1.45, 95% CI: 0.24, 2.82.

Hierarchical regression was also conducted on child vegetable intake with covariates of gardening status, parent vegetable intake, and education. All covariates were selected based on statistical bivariate significance with child vegetable intake. As with the child fruit intake regression, only one parent health outcome covariate was included due to collinearity. The regression indicated that 17% of the variance was explained by these variables (R^2 = 0.17, F(3,101) = 7.01, p <0.001). Non-gardening status had a negative linear association with child vegetable intake (β = -3.4, p = 0.02), whereas parent vegetable intake had a positive association (β = 0.21, p = 0.004). When gardening belief was added into the regression it did not have an association with child vegetable intake. We further examined the interaction term of gardening status × parent vegetable in the vegetable intake model, but it was not statistically significant, suggesting that the two variables act independently in the regression (Table 12).

Mediation analysis was also performed to examine the mediation effect of parent vegetable intake on the association between gardening status and child vegetable intake (Figure 3). Gardening status (Gardener) was positively associated with child vegetable intake (c: β = 3.68, 95% CI: 0.95, 6.41, p = <0.01). Gardening status as a Gardener was not associated with increased parent vegetable intake (a: β= 3.27, 95% CI: -0.60, 7.15, p = 0.10); however, was parent vegetable intake was associated with increased child vegetable intake (b: β = 0.22, 95% CI: 0.09, 0.36, p = <0.01). Additionally, gardening status was still associated with child vegetable intake after the inclusion of parent vegetable intake (c': β = 3.22, 95% CI: 0.48, 5.97, p = 0.02), suggesting that parent vegetable intake did not fully mediate the relationship between gardening status and child vegetable intake. The indirect effect of gardening status on child vegetable intake with mediator of parental vegetable intake was β = 0.73, 95% CI: -0.14, 2.15.

Table 12. Ascending hierarchical linear regressions of parent covariates on child vegetable intake.

Parent Variable	Model 1: Gardening status			Model 2: Vegetable intake + M1 variable			Model 3: Education + M2 variables			Model 4: Parent gardening belief + M3 variables			Model 5: M4 variables + Interaction		
	B	95% CI	p	B	95% CI	p	B	95% CI	p	B	95% CI	p	B	95% CI	p
Gardening															
Gardening (ref.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-gardening	-4.0	(-6.79, -1.13)	<0.01	-3.22	(-5.97, -0.48)	0.02	-3.40	(-6.14, -0.66)	0.02	-2.62	(-5.54, 0.30)	0.08	-1.18	(-6.62, 4.26)	0.67
Vegetable intake				0.22	(0.09, 0.36)	<0.01	0.21	(0.07, 0.34)	<0.01	0.19	(0.05, 0.33)	<0.01	0.31	(-0.10, 0.72)	0.13
Education															
≤BD							-	-	-	-	-	-	-	-	-
>BD (ref.)							1.76	(-0.67, 4.20)	0.15	1.89	(-0.53, 4.32)	0.13	1.94	(-0.50, 4.38)	0.12
Parent gardening belief										2.43	(-0.83, 5.68)	0.14	2.48	(-0.79, 5.75)	0.14
Interaction (Gardening × Parent gardening belief)													-0.09	(-0.40, 0.21)	0.54
R^2	0.07			0.16			0.17			0.19			0.20		

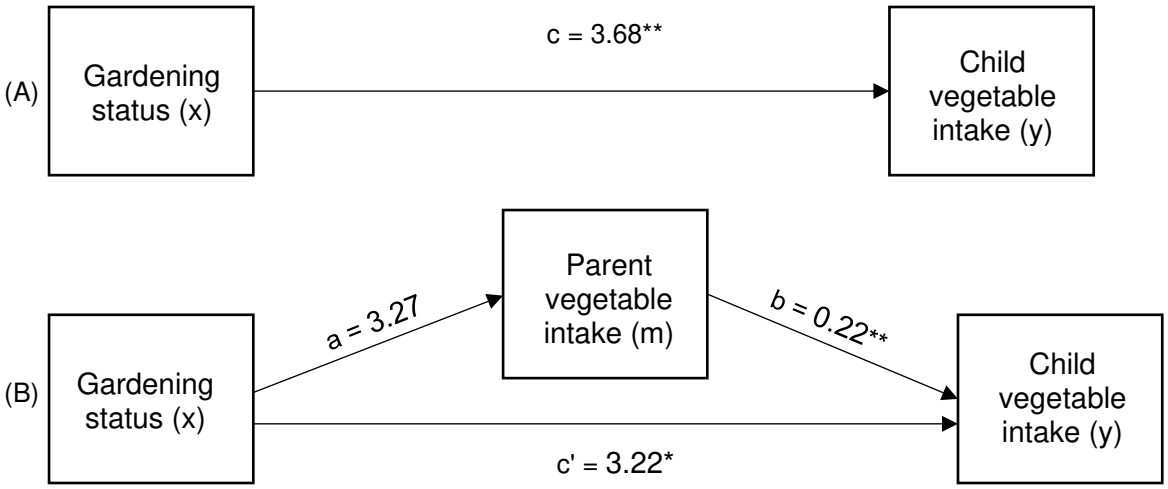

Figure 3. Mediation analysis for the influence of parent vegetable intake on the relationship between gardening status and child vegetable intake.

*Notes: (A) Illustration of total effect; (B) Illustration of a mediation effects; Path c: Total Effect; Path c': Direct effect; a Path ab: Indirect effect; * = p<0.05; ** = p<0.01, *** = p<0.001*

CHAPTER 4: DISCUSSION

4.1 Overview

In this study, we examined the association of youth involvement in a home/community garden with their various health outcomes. BMI and perceptions of overall health and weight did not differ between groups. Gardening youth spent an average of 68.1 MVPA minutes weekly doing gardening-related PA, which constituted 6.9% of their total weekly MVPA. Despite the MVPA originating from gardening-related activities, total weekly MVPA did not differ significantly between the Gardening and Non-gardening groups. Gardening youth had lower weekly sedentary time; however, the association between gardening status and sedentary time disappeared after controlling for child sex and age as well as parent age in separate hierarchical linear regressions. Gardening youth had a higher fruit and vegetable intake; however, there was not a difference between groups in meeting the various dietary guidelines. When controlling for additional variables, parent fruit intake and parent gardening beliefs were more significant predictors of child fruit intake than gardening status. When controlling for selected covariates, both gardening and high parent vegetable intake were associated child higher vegetable intake. None of the two mental health indicators (i.e., depression symptom and anxiety level) were associated with gardening status.

4.2 Youth Involvement in Gardening

To our knowledge, no other study has evaluated the extent to which youth are involved in a home or family-led community garden plot. Our study suggests that youth with a family garden are actively involved in the weekly gardening tasks, and participate in an average of 48.9 minutes of gardening tasks per week. Common tasks that children performed in order of frequency were watering, weeding, harvesting, and digging. Most of the PA obtained through gardening-related activities was of moderate intensity. An additional average of 130.5 weekly minutes was spent playing outside while family members garden. These combined times

suggest that gardening children spend just under 3 hours outside due to gardening-related activities, which was estimated to equate to 68.1 minutes of MVPA.

4.3 Overall health

According to our results, there was not a significant difference in parent perceived child overall health, child weight or parent-reported BMI between the Gardening and Non-Gardening groups. Most school-based gardening studies that have measured BMI have reported modest but positive reductions in child BMI;[35,91,92] however, a school-based randomized controlled trial study in Texas also reported similar findings to this study, showing that gardening children had increases in vegetable intake but no reduction in BMI.[93] The researchers of the trial[93] and others[35] have hypothesized that although school gardening interventions may not always demonstrate an obvious effect on BMI or waist circumference, improved health behaviors are expected to eventually improve other health outcomes. Due to the cross-sectional nature of this study, it is unknown whether continued involvement in a home/community garden, and related higher intakes of fruit and vegetables, would positively affect BMI over the course of several years. Another potential factor that may have impacted the results is that child BMI was self-reported by parents, which may have led to underreporting for both groups.[94] Participant recruitment region does not seem likely to have impacted BMI scores. Recruitment area included all of Colorado, which typically has a child obesity rate lower than the national average;[95] however, a majority of the final sample of participants reside in Larimer County, which has an obesity rate more reflective of the national average.[95,96] Most of the participants came from Colorado State University Youth Sports Camps. Therefore, it is unknown whether the BMI frequency of this population is representative of the Larimer County demographic, which may have affected the potential variability in our participant pool.

4.4 Physical Activity

Physical activity, reported in moderate-vigorous physical activity minutes, did not differ significantly between Gardening and Non-Gardening groups. There was also no significant

difference between the two groups in meeting the physical activity guidelines, with a majority of participants in both groups meeting the guidelines. As previously mentioned, many studies evaluating the impact of school gardens on child health outcomes have reported increased physical activity.[32] One difficulty with comparing school-based gardening studies is that the methodology included is often limited. This makes it difficult to elucidate whether the physical activity performed was specifically gardening activities or was supplemental non-gardening physical activity incorporated into curriculum. As such, another difficulty of comparing school-based gardening programs with family-run gardens is that school gardens are likely more structured and include specific lesson plans that set to run for a specific amount of time. Much of the available literature about school-gardening program or interventions do not include the specific instructions utilized during gardening sessions. As such, it is not clear whether school-based gardening sessions were required to last an allotted period of time or concluded once the scheduled work was completed. Child participation in family-based gardening activities may also vary widely based on family culture and expectations for the child. These differences in culture might include if child participation is expected versus purely voluntary, the type, quantity and frequency of tasks the child is asked to perform, and if gardening activities are viewed by the family as enjoyable time together. A final factor that may have influenced the non-significant difference in MVPA between groups is that gardening families may use gardening activities to replace other opportunities for physical activity rather than to replace a sedentary activity. As such, for future studies, it may be valuable to have families report all of their leisure-time activities so that more effective comparisons can be made.

4.5 Sedentary Time

Gardening youth had lower reported sedentary time compared to Non-gardening youth, averaging at 1.7 hours daily compared to 2.1 hours daily respectively. The sedentary time variable was created by combining weekday and weekend sedentary time; however, further analyses indicated that weekend sedentary time, but not weekday sedentary time, differed

between groups. Current recommendations do not set hour limits on child sedentary time, but rather suggest limiting time sedentary time as much as possible,[2,13] as such, this health outcome was not compared to recommended guidelines. When controlling for parent sedentary time and parent age, the effect of gardening status on child sedentary time was reduced. Parent age did not differ significantly between the Gardening and Non-gardening groups, suggesting that younger parent age is a strong predictor of reduced child sedentary time. It is interesting to note that although both gardening parents and children had lower weekend sedentary time, child and parent weekend sedentary time were not strongly correlated. A separate analysis that controlled for child sex and age indicated that sex and age are more likely to be associated with sedentary time than gardening status. Characteristics of younger child age and being female were more strongly related to lower sedentary time than was gardening status.

To our knowledge, only two studies have evaluated the impact of a gardening intervention on youth sedentary behavior, both of which reported non-significant findings.[31,32] Although bivariate analyses found that gardening youth had lower sedentary time, after controlling for other variables our conclusions are similar to the previous studies. Similar to physical activity, gardening status may not strongly predict sedentary behavior because gardening activities may replace other activities of similar intensity instead of sedentary ones.

4.6 Dietary Outcomes

Gardening youth had more positive dietary outcomes compared to Non-gardening youth, reporting higher mean fruit and vegetable intake. Median fruit and vegetable intake and number of youth meeting the dietary intake guidelines did not differ between groups.

When controlling for parent fruit intake and parent gardening beliefs, gardening status was less significant of a predictor for child fruit intake. Our regressions indicated that child fruit intake frequency increased by 0.5 for every 1.0 increase in parent fruit intake frequency. Children whose parents reported a belief in the health benefit of gardening had 4.0 higher fruit intake frequencies. These findings are especially interesting because the main proposed

difference between school and home-based gardens is the influence of parents. In this study, there was a strong correlation between reported parent intake and child intake for almost all dietary categories, providing insight into the effect of parent dietary behaviors on child dietary behaviors. The only child health outcome that was mediated by a parental health outcome was fruit intake. Parent intake full mediated the relationship between gardening status and child fruit intake, indicating that participating in a HCG may increase child fruit intake through the influence of parental behaviors.

A final reiteration is warranted to emphasize that the BRFSS questions ask for reported frequency of food intake, rather than serving frequency. As such, actual serving amount per frequency likely varied, which limitation should be considered in the interpretation and application of these findings.

4.7 Mental Health Outcomes

Indicators of anxiety and depression symptoms did not differ between the two groups. A majority of participants in both groups reported anxiety and depression symptoms at a frequency of less than one time per month. Many qualitative studies including interviews have been done to evaluate the well-being impacts of youth involvement in gardening, and have reported highly positive feelings.[29] It is important to note that these studies reported feelings while gardening, whereas the mental health indicators in this study reported frequency of symptoms over a year. Previous research does not indicate whether mental health improvements that occur during gardening sessions result in long term benefits to well-being. Another reason why the findings are not consistent could be that parents reported child symptoms in our study, whereas the previously mentioned studies use the data reported by the child self. It is unknown whether the time spent doing gardening activities replaced other activities that might be positive for child mental health, such as active outdoors play[97] or family time. Finally, although many qualitative studies have reported mental health benefits associated

with gardening involvement, the findings from this study match the few quantitative findings presented by other studies.

4.8 Parental Influence on Child Health Outcomes

Overall, the strongest indications for an association between parent and child health was illustrated through dietary outcomes. Parent vegetable intake was associated with child vegetable intake. Parent fruit intake was also associated with child fruit intake, and mediation analysis illustrated that parental fruit intake fully mediated the effect seen between gardening status and child fruit intake. Parent sedentary time was not associated with child sedentary time. The relationship between child MVPA and parent MVPA was not tested due to t-test results indicating that MVPA did not differ between the Gardening and Non-gardening groups. Other child health variables collected in this study included mental health, BMI, and overall health variables; however, this study did not collect parental data about these health outcomes. As such, the relationship between child health outcomes and parental behaviors could not be analyzed for these variables. This study has added to the body of evidence suggesting that parental behaviors can have a powerful influence on child behaviors, reinforcing the value of parental involvement in youth health interventions.

4.9 Limitations

Although this study may be one of the first to explore the health benefits of youth participation in a family-based garden, there are limitations to be considered when evaluating the findings. It is important to note that slightly under 75% of the youth in our study were participating in a family-based home/community garden. A relatively small portion of the organizations that disseminated study information were gardening related, and most participants were recruited from a non-gardening source. Despite this, the large proportion gardeners in our sample indicates that individuals with a personal interest in gardening were more likely to volunteer for the study. This study had sufficient samples sizes to conduct several analyses; however, a larger sample of non-gardening youth would have been ideal.

Another limitation of this study is that the participant sample had very few individuals of racial minorities and a large percentage of individuals with higher education degrees. These whole sample characteristics are reflective of the local demographics. As such, thoughtfulness should be used when generalizing these findings to other specific minority populations and socioeconomic classes.

This study caught a cross sectional glimpse into family behaviors during the gardening season, but the data was not collected for where families were in the gardening process. Fluctuations in tasks needed to maintain the garden are likely to vary by week. Asking participants to report behaviors of the previous week is more accurate than reporting typical behaviors; however, reporting previous week does not guarantee that the information is reflective of a typical behavior.

Additionally, this study was survey based, with parents self-reporting health outcomes for both themselves and their child. Self-reported data can be susceptible to the effect of bias and misreported information. Despite such, self-report plays a critical role in behavioral science because it provides a broader picture of populations. Such population views are often impractical or ineffectively caught with solely objective measures or biomarkers of health. Limitations of using self-report were acknowledged in the study design by using precautions such as validated questions where possible, providing detailed instructions and attempting to obtain information from various angles. Using dietary outcomes as a specific example, objective dietary measurements are extremely expensive and have high participant burden. As such, self-report is the most frequently used tool for dietary measurement and use of validated and comparable scales is essential. Furthermore, dietary self-reports are effective tools to capture general differences between populations and to estimate risk associated with dietary quality, rather than to diagnose or quantify actual specifics about diet, such as energy intake.[98] Finally, this study provided mean and median consumption, as well as comparison to low-intake guidelines to give a more comprehensive view of dietary difference between groups.[81]

A final limitation is that this study attempted to catch a broad view of group differences, and so most health outcomes were determined by very few survey questions. As such, it is not an in-depth analysis of the full impact gardening can have on youth, but rather provides some direction into future research studies that can provide depth into the literature around family-based, home gardening.

4.10 Future Directions

As has been previously emphasized, this may be one of the first studies to evaluate the effect of a family-based home or community garden on child health behaviors and outcomes. As such, it is a general and exploratory view of the health benefits that may be seen in children who participate in a family-based garden.

More studies are needed in order to generalize these findings to other populations and to support the findings from this study. Samples that more fully represent minorities and various socioeconomic classes would provide valuable insight into potentially differing effects of gardening among different demographics.

Furthermore, valuable information would be obtained by analyzing each health outcome at greater depth. Few survey indicators were used for each outcome, and so more involved methods of data collection, such as a 24-hour dietary recall or accelerometer use would provide more objective context to the findings presented here. Additionally, conducting intervention studies and policy implementation studies would provide needed information about the effect and practicality of implementing home-based gardening interventions.

Future studies should evaluate the effects of long-term involvement in a family-based garden, both throughout the gardening season and over multiple seasons. This information would provide clarity about the potential impact of a family gardening culture on child health outcomes longitudinally. Additionally, parental influences on child involvement in gardening should also be further studied in order to determine parenting techniques, knowledge and beliefs that may promote child involvement in a home/community garden.

4.11 Implications

Findings from this study suggest that youth involvement in a home and/or community garden can promote positive health outcomes of improved fruit and vegetable intake, as well as potentially reduce sedentary time. Discovering interventions that can improve health behaviors is essential towards progression in curving the acquisition rate of childhood obesity, hypertension, and other health conditions that have historically been “adult diseases”. A home-based gardening intervention would be cost-effective to implement and would draw on existing parent-child relationships to encourage positive health behaviors.

4.12 Conclusions

Youth involvement in a family-based home and/or community garden is associated with lower sedentary time and increased mean frequency of fruits and vegetables. The findings suggest that home and community gardening programs can be an effective strategy for promoting healthier dietary habits and reducing sedentary behavior among youth. Child outcomes of MVPA, mental health and meeting the dietary guidelines did not differ between the Gardening and Non-gardening groups. Regressions indicated that parent vegetable intake was associated with child vegetable intake after controlling for other variables, such as gardening status and certain demographics. Parental involvement of healthy behaviors plays a crucial role in promoting positive health behaviors in children. Parent fruit intake fully-mediated the relationship between gardening status and child fruit intake. These findings suggest that youth involvement in a family-based home/community garden may promote positive health behaviors, and that parental involvement may positively influence child health behaviors.

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APPENDICES

1.1 Additional Tables and Figures

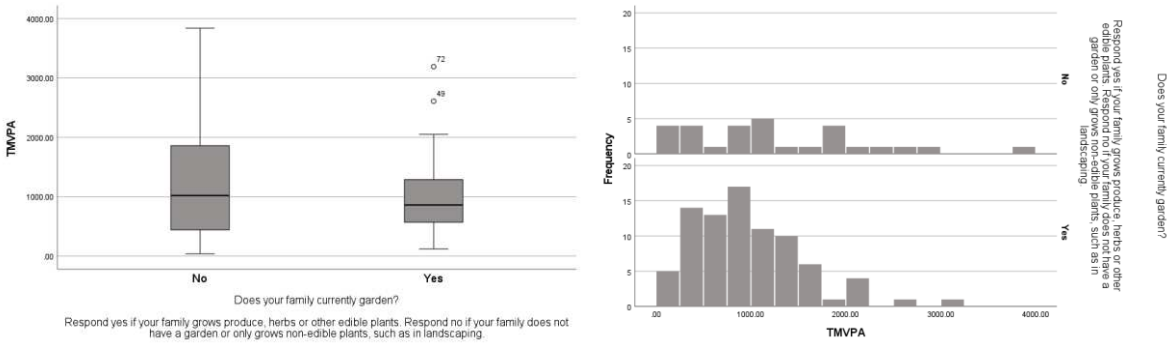

Figure A1: Boxplot and histogram of MVPA reports for gardening and non-gardening children.

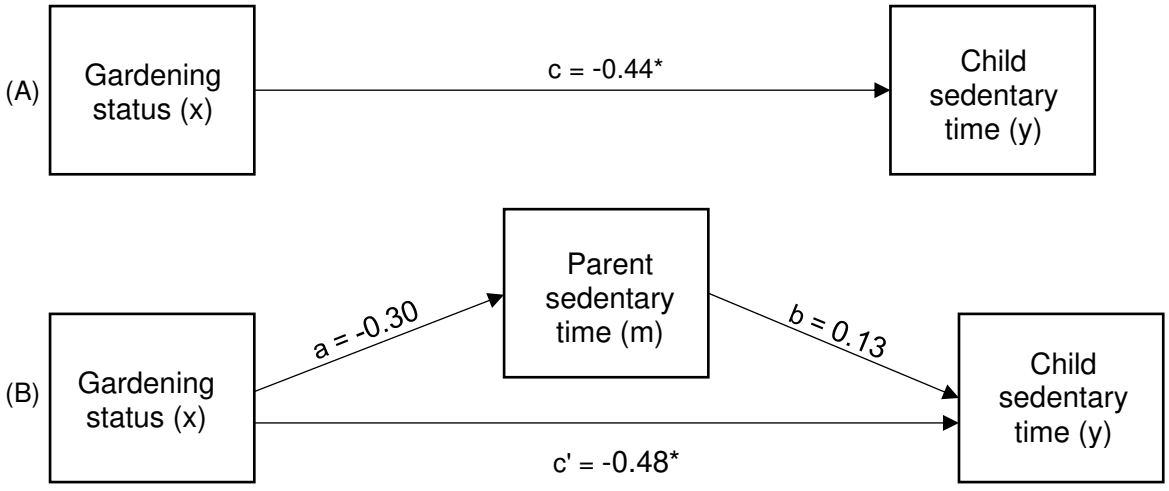

Figure A2. Mediation analysis for the influence of parent sedentary time on the relationship between gardening status and child sedentary time.

*Notes: (A) Illustration of total effect; (B) Illustration of a mediation effects; Path c: Total Effect; Path c': Direct effect; a Path ab: Indirect effect; * = p<0.05; ** = p<0.01, *** = p<0.001*

Table A1. Bivariate association (unadjusted linear regression) of child health outcome variables with potential child covariates

	Weekly fruit intake				Weekly vegetable intake				Sedentary time			
	B	95% CI	p	R^2	B	95% CI	p	R^2	B	95% CI	p	R^2
Gardening												
Gardening (ref.)												
Non-gardening	-3.16	(-6.09, -0.23)	0.04	0.04	-3.68	(-6.41, -0.95)	0.01	0.06	0.44	(-0.01, 0.88)	0.05	0.03
Child sex												
Male (ref.)												
Female	-0.43	(-3.13, 2.26)	0.75	0.01	-0.45	(-3.01, 2.12)	0.73	0.01	-0.41	(-0.81, -0.01)	0.05	0.04
Child race												
White (ref.)												
Other	0.54	(-4.57, 5.06)	0.92	0.00	1.37	(-3.16, 5.89)	0.55	0.003	0.54	(-0.18, 1.26	0.14	0.02
Child age	-0.43	(-1.07, 0.22)	0.20	0.02	-0.17	(-0.78, 0.45)	0.59	0.003	0.12	(0.03, 0.22)	0.01	0.06
Hisp/Latino												
No (ref.)	-	-	-		-	-	-	-	-	-	-	-
Yes	-2.46	(-6.96, 2.05)	0.28		-1.26	(-5.60, 3.08)	0.57	0.06	0.22	(-0.44, 0.87)	0.51	0.06

Notes: B (Unstandardized beta)

Table A2. Bivariate correlates to check for collinearity between child health outcome variables

	Fruit Intake		Vegetable intake		Fruit Guidelines		Vegetable Guidelines		Combined F/V Guidelines		MVPA		Sedentary time		Depression		Anxiety	
	C	p	C	p	C	p	C	p	C	p	C	p	C	p	C	p	C	p
Fruit Intake	-	-	0.53	<0.001	0.59	<0.001	0.38	<0.001	0.55	<0.001	0.18	0.07	-0.15	0.12	0.09	0.34	-0.05	0.64
Vegetable intake	0.53	<0.001	-	-	0.36	<0.001	0.63	<0.001	0.64	<0.001	0.11	0.26	-0.27	0.004	-0.02	0.81	0.09	0.34
Fruit Guidelines	0.59	<0.001	0.36	<0.001	-	-	0.33	<0.001	0.65	<0.001	0.10	0.28	-0.11	0.27				
Vegetable Guidelines	0.38	<0.001	0.63	<0.001	0.33	<0.001	-	-	0.85	<0.001	0.08	0.19	-0.14	0.14				
Combined F/V Guidelines	0.55	<0.001	0.64	<0.001	0.65	<0.001	0.85	<0.001	-	-	0.19	0.04	-1.79	0.06				
MVPA	0.18	0.07	0.11	0.26	0.10	0.28	0.17	0.08	0.19	0.04	-	-	-0.049	0.61				
Sedentary time	-0.15	0.12	-0.27	0.004	-0.11	0.27	-0.14	0.14	-1.79	0.06	-0.049	0.61	-	-				
Depression	0.09	0.34	-0.02	0.81											-	-		
Anxiety	-0.05	0.64	0.09	0.34													-	-

Note: C = Pearson correlation

Table A3. Bivariate association (unadjusted linear regression) of child health outcome variables with potential parent covariates

		Weekly fruit intake			Weekly vegetable intake			Sedentary time		
	Parent Variables	B	95% CI	p	B	95% CI	p	B	95% CI	p
Health Variables	**MVPA**	0.002	(0.001, 0.005)	0.20	0.002	(-0.001, 0.005)	0.19	0.00	-0.001, 0.0	0.29
	Fruit Intake	0.50	(0.33, 0.67)	<0.001	0.32	(0.13, 0.50)	<0.001	-0.05	-0.08, -0.02	<0.001
	Fruit Guidelines	4.33	(1.49, 7.17)	0.003	3.76	(1.02, 6.40)	0.008	-0.31	-0.76, 0.15	0.19
	Vegetable Intake	0.27	(0.13, 0.42)	<0.001	0.25	(0.11, 0.39)	<0.001	-0.03	-0.05, -0.01	0.015
	Vegetable Guidelines	2.86	(-2.35, 8.07)	0.28	1.1	(-4.10, 4.32)	0.96	-0.28	-1.07, 0.51	0.49
	Comb. F/V Guidelines	3.07	(-0.11, 6.26)	0.058	1.96	(-0.59, 4.50)	0.13	-0.29	-0.78, 0.20	0.24
	Sedentary Time	-0.88	(-1.98, 0.23)	0.118	-0.52	(-1.57, 0.53)	0.33	0.14	-0.08, 0.35	0.21
Demographic Variables	**Race**	1.03	(-4.38, 6.43)	0.71	1.63	(-3.46, 6.71)	0.53	1.24	-4.36, 6.84	0.66
	White (ref.)									
	Other									
	Age	0.06	(-0.16, 0.28)	0.59	0.02	(-0.19, 0.24)	0.84	0.04	0.007, 0.072	0.02
	Sex									
	Female (ref.)	-	-	-	-	-	-	-	-	-
	Male	-1.40	(-6.24, 3.43)	0.57	-3.21	(-7.73, 1.31)	0.16	0.02	(-0.72. 0.76)	0.96
	Marital Status									
	Married (ref.)	-	-	-	-	-	-	-	-	-
	Other	1.63	(-2.23, 5.48)	0.41	2.10	(-1.64, 5.83)	0.27	0.05	(-0.54, 0.64)	0.87
	Education									
	BD or lower	1.48	(-1.21, 4.17)	0.28	2.37	(-0.16, 4.89)	0.07	0.17	(-0.25, 0.58)	0.42
	Above BD (ref.)	-	-	-	-	-	-	-	-	-
	Employment									
	Full-time (ref.)	-	-	-	-	-	-	-	-	-
	Other	0.68	(-2.20, 3.56)	0.64	0.71	(-2.01, 3.42)	0.61	0.25	(-0.19, 0.69)	0.26
	County									
	Larimer (ref.)	-	-	-	-	-	-	-	-	-
	Other	-1.80	(-5.14, 1.53)	0.29	0.59	(-2.65, 3.83)	0.72	0.32	(-0.20, 0.84)	0.22
Belief Variable	**Gardening PA Belief**	3.49	(0.26, 6.71)	0.03	4.17	(1.16, 7.17)	0.007	0.06	(-0.44, 0.55)	0.83

Notes: Comb. F/V Guidelines (combined fruit and vegetable guidelines); BD (bachelor's degree). Gardening PA Belief: Gardening helps my child to be physically active. Reponses were coded 1: agree, somewhat agree, neutral; 0: disagree, somewhat disagree

Table A4. Bivariate correlates to check for collinearity between parent health outcome variables.

	Fruit Intake		**Vegetable intake**		**MVPA**		**Sedentary time**		**Gardening Belief**	
	C	p	C	p	C	p	C	p		
Fruit Intake	-	-	0.62	<0.001	0.25	0.01	-0.21	0.03	-0.08	0.40
Vegetable intake	0.62	<0.001	-	-	0.39	<0.001	-0.25	0.01	-0.17	0.08
MVPA	0.25	0.01	0.39	<0.001	-	-	-0.22	0.02	-0.09	0.38
Sedentary time	-0.21	0.03	-0.25	0.01	-0.22	0.02	-	-	0.11	0.27
Gardening belief	-0.08	0.40	-0.17	0.08	-0.09	0.38	0.11	0.27	-	-

Note: C = Pearson correlation

Table A5. Child Sedentary Time by Weekday vs. Weekend

Sedentary Time (hours)	**Gardening**		**Non-Gardening**		***t-statistic***	**Adjusted P-value** Bonferroni Method	***p***
	N	Mean (SD)	N	Mean (SD)			
Weekday	83	1.34 (0.9)	29	1.69 (1.3)	-1.30	0.025	0.063
Weekend	83	2.0 (1.2)	29	2.6 (1.3)	-1.97	0.025	0.026

Table A6: Child Involvement in Home/Community Garden by Task Type

Gardening Task	**Average Minutes: All Participants**		**Average Minutes: Non-Zero Responses**	
	N	Mean ± SD	N	Mean ± SD
Helping with outdoor gardening tasks	90	49.8±62.6		
Outdoor play during gardening session	85	130.5±128.5		
MVPA from outdoor play during gardening session	85	18.3±18.0		
Time spent doing specific gardening tasks	88	49.0±51.0		
Digging	88	5.4±12.2	30	15.9±16.50
Raking	88	3.1±10.6	10	27±19.0
Weeding	88	9.9±15.6	43	20.2±17.1
Mulching	88	1.7±13.1	3	50.0±60.9
Hoeing	88	0.3±1.9	2	12.5±3.5
Sowing Seeds	88	2.8±7.4	17	14.7±10.8
Harvesting	88	5.5±9.7	37	13.1±11.2
Watering	88	15.7±17.0	68	20.3±16.8
Mixing Soil	88	0.6±2.7	6	9.2±5.8
Planting Transplants	88	2.6±8.4	13	17.3±15.2
Other	88	2.2±10.9	7	27.9±29.8

Table A7. Comparison of parent beliefs about gardening participation on child physical activity levels

Parental Belief	**Gardening**		**Non-Gardening**		***Statistical Method***	***T***	***p***
	N	Mean (SD)	N	Mean (SD)			
Gardening helps my child to be active	90	0.89 (0.32)	29	0.55 (0.51)	T-test	3.38	<0.001

Table A8. Frequency of consuming produce from the garden for gardening children and parents.

	< Weekly	**1-6 days per week**	**≥Daily**
Child	26.8%	56.1%	17.1%
Parent	29.1%	46.8%	24.0%

Notes: <Weekly was coded from responses "not at all", 1-6 days was coded from "1-3 days", and "4-6 days"; ≥ daily was coded from "1 time per day", "2 times per day", and "3 or more times per day".

1.2 IRB Approval Letter

PROTOCOLS

kuali

COLORADO STATE UNIVERSITY

The protocol listed below has been approved by the CSU IRB Determinations Fort Collins on Friday, October 13th 2023.

PI: Li, Kaigang

Submission Type and ID: Amendment 4485

Title: Youth Health Behaviors Survey

Approval Date: Friday, October 13th 2023

Expiration Date: Monday, June 19th 2028

The CSU IRB (FWA0000647) has completed its review of protocol 4485 Youth Health Behaviors Survey. In accordance with federal and state requirements, and policies established by the CSU IRB, the committee has approved this protocol under Exempt review.

Any additional comments regarding this approval are included below. If you have additional questions about this please contact IRB Staff.

The IRB has reviewed the above-referenced amendment submission. The IRB has determined this amendment request does not change the level of risk or the level of review required. This study remains exempt under CFR 46.104(d)(2)(ii): Research that only includes interactions

involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording); (ii)Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.
Although this research is considered exempt, CSU expects that researchers continue to follow moral and ethical obligations of research conduct, by honoring the principles in the Belmont Report.
Please note, any changes to the proposed research should be reported to the IRB via an amendment prior to implementation.
Thank you,
CSU_IRB@colostate.edu

Please note:

Any additional changes to this approved protocol must be obtained prior to implementation of those changes, by submitting an amendment request to the CSU IRB for review/approval.

Good luck in your research endeavors!

1.3 Survey

Child Gardening and Health Behaviors Survey

We really appreciate your time in answering EACH question.
Please only complete this survey once, and for one child!

First please tell us about your child.

1. What is your child's month and year of birth? _____(MM)_____(YYYY)

2. How did you hear about our survey?
   - O CSU Youth Sports Camp
   - O Gardens at Spring Creek
   - O Loveland Youth Gardeners
   - O Local business, community event or other source (please specify)

     _____

Next, we would like to ask some questions about the gardening activities that your family does.

3. Did your child participate in a gardening camp last week?
   O Yes O No

4. Does your family currently garden?
   Respond **yes if your family grows produce, herbs or other edible plants. Respond **no** if your family does not have a garden or only grows non-edible plants, such as in landscaping.*

   O Yes O No ** **If you answered "No" skip to question 12.**

5. What type of garden does your family have? (Check all that apply)
   ☐ outdoor home garden ☐ community garden ☐ other (please specify)

   _____

6. Consider your family's gardening activities since the beginning of the year (January 2023). How many weeks has your family been gardening?
   **Count the number of weeks starting when you first sowed seeds.*

   _____ weeks

7. Do you participate in at least half of the family gardening activities?
   ○ Yes ○ No

8. Does your child help with gardening tasks or play outside while family members are gardening?
   ○ Yes ○ No ** **<u>If you answered "No" skip to question 12.</u>**

NOTE: Questions 9-10 ask about your child's participation in **family gardening tasks over the past week**. ***<u>If last week was not a typical week, consider the week before that.</u>***

9. During the past week, how many **minutes** did your child:

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<u>Help a family member</u> with outdoor gardening tasks?	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**
Play outside <u>while</u> you or another family member gardened? **Do not include time doing gardening tasks*	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**

<u>PLEASE CONTINUE THE SURVEY ON THE NEXT PAGE</u>

10. During the past week, how many <u>total minutes</u> did your child spend **doing the following gardening activities** in the family garden?

Digging	Raking	Weeding	Mulching	Hoeing	Sowing seeds	Harvesting
Minutes	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**

Watering	Mixing soil	Planting transplants
Minutes	**Minutes**	**Minutes**

11. How would you rate the following statements?

	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree
I encourage my child to garden with me.	○	○	○	○	○
Gardening makes it easier for my child to be active.	○	○	○	○	○

We would like to ask you some questions about your child's health and health habits.

12. In general, how would you describe this child's health?
    - ○ Excellent
    - ○ Very good
    - ○ Good
    - ○ Fair
    - ○ Poor (please explain) _____

13. What is your child's height without shoes on? _____ (feet) _____ (inches)

14. What is your child's weight without shoes on? _____(lbs.)

15. How would you describe your child's weight?
- ○ very underweight
- ○ slightly underweight
- ○ about the right weight
- ○ slightly overweight
- ○ very overweight

NOTE: Questions 16-18 ask about your child's health behaviors during the past week*. **If last week was not a typical week, consider the week before that.***

*These next questions ask about your child's physical activity**, not including gardening activities**.*

*We are interested in two types of physical activity: moderate and vigorous intensity. **Moderate-intensity** activities cause moderate increases in breathing or heart rate whereas **vigorous-intensity** activities cause large increases in breathing and heart rate.*

*When children ride a scooter or play games that require catching and throwing, they're probably doing **moderate**-intensity aerobic activity. But when children jump rope or play sports such as soccer, swimming, or tennis, they're probably doing **vigorous**-intensity activity.*

16. During the past week, how many minutes did your child participate in moderate and vigorous-intensity physical activity?

__Do not__ include physical activity from gardening activities or physical activity that occurred while family members were gardening. **Do include other physical activities from camps, sports teams, unstructured play, etc.*

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Moderate intensity physical activity	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**
Vigorous intensity physical activity	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**

17. On most days, about how much time per day does your child spend in front of a TV, computer, cellphone or other electronic device watching programs, playing games, accessing the internet or using social media? (**Do not** include time spent doing schoolwork.)

Typical Weekday	Typical Weekend Day
○ None at all	○ None at all
○ About half an hour a day	○ About half an hour a day
○ About 1 hour a day	○ About 1 hour a day
○ About 2 hours a day	○ About 2 hours a day
○ About 3 hours a day	○ About 3 hours a day
○ About 4 hours a day	○ About 4 hours a day
○ About 5 hours a day	○ About 5 hours a day
○ About 6 hours a day	○ About 6 hours a day
○ About 7 or more hours a day	○ About 7 or more hours a day

18. During the past week, how often did your child:

	Not at all	1-3 days	4-6 days	1 time per day	2 times per day	3 or more times per day
Eat **fruit**? (Do not include juice.)	○	○	○	○	○	○
Drink **100% fruit juice** such as orange juice or apple juice? (Do not include fruit-flavored drinks or fruit juices with added sugar.)	○	○	○	○	○	○
Eat a **green leafy or lettuce salad**, with or without other vegetables?	○	○	○	○	○	○
Eat any kind of **fried potatoes**, including French fries, home fries or hash browns?	○	○	○	○	○	○
Eat any **other kind of potatoes**, or sweet potatoes, such as baked, boiled, mashed potatoes, or potato salad?	○	○	○	○	○	○
Not including lettuce salads and potatoes, how often did your child eat **other vegetables?**	○	○	○	○	○	○
Consume foods that were **grown in your garden**?	○	○	○	○	○	○

19. How often does your child seem very anxious, nervous, or worried? Would you say:

- O daily
- O weekly
- O monthly
- O a few times a year
- O never

20. How often does your child seem very sad or depressed? Would you say:

- O daily
- O weekly
- O monthly
- O a few times a year
- O never

Please tell us about your child's demographics.

21. Is your child Hispanic or Latino?

O Yes O No

22. What race or races is your child? Please select one or more.

- ☐ American Indian Or Alaskan Native
- ☐ Asian
- ☐ Black Or African American
- ☐ Native Hawaiian Or Pacific Islander
- ☐ White
- ☐ Other (please specify) _____

23. Is your child male or female?

- O Male
- O Female
- O Prefer not to answer
- O Don't know

24. What is your relationship to the child?

- O Mother
- O Father
- O Grandparent
- O Other Legal Guardian (please specify) _____

Next we would like to ask you some questions about your health and health habits.

NOTE: Question 25-27 ask about your health behaviors during the past week. ***If last week was not a typical week, consider the week before that.***

*These next questions ask about your physical activity**, including gardening activities**.*

*We are interested in both moderate and vigorous intensity. **Moderate-intensity** activities cause moderate increases in breathing or heart rate whereas **vigorous-intensity** activities cause large increases in breathing and heart rate.*

*As a rule of thumb, a person doing **moderate-intensity** aerobic activity can talk, but not sing, during the activity. This might be activities like briskly walking or recreational swimming.*

*A person doing **vigorous-intensity** activity cannot say more than a few words without pausing for a breath. This might be activities like jogging, swimming laps or hiking uphill.*

25. During the past week**,** how many minutes did you participate in **moderate and vigorous-intensity leisure-time** physical activities, which means activities that were NOT part of housework, job duties or transportation?

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Moderate intensity physical activity	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**
Vigorous intensity physical activity	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**	**Minutes**

PLEASE CONTINUE THE SURVEY ON THE NEXT PAGE

26. The following question is about sitting at work, at home, getting to and from places, or with friends, including time spent sitting at a desk, traveling in a car or bus, reading, playing cards, watching television, or using a computer. Do not include time spent sleeping.

On most days, about how much time per day do you spend sitting?

Typical Weekday	Typical Weekend Day
○ About 4 hours a day or less	○ About 4 hours a day or less
○ About 5 hours a day	○ About 5 hours a day
○ About 6 hours a day	○ About 6 hours a day
○ About 7 hours a day	○ About 7 hours a day
○ About 8 hours a day	○ About 8 hours a day
○ About 9 hours a day	○ About 9 hours a day
○ About 10 or more hours a day	○ About 10 or more hours a day

27. During the past week, how often did you:

	Not at all	1-3 days	4-6 days	1 time per day	2 times per day	3 or more times per day
Eat **fruit**? (Do not include juice.)	○	○	○	○	○	○
Drink **100% fruit juice** such as orange juice or apple juice? (Do not include fruit-flavored drinks or fruit juices with added sugar.)	○	○	○	○	○	○
Eat a **green leafy or lettuce salad**, with or without other vegetables?	○	○	○	○	○	○
Eat any kind of **fried potatoes**, including French fries, home fries or hash browns?	○	○	○	○	○	○
Eat any **other kind of potatoes**, or sweet potatoes, such as baked, boiled, mashed potatoes, or potato salad?	○	○	○	○	○	○
Not including lettuce salads and potatoes, how often did you eat **other vegetables?**	○	○	○	○	○	○
Consume foods that **were grown in your garden**?	○	○	○	○	○	○

Finally, please tell us about your demographics.

28. Do you consider yourself to be Hispanic, Latino or of Spanish origin?
    ○ Yes ○No

29. What race or races do you consider yourself to be? Please select one or more.

    ☐ American Indian or Alaskan Native

    ☐ Asian

    ☐ Black or African American

    ☐ Native Hawaiian or Pacific Islander

    ☐ White

    ☐ Other (please specify) _____

30. What is your age? _____ (years)

31. What is your gender?
    ○ Male
    ○ Female
    ○ I do not identify as either.

32. Are you now married, widowed, divorced, separated, never married or living with a partner?
    ○ Married
    ○ Widowed
    ○ Divorced
    ○ Separated
    ○ Never married
    ○ Living with a partner
    ○ Prefer not to answer
    ○ Don't know

33. What is the highest grade or level of school you have completed or the highest degree you have received?
    ○ High School Graduate, GED or equivalent
    ○ Some college, no degree
    ○ Associate degree: occupational, technical, or vocational program
    ○ Associate degree: academic program
    ○ Bachelor's degree (Example: BA, AB, BS, BBA)
    ○ Master's degree (Example: MA, MS, MEng, MEd, MBA)
    ○ Professional School degree (Example: MD, DDS, DVM, JD)
    ○ Doctoral degree (Example: PhD, EdD)

- O Prefer not to answer
- O Don't know

34. Are you currently…
    - O Employed for wages full-time
    - O Employed for wages part-time
    - O Self-employed
    - O Out of work for less than 1 year
    - O Out of work for more than 1 year
    - O Homemaker
    - O Student
    - O Retired
    - O Unable to work
    - O Other (please specify) _____

35. What is the zip code where you currently live? _____

36. Would you like to be entered to win one of five $50 Amazon gift cards? **If so, include your email address below**:

    _____

37. Can our research team contact you about future studies on topics such as family gardening, child health or parent health?

    - O Yes (Please provide an email address that we can use to reach you.)

      _____

    - O No

Thank you for your time!

1.4 Recruitment Materials

1.4.1 Community Recruitment Advertisement Flyer

HEALTH STARTS DURING CHILDHOOD

Request for research participants!

WHAT IS THIS STUDY ABOUT?

Researchers from the Department of Health and Exercise Science at Colorado State University are studying the relationship between home/community gardening and child health behaviors.

WHO CAN PARTICIPATE?

Parents of children between the ages of 6-14 years old. Your family does not need to garden in order to participate!

WHAT WILL I BE ASKED TO DO?

Participants will be asked to complete a Health Behaviors Survey about your child's physical activity, sedentary behaviors, diet and family gardening activities. The survey will take approximately 10-15 minutes to complete.

WHY SHOULD I JOIN THIS STUDY?

While there are no direct benefits to you, survey information will help us to design more tailored health programs to meet the needs of children and adolescents in the future. Upon completion of the survey you will be entered to win one of five $50 Amazon gift cards.

HOW DO I TAKE THE SURVEY?

Scan the QR code to access the survey!

For questions, please contact Ashley Perrault
Email: ashley.perrault@colostate.edu

Telephone: (970) 829-1912
CSU IRB Protocol #4485

14.2 Rocky Mountain Parenting Magazine Advertisement (3.5” x 4.25”)

HEALTH STARTS DURING CHILDHOOD

Request for research participants!

WHAT IS THIS STUDY ABOUT?

Researchers from the Health and Exercise Science Dept. at Colorado State University are studying the relationship between gardening and child health behaviors.

WHO CAN PARTICIPATE?

Parents of children ages of 6-14. Your family does not need to garden to participate!

WHAT WILL I BE ASKED TO DO?

You will be asked to complete a survey about your child's physical activity, diet and gardening activities. The survey will take 10-15 minutes to complete.

HOW DO I TAKE THE SURVEY?

Scan the QR code!

For questions, contact Ashley Perrault: (970) 829- 1912
ashley.perrault@colostate.edu

1.4.3 Community Contact Email Template

1.4.3.1 Gardening-Related Organizations

My name is Ashley Perrault and I am a graduate student at CSU in the Health and Exercise Science Department. I am working on a project that looks at the effect of family-based gardening (at home or a community garden) on child physical activity and fruit and vegetable consumption. I think that gardening within a family setting gives parents a chance to model being physically active, and that this modeling is especially powerful when you also have the benefits of nature.

I am looking for ways to recruit families from community, including those that garden and those that don't, so I can compare between the two groups. I would be asking the families to complete a 10-15 minute survey about the health behaviors of one of their children.

If this sounds like something your organization would be interested in, I'd love to [hang a flyer at your store; set up an information booth at one of your events, etc]. If you have questions I would be very happy to meet and discuss any feedback that you might have for me.

I really appreciate your time!
Ashley

1.4.3.2 Other Organizations

My name is Ashley Perrault and I am a graduate student at CSU in the Health and Exercise Science Department. I am working on a thesis project that looks at the health habits of children in our community, and I am attempting to get a group of participants that is as representative of our community as possible. I have been looking for different organizations that would be willing to let me share about the project either through setting up an information stand outside of businesses or through including a small ad in a membership newsletter, etc. I was wondering if you allow groups to set up a temporary information table outside of the museum?

The project specifically looks at the effect of family-based gardening (at home or a community garden) on child physical activity and fruit and vegetable consumption. I think that gardening within a family setting gives parents a chance to model being physically active, and that this modeling is especially powerful when you also have the benefits of nature. Parents who want to be involved in the project would be asked to complete a 10-15 minute survey about the health behaviors of one of their children. If you have questions I would be very happy to meet and discuss any feedback that you might have for me.

I really appreciate your time!
Ashley

1.5 Consent

Consent to Participate in a Research Study
Colorado State University

1.1 TITLE OF STUDY: YOUTH HEALTH BEHAVIORS SURVEY

PRINCIPAL INVESTIGATOR:
Kaigang Li, Ph.D.
Department of Health and Exercise Science
Director of the Lab for the Assessment and Promotion of Physical Activity and Health (APPAH)
Colorado State University
Fort Collins, CO 80523-1582

Telephone: (970) 491-7253
Email: Kaigang.Li@colostate.edu

WHAT IS THE PURPOSE OF THIS STUDY?
It is well documented that American youth do not meet many of the health behavior recommendations for physical activity and fruit and vegetable consumption. These trends are concerning because many health behaviors that are established during childhood continue to be perpetuated into adulthood and can ultimately increase the risk for developing chronic diseases. Because most health habits are formed within the home, interventions that occur within a family setting may be more likely to produce lasting changes. The purposes of this study are to examine (1) if youth who participate in home/community gardening have higher physical activity levels, increased fruit and vegetable consumption and positive mental health and (2) if the behavior change is facilitated by participating in appropriate health behaviors with a parent.

WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?
We invite you to take part in this research study because you, as a parent or guardian, have a child who is between the ages of 6-14 and you live in Colorado.

WHO IS DOING THE STUDY?
Ashley Perrault, a graduate student in the Department of Health and Exercise Science at Colorado State University (CSU) will perform this research under the direction of Kaigang Li, Ph.D., an associate professor in the Department of Health and Exercise Science. CSU faculty, appropriately qualified staff, and trained graduate and undergraduate students will assist in the study.

WHAT WILL I BE ASKED TO DO?
If you agree to participate in this study, you will be expected to complete a Youth Health Behaviors Survey your child's current health behaviors (including physical activity, sedentary behaviors, eating behaviors, and mental health) and your family's participation in home/community gardening. Your family does not have to have a garden in order to participate in the study. The survey takes approximately 10-15 minutes to complete. The survey can be completed online or in person.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?
All procedures will take place online or in person, depending on which format you choose to take the survey. You will be asked to be involved for completing a one-time survey about your child's healthy habits.

ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?
There are no direct benefits in participating; however, the information you provide will help us to design more tailored healthy habits programs that meet the needs of children and adolescents in the future.

ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS STUDY?
You will not be allowed to participate in this study if your child is not between the ages of 6-14 years old and if you are not the parent or legal guardian of the child.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?
The risks associated with participating in this study are minimal. To reduce any risks associated with the study, your responses will be confidential. It is not possible to identify all potential risks in research procedures, but the researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

DO I HAVE TO TAKE PART IN THE STUDY?
Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

WHAT WILL IT COST ME TO PARTICIPATE?
There will be no costs for online completion of the survey. For surveys completed in person, the completed survey will need to be turned in.

WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?
You will not receive any financial compensation for your participation. However, if you choose to complete the survey you will be eligible to be entered to win one of five, $50 Amazon gift cards. The recipients of the gift cards will be determined by lottery once the study is completed and will be emailed the digital gift card information. Odds of winning a gift card are estimated at 1 out of 150 participants. If you would like to be entered for the gift card drawing, please provide your email address where it is requested at the end of the survey.

WHO WILL SEE THE INFORMATION THAT I GIVE?
All information gathered in this study will be kept as confidential as possible. Your privacy is very important to us and the researchers will take every measure to protect it. Your information may be given out if required by law; however, the researchers will do their best to make sure that any information that is released will not identify you or your child. No reference will be made in written or oral materials that could link you or your child to this study.

This survey will be completed anonymously and will not include any information (such as name or full birthdate) that would identify you or your child. Digital records will be stored in a restricted access folder on an encrypted, cloud-based storage system. Paper documents will be stored in a locked drawer in a restricted-access office at CSU. Both paper and digital files will be stored for three years after completion of the study. After the storage time, the information gathered will be destroyed. We may be asked to share the research files with the sponsor or the CSU Institutional Review Board ethics committee for auditing purposes. Your identity/record of

receiving compensation (NOT your data) may be made available to CSU officials for financial audits.

The research team works to ensure confidentiality to the degree permitted by technology. It is possible, although unlikely, that unauthorized individuals could gain access to your responses if you are responding online. However, your participation in the online survey involves risks similar to a person's everyday use of the internet.

WHAT IF I HAVE QUESTIONS?
Before you decide whether to accept this invitation to take part in the study, please ask any questions that you might have. Later, if you have questions about the study, you can contact Ashley Perrault at ashley.perrault@colostate.edu or (970) 829-1912, or Kaigang Li at Kaigang.li@colostate.edu or (970) 491-7253. If you have any questions about your rights as a volunteer in this research, contact the CSU IRB at: CSU_IRB@colostate.edu; 970-491-1553. We will give you a copy of this consent form to take with you.

WHAT ELSE DO I NEED TO KNOW?
Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 3 pages.

_____ _____
Signature of person agreeing to take part in the study Date

_____
Printed name of person agreeing to take part in the study

_____ _____
Name of person providing information to participant Date

_____
Signature of research staff