PHYSICAL ACTIVITY AND CURRICULUM DEVELOPMENT OF AN AFTER-SCHOOL GARDENING PROGRAM FOR YOUTH HEALTH

by

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B.S., California Polytechnic State University, San Luis Obispo, CA, 2004
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AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Horticulture, Forestry and Recreation Resources
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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Abstract

Public health research shows that targeting behavior directly when promoting healthy behaviors is not as effective for sustainability. Instead the recommendation is to integrate a theoretical framework that identifies factors which affect the targeted behavior and develop the intervention aimed at those factors. The objectives of this dissertation were to measure the healthful benefits of gardening for youth. Strategies were developed for creating an after-school garden club curriculum to target healthy eating, physical activity, sedentary behavior, and gardening. Accelerometers were used to determine physical activity intensity during a garden club session following a curriculum developed to promote physical activity through gardening. In a separate experiment, a portable gas analyzer was used to measure energy expenditure of youth while gardening.

The constructs of Social Cognitive Theory were used to provide a guide with strategies for developing a curriculum with a theoretical basis for an after-school garden club targeting overweight prevention. Strategies presented include activities for targeting the theoretical constructs as well as for implementing evaluations.

Fourth and fifth grade students at four randomly selected elementary schools in Manhattan, Kansas were invited to join the garden club. Students with parental permission attended the club for ten weeks in the fall and twelve weeks in the spring. During the second year of implementation students with parental permission participated in the accelerometer study. For six days students wore an accelerometer and completed a daily activity log detailing their activities during that time.

Students in the fourth and fifth grades from eight Manhattan, Kansas elementary schools were invited to participate in the energy expenditure study during the summer of 2010. Students who participated in this study (n=20) wore a portable gas analyzer and heart rate monitor while performing four gardening tasks. Data were used to calculate energy expenditure of youth while gardening.

A theoretically-based after-school garden club curriculum was developed to target increasing youth healthy behaviors. Results from the accelerometer study showed that students were significantly more physically active at the moderate and vigorous intensity level and

significantly less sedentary at garden club compared to not at garden club. For students who participated in the energy expenditure study, the gardening tasks (transplanting, weeding, cultivating, and raking) were moderate physical activity (3-5.99 METs). Gardening can be a valuable tool for promoting and increasing physical activity in youth.

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Table of Contents

List of Figures

List of Tables

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Dedication

This dissertation is dedicated to my beautiful family, Cody and Dawson Domenghini. I am better because I have you two.

Chapter 1 - Review of Curriculum and School Garden Programs Targeting Behavior Change

The purpose of this literature review is to provide background information on the problem of overweight and obesity in youth as well as the research done through school garden programs to target this problem and others. School garden programs will sometimes follow a curriculum to reach common objectives so a third section to this literature review describes general curriculum.

This first section of this literature review describes the condition of being overweight/obese as well as unhealthy behaviors that contribute to it and healthy behaviors that can be targeted to overcome it. The behaviors that are reviewed in this section include: physical activity, sedentary behavior, fruit and vegetable consumption, and gardening.

The second section provides a definition of curriculum that will be used to identify curricula used in school garden programs. Along with the definition of the curriculum, the purpose, use and development of curriculum will also be explained.

The third component of this literature review is school gardens. The school gardens portion is divided into two sections: school garden curricula and school garden programs. The school garden curricula section describes the content of specific curricula designed to be used with a school garden program and the methods used to find these curricula. These curricula are detailed in three categories based on the aim of the curriculum. The three categories include: Environmental Awareness/Appreciation, Garden-Based Science, and Nutrition-Based Gardening. Methods used to search and identify the school garden programs are explained after the curricula section. The school garden programs are divided into five groups based on the focus of the program. The five categories are: Nutrition, Physical Activity, Academic Achievement, Attitude and Self-Development, and Gardening. Results of the school garden programs and author recommendations are summarized at the end of this section followed by conclusions for further research in the area of school garden programs and curricula.

The final section of this chapter states the objectives of this dissertation.

Youth Overweight and Obesity

The terms overweight and obesity are used to identify weight statuses that are greater than what is recommended for an individual's height (CDC, 2011a). Weight status is often reported as BMI (body mass index) which is calculated by dividing an individual's weight (kilograms) by height (meters) squared to provide an estimate of body fat. For youth, BMI is reported as a percentile. Percentiles are based on BMI for age and gender which are factors that affect child growth. They are used to compare the growth of children with the average growth of other children in the same age and gender group so they can be placed in a BMI category. BMI percentiles are determined using reference values (Ogden & Flegal, 2010) presented in the form of growth charts. The reference values were determined by a national survey of thousands of children and adolescents which were determined to be representative of the United States. There are four main categories: Underweight (BMI $< 5^{th}$ percentile); Normal weight (BMI $\geq 5^{th}$ percentile & $<85^{th}$ percentile); Overweight (BMI $\geq 85^{th}$ percentile & $< 95^{th}$ percentile); Obese (BMI $\geq 95^{th}$ percentile) (CDC, 2011b). These percentiles explain that in a group of 100 children, approximately five will be underweight, eighty will be normal weight, ten will be overweight and five will be obese. Being overweight or obese can have severe health implications. Reporting youth BMI can give parents a tool to determine how to proceed with their child's nutrition and activities.

In a 2007-2008 report of the trends of overweight and obesity for youth in the United States aged 2 to 19, 11.9% were at or above the 97^{th} percentile, 16.9% were at or above the 95^{th} percentile, and 31.7% were at or above the 85^{th} percentile (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Almost 20% of children six to eleven years old were at or above the 95^{th} percentile. In a 2009 report, 15.8% of adolescents in the ninth through twelfth grades were overweight and 12% were obese (Eaton, Kann, Kinchen, et al., 2010). Ogden et al. (2010) reported that these trends of high BMI have not declined in the past ten years but remain at an elevated rate.

Overweight is caused primarily by an imbalance in the amount of energy consumed versus the amount of energy used (Daniels, Arnett, Eckel, Gidding, Hayman, Kumanyika, Robinson, Scott, St. Jeor, & Williams, 2005). In other words, it results from the combination of an improper diet and insufficient exercise. This problem has been exacerbated by the increase in availability of sugar sweetened beverages (Ludwig, Peterson, & Gortmaker, 2001) and sedentary options including television (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998) and video games.

Consequences of Overweight/Obesity

Children who are classified as having a high amount of body fat are at risk for developing Type 2 diabetes, suffering orthopedic complications, developing asthma and cardiovascular diseases (Daniels, et al., 2005). Sleep apnea and other sleeping disorders are more common in obese individuals which lead to being overly tired during the daytime (Vgontzas, Tan, Bixler, Martin, Shubert, & Kales, 1994).

Youth who are overweight may feel more isolated. Research has shown that overweight children are less likely to be chosen as a friend (Strauss & Pollack, 2003). Number of friends has been inversely related to child BMI with children who have the highest BMI at a school site having the fewest number of friends (Strauss & Pollack, 2003).

Being teased about body weight has been associated with low satisfaction with body, low self-esteem, and greater incidences of depression symptoms and suicidal behaviors (Eisenberg, Neumark-Sztainer, & Story, 2003). Having depression symptoms can begin a vicious cycle as depression has also been shown to worsen obesity among adolescents who are already obese (Goodman & Whitaker, 2002).

Childhood obesity is a problem not only because of the negative health outcomes but also the implications it has for the child's future. Obesity in youth has been shown to be a predictor for adult obesity (Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001). Transitioning from adolescent to adult increases an individual's risk of becoming obese and adolescents who are already obese are likely to remain obese as an adult (Gorden-Larsen, Nelson, & Popkin, 2004; Freedman, et al., 2001). Only a small percentage of obese adolescents will reverse this diagnosis in adulthood (Gordon-Larsen, et al., 2004). Physical activity among youth has been shown to decrease with age, particularly for girls (Armstrong, Welsman, & Kirby, 2000). However, individuals who achieve high levels of physical activity as adolescents are more likely to continue achieving high levels of physical activity into adulthood (Kelder, Perry, Klepp, & Lythe, 1994). This illustrates the importance of targeting overweight and obesity prevention in children at a young age by encouraging healthy eating and physical activity.

Youth Physical Activity

Physical activity provides many health benefits. It helps strengthen bones and muscles and retain bone and muscles mass (United States Department of Health and Human Services, 2009a). Regular physical activity helps to maintain weight and consequently reduces the risk of becoming obese. Lower blood pressure, higher HDL cholesterol and more positive well-being, confidence and self-esteem are other benefits of physical activity (American Heart Association, 2011). Individuals who are physically active are less likely to be diabetic or suffer from cardiovascular disease (United States Department of Health and Human Services, 2009a).

Current recommendations by the Centers for Disease Control and Prevention (United States Department of Health and Human Services, 2009a) state that youth should be physically active for at least 60 minutes each day made up primarily of aerobic activities with vigorous intensity activities at least three days per week. Muscle and bone strengthening activities should be done three days per week.

A report from 2002 showed that 61.5% of children age 9-13 were not participating in organized physical activity during the after school hours. Additionally, 22.6% of youth in that age range reported not participating in any form of free-time physical activity (CDC, 2003). Only 17% of youth in the ninth through twelfth grade reported meeting the recommendation of sixty minutes per day of physical activity (CDC, unpublished data, as cited in United States Department of Health and Human Services, 2009b). This is concerning as studies have shown that adolescent physical activity levels will often continue into adulthood (as reviewed by Malina, 1996) indicating that adolescents who don't engage in sufficient physical activity will remain less active as adults. Furthermore, adolescents have been shown to decrease the amount of time they spend in physical activity and increase the amount of time spent sedentary with age (Gordon-Larsen, et al., 2004). In other words, adolescents who are already not meeting physical activity recommendations may further decrease the amount of time they spend physically active as they enter adulthood. However, if individuals can learn to meet the physical activity recommendations at a young age, they will be more likely to continue these habits into adulthood which again illustrates the importance of targeting a young audience for improving health behaviors.

Children have been reported to be less active when they are in their home which may be a result of increased availability of sedentary options. To overcome the appeal of sedentary choice such as television and video games, and to increase the likelihood that children will sustain an active lifestyle, programs need to incorporate physical activities which are enjoyed and valued by the participants (Sleap & Warburton, 1992). This includes offering physical activity options which meet the needs of female and overweight students, as both of these groups tend to decline more rapidly in physical activity participation (Trost, Rosenkranz, & Dzewaltowski, 2008). To further increase the amount of time children spend active in school programs, it is important to reduce the amount of time teachers/leaders spend in management by ensuring they are properly trained and have a sufficient number of adult helpers. Additionally, games used in these programs should allow all students to participate regardless of their skill level indicating that elimination games should be altered to enable students to remain active (Trost, et al., 2008).

Sedentary Behavior

Sedentary behavior is a description of activities that require such a minimal amount of exertion that energy expenditure is not increased substantially (Pate, O'Neill, & Lobelo, 2008). Some examples include riding in the car, sitting, reading (Ainsworth, et al., 2000), and doing homework (Dietz, 1996). Screen-time sedentary behaviors involve media such as watching television, working on the computer, and playing video games. The American Academy of Pediatrics (Bar-on, Broughton, Buttros, Corrigan, Gedissman, deRivas, Rich, & Shifrin, 2001) recommends children spend no more than one to two hours daily using media with quality programs. However, children six to eleven years old have been reported to spend over six hours sedentary daily with half of that time likely spent in screen time (Mathews, Chen, Freedson, Buchowski, Beech, Pate, & Troiano, 2008). This time increases by two hours per day as children reach adolescence (ages 16 to 19). In a 2010 report, 24.9% of ninth through twelfth grade adolescents were reported to spend at least three hours per day playing computer or video games on an average school day (Eaton, et al., 2010). Additionally, 32.8% of adolescents in this age group were reported to spend an average of three hours per school day watching television (Eaton, et al., 2010). Recognizing the difference between screen time and non-screen time sedentary behaviors is important because they affect children differently.

An increase in the amount of time spent watching television has been associated with a decrease in fruit and vegetable consumption (Boynton-Jarrett, Thomas, Peterson, Wiecha, Sobol, & Gortmaker, 2003; Utter, Neumark-Sztainer, Jeffery, & Story, 2003) while high amounts of time spent reading and doing homework is associated with an increase in fruit and vegetable consumption (Utter, et al., 2003). This is likely due in part to the advertising done during television programs and commercials. Commercial programming targeted at children most often advertises food (Boynton-Jarrett, et al., 2003; Kotz & Story, 1994; Utter, et al., 2003). Children may see as many as one food commercial for every five minutes of television viewing (Kotz & Story, 1994) and rarely are fruits and vegetables marketed in these advertisements (Boynton-Jarrett, et al., 2003; Kotz & Story, 1994). Watching numerous hours of television is associated with less time spent in physical activity (Andersen, et al., 1998) and higher dietary energy intake (Robinson & Killen, 1995; Utter, et al., 2003), likely due to snacking while watching television (Taras, Sallis, Patterson, Nader, & Nelson, 1989; Utter, et al., 2003). Higher BMI levels are also reported for children who watch more than the recommended amount of television (Andersen, et al., 1998; Gortmaker, Must, Sobol, Peterson, Colditz, & Dietz, 1996; Utter, et al., 2003).

Children who spend more hours in sedentary behaviors such as reading or doing homework are reported to have healthier lifestyles than those who choose screen time sedentary pursuits (Utter, et al., 2003). For this reason it is recommended that interventions to affect child sedentary habits specifically target decreasing the availability of screen time sedentary behaviors while increasing the availability of a variety of non-competitive physical activity options (Epstein, Paluch, Gordy, & Dorn, 2000; Epstein, Smith, Vara, & Rodefer, 1991; Tucker, 1986).

Youth Fruit and Vegetable Consumption

The USDA recommends individuals increase their consumption of fruits and vegetables (USDA and United States Department of Health and Human Services, 2010) with a variety of fresh, canned, frozen, and dried produce (Kushi, Byers, Doyle, Bandera, McCullough, Gansler, Andrews, & Thun, 2006) especially dark-green and red/orange vegetables, beans and pods (USDA and United States Department of Health and Human Services, 2010). Fruit and vegetable consumption has been associated with a decreased risk for a number of diseases (USDA and United States Department of Health and Human Services, 2010) including several types of cancer (Kushi, et al., 2006). Fruits and vegetables tend to be lower in calories (USDA and United States Department of Health and Human Services, 2010) and can therefore be used to replace energy dense foods (Kushi, et al., 2006) and help reduce the risk of obesity (He, Hu, Colditz, Manson, Willett, & Liu, 2004). A largely plant-based diet can also contribute much needed nutrients that may otherwise be lacking from the diet (USDA and United States Department of Health and Human Services, 2010).

Regardless of the health benefits of consuming more fruits and vegetables, most Americans do not meet the recommendation of eating more than five servings daily (Kushi, et al., 2006; Guenther, Dodd, Reedy, Krebs-Smith, 2006; USDA and United States Department of Health and Human Services, 2010; Larson, Neumark-Sztainer, Hannon, & Story, 2007; Gillman, Rifas-Shiman, Frazier, Rockett, Camargo, Field, Berkey, & Colditz, 2000). To further compound this issue, fruit and vegetable consumption has been shown to decrease with age as youth enter adolescence (Guenther, et al., 2006; Di Noia & Contento, 2010; Larson, et al., 2007). This indicates that children who might not be meeting the recommendations at a young age will be consuming even fewer fruits and vegetables as they enter and proceed through adolescence. Individuals in the range of ages from two to thirty have reported consuming fruit juice as more than half of their daily fruit intake. This is concerning as juice often contains insufficient dietary fiber and may provide superfluous calories (USDA and United States Department of Health and Human Services, 2010). It is important to understand what factors contribute to the lack of individuals meeting the fruit and vegetable consumption recommendation and how these numbers might be improved through programming.

Youth are heavily reliant on outside sources for food. This reliance primarily rests on the parents or guardians (Geller & Dzewaltowski, 2010) but can also be affected by other factors beyond the individual (Resnicow, Davis-Hearn, Smith, T. Baranowski, Lin, J. Baranowski, Doyle, & Wang, 1997; Geller & Dzewaltowski, 2010). Youth are more likely to eat fruits, fruit juice, and vegetables when they are more readily available (Cullen, Eagan, Baranowski, Owens, & deMoor, 2000) which requires cooperation from the adult who provides the food. In addition to the effect of availability on fruit and vegetable consumption, eating meals as a family is another factor. Youth who are more strongly connected with their family and eat more meals together as a family are reported to have higher fruit and vegetable intake (Gillman, et al., 2000; He, et al., 2004). Older adolescents report eating meals as a family less often (Gillman, et al., 2000) which may contribute to the decline in fruit and vegetable consumption of this age group. Although consuming fruits and vegetables provides numerous benefits, many of these benefits may not be recognized in the short term (Resnicow, et al., 1997) which can be difficult to use as a motivator for youth. Other factors that have been shown to affect fruit and vegetable consumption include youth preference for fruits and vegetables (Resnicow, et al., 1997; Bere & Klepp, 2005; Cullen, et al., 2000). Preference for fruits and vegetables has been shown to be associated with increased fruit and vegetable intake on weekdays and at lunch and dinner as opposed to weekends, breakfast, and snacks (Resnicow, et al., 1997). This may illustrate how intake is affected by the availability of fruits and vegetables. Youth may have greater access to competing foods on weekends making it more challenging for them to choose to eat fruits or vegetables (Resnicow, et al., 1997). Increasing the fruit and vegetable availability to well above the recommendations has been shown to be effective for increasing consumption (Di Noia & Contento, 2010). Several other factors have been associated with level of fruit and vegetable intake. Socio-economic status, males, and poor academic achievers have been reported to have a lower intake of fruits and vegetables (Neumark-Sztainer, Story, Resnick, & Blum, 1996). Individuals with overall healthier behaviors (Thompson, Midthune, Subar, McNeel, Berrigan, & Kipnis, 2005; He, et al., 2004; Neumark-Sztainer, et al., 1996) including those who are of normal weight (Thompson, et al., 2005, Neumark-Sztainer, et al., 1996) and more physically active (Thompson, et al., 2005) are reported to consume more fruits and vegetables.

Based on the low rates of fruit and vegetable consumption by youth, and the multiple benefits that can be obtained by meeting this dietary recommendation, it is relevant that interventions target increasing fruit and vegetable intake of youth (Larson, et al., 2007). Because of the reliance of youth on adults for provision of food, it is essential that these interventions rely on more than just targeting the youth directly (Geller & Dzewaltowski, 2010) through the classroom (Neumark-Sztainer, et al., 1996). It is important to include the family (Neumark-Sztainer, et al., 1996) and other outside factors affecting the youth's dietary decisions (Larson, et al., 2007).

Youth Gardening

Being outside has been shown to be an important factor positively associated with the amount of time children spend in physical activity (Sallis, Prochaska & Taylor, 2000; McKenzie, Feldman, Woods, Romero, Dahlstrom, & Stone, 1995). Unfortunately, the amount of time children spend outside tends to decline with increasing age (Cleland, Timperio, Salmon, Hume, Baur, & Crawford, 2010). For students in the fifth to sixth grade, enjoyment of physical activity was the most important predictor of whether or not the youth were active. This was particularly true for girls (DiLorenzo, Stucky-Ropp, Vander Wal, Gotham, 1998). Furthermore, girls prefer having the opportunity to socialize during physical activity (DiLorenzo, et al., 1998) which may not be possible during organized sports.

While gardening can be done indoors, it is commonly an outdoor activity. There are many opportunities to socialize while gardening and it is often an enjoyable activity for youth and adults alike. Gardening has been reported as a low to moderate form of physical activity for older adults (Park, Shoemaker, & Haub, 2008) with gardening tasks that utilized both upper and lower body movements at a higher level of intensity. Gardening may be an activity that can be enjoyed by youth while still achieving recommended levels of physical activity.

School gardens were once intended primarily for teaching youth about natural science and environmental awareness (Kohlstedt, 2008) but have broadened to also integrate math, writing, reading, social skills, physical activity, and many other topics. School gardens have been utilized for over one hundred years with bountiful gardens appearing in schools in the late 1800's (Kohlstedt, 2008) and continuing to flourish as challenges and benefits are discovered. Youth gardens are used in a variety of forms including summer (Koch, Waliczek, & Zajicek, 2006; Heim, Stang, & Ireland, 2009;

Heim, Bauer, Stang, Ireland, 2011; Rahm, 2002) and community programs (Lautenschlager & Smith, 2007), enrichment during the regular school day (Morris & Zidenberg-Cherr, 2002; Lineberger & Zajicek, 2000; Klemmer, Waliczek, & Zajicek, 2005b; McAleese & Rankin, 2007; Smith & Motsenbocker, 2005; Waliczek, Bradley, & Zajicek, 2001; Robinson & Zajicek, 2005; Aguilar, Waliczek, & Zajicek, 2008; Pigg, Waliczek, & Zajicek, 2006; Parmer, Salisbury-Glennon; Shannon, & Struempler, 2009; Morris, Neustadter, & Zidenberg-Cherr, 2001) and during after-school hours (Phelps, Hermann, Parker, & Denney, 2010; O'Brien & Shoemaker, 2006; Hermann, Parker, Brown, Siewe, Denney, & Walker, 2006; Poston, Shoemaker, & Dzewaltowski, 2005).

Gardens are used to target many youth behaviors and have been reported to increase youth's nutrition knowledge (Koch, et al., 2006; Morris & Zidenberg-Cherr, 2002; Morris, et al., 2001), preferences for vegetables (Heim, et al., 2009; Morris & Zidenberg-Cherr, 2002; Lineberger & Zajicek, 2000; Parmer, et al., 2009) as well as fruits (Parmer, et al., 2009), and increase fruit and vegetable consumption (Parmer, et al., 2009, McAleese & Rankin, 2007; Herman, et al., 2006). Some youth garden programs include a home component to involve the parents/guardians in the gardening activities and lessons (Heim, et al., 2009; Heim, et al., 2011; Morris & Zidenberg-Cherr, 2002). Likely a result of participation in a youth gardening program, availability of fruits and vegetables at home have been shown to increase (Heim, et al., 2011), as has youth's exposure to fruits and vegetables (Heim, et al., 2009), and asking behaviors for fruits and vegetables to be made available at home (Heim, et al., 2009; Heim, et al., 2011).These results are likely to lead to greater fruit and vegetable consumption of youth. Additional benefits observed from participation in youth garden programs include an increased respect for diversity (Lautenschlager & Smith, 2007), increase in physical activity levels (Phelps, et al., 2010; Herman, et al., 2006), improvements in science achievement scores (Klemmer, et al., 2005; Smith & Motsenbocker, 2005; Pigg, et al., 2006), increased knowledge of gardening (Lautenschlager & Smith, 2007) and increase in fruit and vegetable awareness (Somerset & Markwell, 2008).

The most common subject taught with a garden or garden curriculum is nutrition (Koch, et al., 2006; Graham & Zidenberg-Cherr, 2005; Lautenschlager & Smith, 2007; Graham, Beall, Lussier, McLaughlin, & Zidenberg-Cherr, 2005; Cason, 1999; Morris &

Zidenberg-Cherr, 2002; Lineberger & Zajicek, 2000; O'Brien & Shoemaker, 2006; McAleese & Rankin, 2007; Herman, et al., 2006; Parmer, et al., 2009; Morris, et al., 2001; Poston, et al., 2005). Other subjects include science (Graham & Zidenberg-Cherr, 2005; Graham, et al., 2005; Klemmer, et al., 2005; Smith & Motsenbocker, 2005; Pigg, et al., 2006), environmental education (Skelly & Bradley, 2007; Graham & Zidenberg-Cherr, 2005; Skelly & Bradley, 2000; Graham, et al., 2005; Aguilar, et al., 2008), math (Graham & Zidenberg-Cherr, 2005; Pigg, et al., 2006), physical activity (Phelps, et al., 2010; Herman, et al., 2006), and language arts (Graham & Zidenberg-Cherr, 2005). While the value of integrating a garden into the school curriculum is echoed through research, the struggles teachers face are numerous. Insufficient time is the most common barrier preventing teachers from utilizing a school garden followed by a lack of teacher's gardening knowledge, experience, interest, training, and curricular materials (Graham & Zidenberg-Cherr, 2005; Graham, et al., 2005). Overcoming these barriers is further complicated by the reality that much of the funding for school gardens is provided by donations and personal teacher cost (Skelly & Bradley, 2000).

While integrating a garden into the regular school day may allow more students to reap the rewards, it may not be as feasible as after-school hours due to demand for teachers' time. These studies stress the need for curricular materials and trainings for the garden leader. There is also the need to understand factors affecting student behavior including factors at the individual, family, school, and community level (Ozer, 2007).

Curriculum

What is a curriculum?

Curriculum is a complex term with varying definitions depending on the context in which it is used. The term curriculum comes from the Latin word which means "running course" (Armstrong, 2003, p.4). This dates back to the time of chariot races. The track that the horse drawn chariots followed was called the curriculum (Olivia, 2005). This was a well-defined course that should be followed to reach a pre-determined end. The use of the word curriculum today; although in a much different scenario, is still similar to running a course.

Curriculum, as it is referred to today, is what is taught or what should be learned (Posner & Rudnitsky, 2006). To use the historical meaning of curriculum as "running course", curriculum can be thought of as where the students should be intellectually (learning objectives = end of race) after learning the information (what is taught = course). The course, or what is taught, should be organized so it leads to the pre-determined end, which in this case is learning the stated objectives.

Posner & Rudnitsky (2006) relate a curriculum to the blueprints for a house. Blueprints are a design for what an end product, the house, will look like. The blueprint guides how the construction plan for building the house is developed. A curriculum is a design for what the students are intended to learn. It is a guide for how teachers will develop their instructional plan for teaching to meet the end goal of students learning the intended information.

Eisner (1979, p.39) defined curriculum as "a series of planned events intended to have educational consequences for one or more students." With this definition the idea that a curriculum is the result of planning during course development is clear. The "educational consequences" refer to students attaining knowledge useful for their growth. This is the intended learning or the pre-determined end in the "running course" definition. The student should be changed in an educational way because of their interaction with the curriculum.

Curricula can be thought of as lesson plans that are organized in a way to help the students reach the objectives. To determine whether or not the students learn the objectives the curricula should include a method of evaluation (Armstrong, 2003). From there it can be determined whether or not the instructional plan needs to be adjusted so the goals of the curricula are being met. The components of the curricula include the organization of the material which refers to not only the order in which the material is presented but also the emphasis placed on specific topics. This makes it clear that curricula are more than just content (Armstrong, 2003). Curricula are more than books of activities relating to a certain topic. A good curriculum requires planning with focus on the intended outcomes.

In a general sense, curriculum is “a plan for learning” (Taba, 1962, p.11). This plan may have some teaching methods implied through the content. In order to better understand what curriculum is, it is helpful to look at the purpose of a curriculum.

What is the purpose of a curriculum?

If you look at the previous definitions, the purpose of a curriculum is to identify a product that demonstrates the level of student understanding of the curricular material. The product is evidence of an educational experience. What that experience is will vary depending on the curriculum and the instruction. It is important to understand the difference between these terms. Curriculum can be thought of as what is taught, while instruction is how that material is taught (Posner & Rudnitsky, 2006). Instruction is an action while curriculum is not. Curriculum should state what is intended to be learned by the completion of the course (Posner & Rudnitsky, 2006).

A well-designed curriculum serves the purpose of stimulating teachers’ instruction (Armstrong, 2003). Curriculum is essential because time is limited and teachers cannot teach every detail of educational material available. The purpose of the school curriculum is to have grade level material organized in logical pieces relevant to the students. Without a curriculum teachers would have to decide what material to teach and how to organize it logically which would create more demand on their time. In a setting outside of the school, a curriculum may be designed for an age group or particular setting with different types of learning objectives and goals. The curriculum may be organized differently depending on who will be leading the instruction.

Taba (1962) explains one purpose of curriculum is to help the students become “productive members of our culture (p.10).” This will affect what content is appropriate based on the needs and values of each culture. To successfully serve this purpose, the planning during the development of the curriculum and the evaluation of the curriculum are important to meeting the overall purposes of the curriculum.

How is a curriculum used?

Teachers have their own background and experiences which will influence how they interpret and deliver curriculum to students. Therefore, a curriculum will come across differently depending on the instructor (Armstrong, 2003). The curriculum should serve as a teacher guide enabling teachers to use their experiences to enhance the lessons.

Students also have unique backgrounds which will cause them to receive the information from a curriculum differently from each other and perhaps differently from how the teacher intended.

These differences illustrate the need for curriculum to guide teachers' instruction so they can promote students' inquiry to learn. This guide should also serve as a calendar for the school year with the academic content clearly and logically identified so the teachers can rely on the organization.

For ease of use, curricula should be formatted with logical and consistent organization. Page numbering and a clear table of contents will help the teachers retrieve information quickly (Armstrong, 2003).

How is a curriculum developed?

Curriculum is often thought of in terms of the information it holds but, as stated previously, curriculum is more than content. A curriculum is the result of decisions and boundaries that have been set. These decisions refer to what information has been included based on the targeted students and institution or setting. The order material is presented and the amount of detail included are other decisions made by curriculum developers. Curriculum developers can add emphasis to content through the formatting and visual effects within the curriculum (Armstrong, 2003).

While it is important for the curriculum to be organized and thorough, it is essential that it also offers teachers the flexibility to adapt it to meet the needs of the students (Hlebowitsh, 2005). The curriculum should contain material relevant to a given grade/age level and reference why that information is relevant, but teachers have an understanding of their students and need to be able to decide how the instruction of the curriculum will look in their own classroom (Hlebowitsh, 2005). Curriculum developers should recognize that with the unique instruction by the teachers, and understanding of the students, their role is limited to designing a guide for what should be taught with little to no effect on what will actually be learned (Armstrong, 2003).

Curriculum can be developed in many ways. Tyler (1949) created a continuum for developing curriculum. According to this process, now known as the "Tyler Rationale", there are four questions that should be asked when developing a curriculum (Tyler, 1949, p. 1).

1.) "What educational purposes should the school seek to attain?"

2.) "What educational experiences can be provided that are likely to attain these purposes?"

3.) "How can these educational experiences be effectively organized?"

4.) "How can we determine whether these purposes are being attained?"

The focus of these questions is creating a curriculum that is based on the purpose or objective of having the curriculum in the first place (Hlebowitsh, 2005). The purposes are identified by the needs of the students and the desires of the site/community (Tyler, 1949). The needs may vary depending on the culture, student background, teacher background, etc. (Taba, 1962). Tyler (1949) explains that "education is a process of changing the behavior patterns of people" (p. 5-6). The curriculum is the tool used to promote that change (Toombs & Tierney, 1993), therefore, any objectives, or goals in a curriculum, should reflect the behavior change desired by those adopting the curriculum.

Educational experiences, or learning experiences, students are intended to have should be created based on those purposes (Hlebowitsh, 2005). Experiences are different from content (Tyler, 1949). Experiences include strategies to aide student comprehension of the objectives. This may be a section of the curriculum where instruction is implied. Curriculum developers can incorporate learning experiences used successfully in the past, or those studied through research to enhance the objectives (Taba, 1962). Learning experiences require the students to be active. These are opportunities for the students to practice the goals stated in the objectives. The experiences should be enjoyable for the students in order for them to continue progressing towards the objectives. Teachers may need to adapt learning experiences for their specific students' needs and interests (Tyler, 1949).

Taba (1962) includes selecting and organizing lesson content in her ordered list for the process of curriculum development prior to the selection and organization of learning experiences. Content should be selected on the basis of its relevance to the students and current knowledge (Taba, 1962).

Learning experiences, as with content, need to be organized effectively for the teachers and students. The organization should enable students to build upon previous experiences and integrate these experiences to other subjects. Students should be exposed to similar learning experiences repeatedly but with increasing complexity to become more fluent with the objectives (Tyler, 1949).

Evaluations should be done to determine whether or not the experiences matched the purposes to facilitate the students attaining knowledge (Hlebowitsh, 2005). Evaluations of the curricular content, objectives, and implementation as well as the instructors and the students' abilities can be done and can include a variety of people. They can take a variety of forms including written tests, personal interviews, teacher reports, and observations. This results in another complex term. If we go back to the explanation of the word education as "a process of changing the behavior patterns of people" (Tyler, 1949, p. 5-6) then an evaluation of this type should be used to determine if the desired change in behavior has been achieved. For this reason, there should be an appropriate evaluation done to demonstrate the level of change in behavior for each of the objectives (Tyler, 1949).

When developing a curriculum the issues of time and available resources in the classroom should be considered. A curriculum developed on assumptions that certain resources will be available may become useful to only a specific population. A curriculum designer needs to consider the population including the goals of the schools/groups being targeted to set the boundaries of what material should be included or excluded (Hlebowitsh, 2005).

A new curriculum is often adapted from pre-existing curricula. This process enables developers to update curriculum so it is current with technology and content. Adaptations may also be made for specific student populations and sites with different resources available (Posner & Rudnitsky, 2006). These adaptations must be made to ensure the information is relevant (Armstrong, 2003). Curriculum development will never be complete.

School Gardens

School Garden Curricula

School gardens have become increasingly popular both in classroom and after-school programs. The material taught and activities done in a school garden program vary depending on the purpose of incorporating the garden into the school site. After-school gardens may be used with the primary purpose of providing childcare for students which may require typical gardening jobs to be done without following a set curriculum. Garden programs may have goals identified that fall into line with a pre-existing curriculum so the program may use those lessons and activities with their students. However, if the garden program has unique goals for their students, an appropriate curriculum may need to be compiled.

To determine whether or not a garden program is following a curriculum it is necessary to remember what a curriculum is while keeping in mind the fluidity of this term. For the purposes of this report, to be classified as a "school garden curriculum" there needs to be a written document of lesson plans with educational purpose(s)/objective(s), educational experiences, organization of the experiences and an evaluation to determine whether or not the students are meeting the objectives of the lessons.

Methods

Garden curricula were identified by searching online databases including: ERIC, Agricola, Web of Science, and PsycInfo as well as websites such as National Gardening Association for published curricula. Searches were conducted with the keywords "school garden curriculum". Documents were included in this review if they matched our definition of curriculum previously stated and had a gardening/garden component that could be incorporated into the activities. Curricula had to be available in English and intended for use with school-age children either in the classroom or during the after-school hours. The searches of these databases yielded seventeen published works. None of these were specific curricula but many were articles reporting the use of a school garden curriculum in a program. These articles were then reviewed and the curriculum used was researched. Many authors use a more general term for curriculum and report following a curriculum that was a composition of numerous activities. Although this may be a curriculum by some standards, it does not fit our definition and these examples were not included in this review. Further investigation to find school garden curricula was done by a search of the university library in the curricular materials section. This yielded two additional sources of school garden curriculum for a total of four curricula.

Results

Environmental Awareness/Appreciation

Growing in the Garden curriculum was created to increase agriculture and natural resource awareness. It is an extension publication from Iowa State University and was created for teachers to use in the classroom for grades kindergarten through third. The lessons are designed for teachers to integrate into various subjects in a time frame of two to eight weeks. Each lesson targets specific life skills including, but not limited to, critical thinking, communication, and problem solving. A majority of the lessons are taught indoors with the last week intended to be used to create the outdoor garden area as a culmination of the previous activities and lessons. Two to four health lessons are included in the curriculum for each grade level as well (Iowa State University Extension, 2000).

Junior Master Gardener (JMG) (AgriLIFE Extension, n.d.) curricula were developed to encourage students to enjoy gardening while also developing their appreciation for the environment. This program places a strong emphasis on serving others. It is designed for use in the classroom as well as with an after-school program, home school environment, and/or youth clubs. There are two levels of the main curriculum, with a third in development. Additional units that can be followed separate from the core curriculum are also available. A garden is not essential to utilize the Junior Master Gardener curricula. The level one curriculum is for third through fifth grade. Level two is designed for sixth through eighth grade. The level one curriculum has three additional units that can be used along with the main curriculum or as independent activities. These three units include Literature in the Garden, Health and Nutrition from the Garden, and Wildlife Gardener. There are two modules in the level two curriculum; the first is focused on plant growth and development and the second on soil and water. Most of the curricular activities focus on plants and gardening topics while the concluding chapter(s) addresses service learning and careers. Groups can register with JMG to be eligible for student recognition as they complete stages of the curricula.

Garden-Based Science

The Growing Classroom (Jaffe & Appel, 1990) is the curriculum published by Life Lab. It is designed to be integrated into the classroom by the teacher as a year round supplement to science education with a nutrition component. This curriculum is designed for second through sixth grade. The gardening component, Living Laboratory, can be done in any space, indoors or outdoors, where the children can see the living aspects of science, as it is described in the curriculum. There is not a size requirement for the garden in order to utilize this curriculum. The creators of The Growing Classroom emphasize the importance of working with the students in smaller groups rather than as a whole class. There are 13 units in this curriculum with anywhere from eight to 24 activities provided per unit. The activities are identified in the introduction to each unit for a specific range of grade levels and as indoor/outdoor activities (Jaffe & Appel, 1990).

Nutrition-Based Gardening

Nutrition to Grow On (Morris & Zidenberg-Cherr, 2001) is a nine lesson curriculum published by the California Department of Education. It was researched and developed as a dissertation to link nutrition with gardening activities. This curriculum is designed for the fourth through sixth grades although the authors state some flexibility within the activities for use with upper and lower grades. Lessons were developed to be led by the classroom teacher during the school day and are linked to the state standards. The goal of this curriculum “is to provide children and their caregivers with the knowledge and skills necessary to make healthful dietary choices while simultaneously gaining a greater appreciation for the land that provides us with food” (pg. vi). Each lesson is divided into two sections. The first section, nutrition, lasts approximately one hour. This section can be taught in the classroom and incorporates some agricultural knowledge into the nutrition topic. The second section is an optional gardening component which is intended to last about thirty minutes. To follow the Nutrition to Grow On curriculum, a garden is not necessary, but is recommended. The nutrition and gardening activities were created to complement each other. These lessons can be taught individually or in a series, but the authors stress the importance of following the order the lessons are presented in the curriculum when using the entire curriculum. A newsletter has been created to be sent home with the students after each lesson to share the information from the day's lesson with the families. Assessments of each lesson are also included to measure nutrition knowledge as it relates to each of the lesson objectives.

School Garden Programs

Classroom time is often limited to covering the standard-based curriculum. In order to bring hands-on lessons into the classroom, teachers may incorporate a gardening program into their instruction. This can be a challenge for teachers without gardening experience. In this case, an after-school program led by individuals with gardening experience may be more beneficial. Research has been done to discover some benefits to incorporating a garden at schools as well as some recommendations for future research. This review includes studies that examine the effects of school garden programs on youth.

Methods

Articles were identified through a search of Agricola, PubMed, ERIC, PsycInfo, and Web of Science using the key words "youth" and "school gardens". Articles were included in this review if they evaluated the impact of a school garden program on school-age children or adolescents in the United States. The garden program had to take place at least partially during the academic school year with statistically analyzed results reported from the evaluation of student participants. Articles were only included in this review if they were published in a peer-reviewed journal. Although the garden program did not necessarily have to take place at the school site, to be included in this review, it needed to be affiliated with a school.

Programs that were excluded were those that were designed for community level participation, evaluated adults, or did not measure children/adolescents. The initial search yielded 121 articles. From this 109 articles were eliminated from the review because they did not meet the inclusion criteria. Some examples of reasons articles were excluded were: the article was a review, an international article, results were reported on the effectiveness of a curriculum rather than the garden program specifically, the article was duplicated in multiple databases, and the article was not relevant to the search. Twelve relevant articles were obtained from this search. After reading these articles and other review articles, four more relevant articles were obtained for a total of sixteen school garden program articles.

Overview of School Garden Programs

Table 1.1 outlines the results of the school garden program search. The school garden programs ranged in duration from eight weeks to a full academic school year. A majority of the studies incorporated the garden program into the school day hours, while four of the studies reported meeting during after-school hours. Eleven of the studies had control and intervention groups and twelve of the studies used pre and post intervention measurements. The most commonly used measurement tool for vegetable preference was by Domel, Baranowski, Davis, Leonard, and Baranowski (1993). Jendrysik's (1991) 24 hour recall workbooks were the most common method for measuring food consumption. Science achievement was measured in several studies with the use of a tool developed by Klemmer (2002; Klemmer, et al., 2005a; Klemmer, et al., 2005b). The number of participants included in these studies ranged from 29 to 647 students. While most of the studies evaluated students in the third through fifth grade, students from first grade up to tenth grade were studied.

The most commonly used curriculum for the school garden programs was the Junior Master Gardener Level One (Texas Agricultural Extension Service, 1999a). This guide was utilized by eight of the studies. Two of the studies used lessons developed by the teacher/leader. The classroom teacher was most often the one implementing the lessons for the school garden programs. The amount of time spent gardening in these school garden programs ranged from 10-15 minutes per week to 30 minutes per week, although most of the studies did not specify how much/if any time was spent gardening. Student attendance was only reported in one of the seventeen studies with 96% attendance (O'Brien & Shoemaker, 2006).

The targeted outcomes were varied. The most commonly targeted outcome was nutrition related including increased nutrition knowledge, attitudes about fruits and vegetables, fruit and vegetable preference, willingness to try fruits and vegetables, and fruit and vegetable consumption. Self-efficacy was evaluated for gardening and fruit and vegetable consumption in two studies. Using a gardening program to improve academics in math and/or science was the target of three studies. Two studies targeted improving social variables such as relationships and attitudes. The remainder of this review will focus more specifically on each of these school garden programs including the reported results.

Nutrition Focused School Garden Programs

Morris and Zidenberg-Cherr (2002) targeted improving participant nutrition knowledge and vegetable preferences in their study of fourth grade students. This study included one control group (n=61 students) which received no formal gardening or nutrition education and two experimental groups. The first experimental group (n=71 students) incorporated nutrition lessons into the classroom. The second experimental group (n=81 students) incorporated nutrition lessons as well as a gardening component. There were three schools with three classrooms at each site participating. Schools were matched demographically and non-randomly assigned to treatment or control. The nutrition lessons included information about plant parts, nutrients, healthy diet information (Food Guide Pyramid, serving sizes, food labels), physical activity, setting goals, consumerism, and preparing snacks. For the students at the site with the gardening component there was a gardening lesson to go along with the theme for each nutrition lesson. The lessons were led by the investigator and taught during the school day. This program lasted 17 weeks with one nutrition lesson taught every other week for the experimental sites. During the weeks when students were not participating in the nutrition lessons, a newsletter was sent home to share with the families what had been taught at school. For the second experimental site there was a gardening lesson taught on the alternating weeks. During the time spent gardening, students were reported to have planted carrots (*Daucus* spp.), broccoli (*Brassica* spp.), spinach (*Spinacia* spp.), snow peas (*Pisum* spp.), radishes (*Raphanus* spp.), and Swiss chard (*Beta* spp.). Attendance at this program was not reported. Pre, post, and follow-up measurements were recorded for students in the three groups to measure nutrition knowledge (Morris & Zidenberg-Cherr, unpublished data) and vegetable preference (Birch, 1979; Domel, et al., 1996; Resnicow, et al., 1997).

Results showed that at the end of the program, students in the two experimental groups had a significantly higher preference for carrots and broccoli and a higher knowledge of nutrition than control group students. The increase in nutrition knowledge was maintained at follow-up. Students at the experimental site with gardening had a significantly higher preference for snow peas and zucchini (*Cucurbita* spp.) than the other experimental group and control group. At follow-up the nutrition only experimental group had maintained the significant preference for carrots while the gardening experimental group maintained the significant preference for broccoli, snow peas, and zucchini. This was an interesting result as zucchini was not one of the vegetables grown during the gardening sessions. Authors concluded from this study that using a nutrition curriculum with a gardening component can improve students' nutrition knowledge.

While having lessons led by the investigator may ensure lessons are implemented as intended by research protocol, it could lead to bias since the investigator knows of the desired outcomes. Follow-up measurements provide a measure of sustainability of the outcomes. Although the researchers do report some of the activities done during the gardening time and topics covered during nutrition lessons, the actual amount of time spent weekly in each is not reported.

In another study, by Morris, Neustadter & Zidenberg-Cherr (2001), researchers assessed the nutrition knowledge and fruit and vegetable consumption of first grade students. Two elementary schools, matched demographically and geographically, participated. Three classes at one site, selected by the state's department of education and USDA, were designated as the experimental group (n=48 students) and three classes at the other site, selected by researchers based on the site's responses to a prior survey, served as the control group (n=49 students). The experimental group was exposed to nutrition lessons developed by the classroom teachers and approved by the investigators. Teachers at the experimental site were to incorporate nutrition related examples into the regular curriculum and cover specific nutrition topics as was feasible during the school day. The experimental site also had gardening time, although the specific amount of time spent gardening was not clear. During the gardening time students were able to plant, maintain, and harvest fall and spring gardens. The vegetables they grew included spinach (*Spinacia* spp.), carrots (*Daucus* spp.), peas (*Pisum* spp.), broccoli (*Brassica* spp.), zucchini (*Cucurbita* spp.), and red bell pepper (*Capsicum* spp.). Attendance data was not reported in the article. This program lasted an entire academic school year. Researchers interviewed each student individually to record pre and post measurements. Students completed a food group identification questionnaire as well as a vegetable tasting questionnaire to measure willingness to taste, preference, and knowledge of vegetables (Birch, 1979).

Results of this study showed that students at the experimental site were significantly better able to identify the food groups at the posttest compared with the pretest measurement. However, because the pretest scores of the experimental group students were much lower than those of the control students, when the pretest scores were put in the analysis there was no longer a significant effect of the education program on this variable. Students at the experimental site were also significantly more willing to taste vegetables they had grown in the school garden at the posttest than the control group. However, preferences for vegetables and the students' ability to identify the vegetables correctly did not significantly change. Researchers indicate that to identify the vegetables, students were required to speak to the researcher which may have been intimidating to some of the first graders. The authors concluded that a nutrition program enhanced by a garden is a reasonable asset to the school day.

While this study does offer some flexibility for the teachers who are leading the lessons, it does not evaluate the level of implementation of the lessons. This can result in a vast difference in the quality and quantity of the nutrition lessons being taught. Consequently, it could be more difficult to draw conclusions from the results as they relate to the amount of exposure to the lessons.

In an after-school garden program, O'Brian and Shoemaker (2006) implemented eight garden/nutrition lessons with fourth grade students to determine if there was an increase in the participants' nutrition knowledge and fruit and vegetable preference. Additionally, the researchers were evaluating changes in self-efficacy and outcome expectations for gardening and eating fruits and vegetables. Thirty-eight fourth graders from two elementary schools participated in this study with 21 students at the control and 17 at the experimental site. This was a quasi-experimental design and the students were recruited to participate. The curriculum used was Junior Master Gardener: Health and Nutrition from the Garden (Genzer, Seagraves, Anding, Whittlesey, Aguilar, Graves, Klemmer, Koch, Lineberger, Reed, Robinson, Sebesta, Laanen, Wagner, Walton-Robinson, Welsh, Woodson, & Zajicek, 2001). At the experimental site there were eight lessons which were taught by a researcher along with help from volunteers. Students met once a week for ten weeks with baseline measurements taken the first week of the program and end program measurements taken the final week of the program. At each session the students were involved with a lesson, healthy snack, and gardening. The sessions lasted 80 minutes each with 30 minutes of that time spent gardening. The student attendance was reported at 96%. Nutrition knowledge (FNP, 2003), fruit and vegetable preference (Domel, et al., 1993), self-efficacy for gardening and fruit and vegetable consumption (adapted from Domel, et al., 1996), and outcome expectations for gardening and fruit and vegetable consumption (adapted from Domel, Baranowski, Davis, Leonard, & Baranowski, 1995) were evaluated.

Results from this study showed no significant changes in nutrition knowledge, fruit and vegetable preference, or gardening self-efficacy for the experimental group. However, the researchers reported a high score for these variables at baseline. The students in the control group significantly increased their gardening self-efficacy and outcome expectation scores from the baseline to end program measurements. The gardening outcome expectation scores for the experimental site students were high at baseline and were maintained through the end of the program. Fruit and vegetable consumption outcome expectations significantly decreased for the experimental site from pre to post measurement but remained high for the control site. Self-efficacy for fruit and vegetable consumption for both sites increased but it is not clear whether or not that was a significant increase. From this study the authors concluded that the social cognitive theory is useful in gardening and nutrition research programs by measuring fruit and vegetable preference, self-efficacy, and outcome expectations.

A strength of this study is the implementation of lessons by one of the researchers while the other researcher documented implementation. This ensures the lessons are followed as intended by the research program and/or variations from the intended lesson plan are noted. Based on the curriculum used, this study did not specifically target the social cognitive theory constructs that were measured. Changes to curriculum can be made to target these specific variables in order to affect a change in behavior. The small sample size in this study is one limitation, although the high attendance rate allowed for most of the students to receive the full exposure to the lessons.

McAleese and Rankin (2007) targeted increasing fruit and vegetable consumption in their study of sixth graders. Three elementary school sites participated in this study (n=122 students). One site served as the control site and participated in only the measurements. The other two sites were experimental sites and were exposed to the nutrition curriculum, Nutrition in the Garden (Lineberger & Zajicek, 1998). One experimental site also participated in a gardening program. This was a convenience sample with the control and one experimental site selected randomly. The second experimental site was selected based on garden availability. This study lasted twelve weeks and occurred during the school day, although the amount of time spent on nutrition education and gardening is not reported. It is not clear who was responsible for leading the activities and lessons. Students who participated in the gardening component of this project were responsible for maintaining a 25 square foot garden area. Students grew potatoes (*Solanum* spp.), corn (*Zea* spp.), peppers (*Capsicum* spp.), peas (*Pisum* spp.), beans (*Phaseolus* spp.), squash (*Cucurbita* spp.), cantaloupe (*Cucumis* spp.), cucumbers (*Cucumis* spp.), broccoli (*Brassica* spp.), tomatoes (*Lycopersicon* spp.), spinach (*Spinacia* spp.), lettuce (*Lactuca* spp.), and kohlrabi (*Brassica* spp.) as well as strawberries (*Fragaria* spp.) and herbs. Attendance was not reported. Students completed three 24-hour food recall workbooks (Jendrysik, 1991), administered by the classroom teacher, prior to the intervention as well as at the end of the program (n=99). Teachers were trained by the investigators on how to prompt students and respond to questions.

Additionally, one researcher taught students how to complete the workbooks prior to the first data collection.

Results from this study showed that students who participated at the experimental site with a gardening component significantly increased the number of daily servings of fruits and vegetables, Vitamins A and C, as well as fiber compared with the other two sites. Students at the other two sites had no significant changes. The authors concluded that including a gardening component to a nutrition program is an important factor for affecting fruit and vegetable consumption. This study did not specify the number of students at each of the sites. There were no follow-up measures to determine whether or not the change in fruit and vegetable consumption was sustained beyond the twelve week intervention. As stated before, it is helpful to know the level of implementation of the nutrition and gardening lessons when analyzing results and conclusions.

Another study that targeted fruit and vegetable consumption is by Parmer, et al. (2009). This study tested a school garden's effect on fruit and vegetable knowledge, preference and consumption of second grade students. Six classes participated. Two classes served as the control (n=39 students), two classes as experimental site one (n=37 students), and two classes as experimental site two (n=39). Classes were assigned to control or treatment based on the requests of each teacher. The students at the experimental sites were exposed to two nutrition activity guides: Pyramid Café (1998) and Health and Nutrition from the Garden (Genzer, et al., 2001) every other week. In addition to the nutrition lessons, students at the second experimental site participated in a gardening component on the weeks alternating the nutrition lessons. Each nutrition lesson and gardening lesson lasted one hour during the regular school hours. The leader of these lessons was not reported. During the gardening time, students sowed seeds and planted carrots (*Daucus* spp.), broccoli (*Brassica* spp.), spinach (*Spinacia* spp.) and cabbage (*Brassica* spp.) and were responsible for maintaining the garden area. The program lasted 28 weeks. Pre and post assessments were administered by the researchers. A fruit and vegetable survey was composed of tools that measure fruit and vegetable knowledge (Struempler & Raby, 2005) and preference (Domel et al., 1993). A fruit and vegetable questionnaire (Birch & Sullivan, 1991) measured participants' preference, willingness to try, and knowledge of various fruits and vegetables. Two lunchroom observations of all participants were conducted by one of the researchers. During these observations the researcher recorded the type of lunch the students had, vegetables chosen, and whether or not the participant consumed those vegetables.

The students at both experimental sites had significantly greater improvements in their nutrition knowledge than the students at the control site. The students at the experimental site with a gardening component were significantly better able to identify three of the vegetables tested than either of the other two groups. Both experimental groups were more willing to try fruits and vegetables than the control, although all three of the groups did increase their willingness to try fruits and vegetables over the course of the study. The experimental groups significantly increased their taste ratings of the taste of fruits and vegetables. The experimental site with gardening scored significantly higher on taste ratings of spinach by the end of the program when compared to the other groups. The gardening group was also more willing to choose vegetables during lunch at school compared with the nutrition only and control groups. Finally, though the gardening group significantly increased their vegetable consumption, there was no change in consumption for the nutrition only group and a decrease in vegetable consumption for the control group. From these results the authors concluded that a school gardening program can help increase knowledge, preference and consumption of fruits and vegetables for young children.

This study assigned treatments to the classes based on the interest of the teachers. This can bias results as teachers who have a background in gardening/nutrition may already be implementing such activities into the classroom and may continue to do so regardless of group assignment. Although time consuming, the lunchroom observations are a way to avoid using self-report for behavior and may provide a more accurate measure of fruit and vegetable consumption.

In 2000, Lineberger and Zajicek published a study aimed at determining whether or not students' attitudes about fruit and vegetable consumption and nutrition behaviors could be improved through the use of a nutrition activity guide. This study had no control group. Teachers volunteered their classes for participation. One hundred eleven students in the third and fifth grade participated in this project. Teachers implemented lessons from the activity guide, Nutrition in the Garden (Lineberger & Zajicek, 1998), during the school day as they saw fit. Although teachers were allowed to choose how many and which activities they used, they were supposed to cover information from each of the ten unit topics defined by the guide. Each unit has 34 activities which take approximately 20 minutes each to complete. Teachers were allowed to adapt activities as necessary. This study reported that participants spent time gardening but the amount of time and frequency is not detailed. The duration of this study was one academic school year. Students completed pre and post evaluations. Fruit and vegetable preference was measured with a questionnaire (Domel et al., 1993) which included fruit, vegetable, and snack preference. Twenty-four hour food recall workbooks (Jendrysik, 1991) were used to record students' nutritional behaviors.

Results showed a significant increase in the participants' preference for vegetables. Those students who had the lower preference for vegetables at pretest showed the most improvement in scores by posttest. Fruit preference scores did not significantly change, however, these scores were relatively high at both times of evaluation. Snack preference scores increased significantly from pre to posttest, with children becoming more willing to try a fruit or vegetable for a snack after participating in this program. Third graders' scores improved the most from pre to posttest. Females had a significantly higher snack preference score at pretest than males which was further increased by posttest. Participants did not significantly change their fruit and vegetable consumption from pre to posttest. Researchers concluded that student attitudes regarding nutrition can be improved through a gardening program that includes directed activities. Offering teachers flexibility with implementation of a new program is important for participation.

This study did allow teachers to make changes to activities as needed for their students. Teachers were also given the freedom to choose which and how many activities they would incorporate into their regular curriculum. While this may generate greater compliance from the teachers, it also can present challenges when trying to determine what dose of the intervention students received. Furthermore, time spent gardening and hands-on garden activities were not reported. It is difficult to claim a gardening program had an effect on targeted outcomes without knowing exactly how much time, if any, children spent gardening.

Physical Activity Focused School Garden Programs

Phelps, et al. (2010) integrated a gardening program into an existing after-school program to determine whether or not gardening could increase the levels of physical activity in children. There was no control group and one intervention site with 31 students who participated. Selection of the school site and students for inclusion was not reported. Students evaluated were in third through fifth grade and participated in a daily after-school program for 90 minutes. One day per week students participated in the gardening program which included hands-on gardening time and nutrition education. The lesson material used came from the Junior Master Gardener Program (Texas Cooperative Extension Service, 2005), Oklahoma Ag in the Classroom (Oklahoma Cooperative Extension Service, 2006), and USDA Team Nutrition (USDA, 2006). It is unclear who lead the after-school gardening program and how much time was spent actually gardening. However, the report does state that children were involved with the planting, fertilizing, mulching, watering, weeding, and harvesting of the garden space. This program was operated for eight weeks and evaluated pre and post intervention. The tool used to evaluate the participants was the Assessment of Young Children's Activity using Technology (Tremblay, Inman, & Willms, 2001) which required students to watch video clips of children performing various intensity levels of activity. Students reported their own levels of physical activity at different times during the day based on the levels they viewed on the screen. Student responses were broken into three categories: non-moving, moving, and fast-moving.

Researchers reported a significant change in pre to posttest scores for the participants with a larger proportion of students reporting they were moving during the after-school hours. The researchers concluded that an after-school gardening program can help to increase the amount of time children report being physically active.

This study does not report the statistical significance of the results. Using an objective measure of physical activity, such as an accelerometer, would give a more accurate measure of the level of physical activity of the participants. Without having a control to compare with this experimental group, and with such a small sample, it is difficult to conclude that the increase in physical activity is due to the gardening program.

Hermann, et al. (2006) did a study to determine what effect an after-school gardening program had on physical activity and vegetable intake of the participants. This study had no control group and 43 students from third through eighth grade in the intervention. Selection of the school site and students for inclusion was not reported. This study used the Junior Master Gardener Program (Texas Cooperative Extension Service, 2005), USDA Team Nutrition (USDA, 2006), and Ag in the Classroom (Oklahoma Cooperative Extension Service, 2006) for the educational component. The program was operated by the project coordinator from the Oklahoma Cooperative Extension Service (OCES) who provided gardening, nutrition, food preparation, food safety and physical activity lessons to participants. Students spent one day per week working in the garden, although gardening and lesson time is not specified. During the gardening time students helped with planting, watering, weeding, fertilizing, mulching, and harvesting and grew corn (*Zea* spp.), beans (*Phaseolus* spp.), squash (*Cucurbita* spp.), onions (*Allium* spp.), peppers (*Capsicum* spp.), tomatoes (*Lycopersicon* spp.), carrots (*Daucus* spp.), okra (*Abelmoschus* spp.), zucchini (*Cucurbita* spp.), cucumbers (*Cucumis* spp.), lettuce (*Lactuca* spp.), and spinach (*Spinacia* spp.). Length of the intervention was not reported. Participants were evaluated pre and post intervention with a two statement survey instrument. The statements were: "I eat vegetables every day" and "I am physically active every day". Students responded with yes, sometimes, or no. For analysis of the surveys, the responses of "sometimes" and "no" were combined.

The researchers reported a significant increase in the proportion of children who reported eating vegetables every day and being physically active every day. They concluded the garden program they established which included nutrition, food prep, and physical activity, was effective for improving the vegetable intake and physical activity reported by the children in this after-school program.

Implementing the lessons by the project coordinator of the OCES more likely ensures the activities will be covered as intended for the purpose of this research. The survey instrument used for this study is not a validated measurement tool. The survey does not take into account number of servings of vegetables nor serving size. Physical activity comes in a variety of intensity levels which are not specified by this survey. Concluding that the students have increased their vegetable intake and level of physical activity as a result of the gardening program is unwarranted as no control group was analyzed and the sample was small with a wide range of ages.

Academic Achievement Focused Gardening Programs

In a study of third through fifth grade students, Klemmer, Waliczek, and Zajicek (2005b) used a school garden program aimed at improving science achievement scores. Six hundred forty seven students participated in this study. Teachers volunteered their classes to participate and the district Math/Science coordinator assigned the classes to control or experimental group. Thirteen elementary classes (n=194 students) served as the control group and followed the regular science curriculum. Twenty seven elementary classes (n=453) made up the experimental group which followed the science curriculum with an additional component. The Junior Master Gardener, Level One (JMG) (Texas Agricultural Extension Service, 1999a, 1999b) curriculum was incorporated in the experimental classes by the classroom teacher. All teachers were encouraged to participate in the program training. Teachers of experimental classes were instructed to incorporate as many of the activities as possible throughout the school year. This JMG guide has eight chapters with topics that include: plant growth and development, soils and water, ecology and environmental horticulture, insects and diseases, landscape horticulture, fruits and nuts, vegetables and herbs, life skills, and career exploration. Along with this activity guide, teachers of experimental group classes were encouraged to use some type of hands-on gardening with the students. All teachers within the district were eligible to participate in the training. Amount of time spent gardening and implementing the activities was not reported. To assess the participants' academic achievement, teachers administered a science achievement posttest designed for this study (Klemmer, Waliczek, and Zajicek, 2005a).

Results indicated that the participants of the experimental group scored significantly higher in science achievement than the control group participants. When analyzed by grade level, the fifth grade experimental group participants scored significantly higher than their control counterparts. There were no significant differences between the other grade levels. Females in the experimental group scored significantly higher than the females in the control group. Males in the experimental group scored significantly higher than males in the control group. Third and fourth grade females in the experimental group were not significantly different from those in the control group. Fourth grade males in the experimental group scored significantly lower than those in the control. Authors concluded that students who participated in this hands-on program incorporated into their regular science curriculum earned higher scores on their science achievement exams.

This study has the benefit of having a large sample of students. Allowing teachers to implement the activities creates an opportunity for greater sustainability and reaching more students through a program that takes place during the school day. However, assignment of the control and experimental groups was not random which may have resulted in some bias. Students with lower science achievement initially may have been assigned to the control group which would have impacted the results. It may have been beneficial to look at pretest scores to determine a baseline measurement. Furthermore, without having record of whether or not experimental classes actually participated in gardening it is difficult to conclude that the reports are a result of a hands-on gardening program. Encouraging all teachers in the district to participate in the training may have promoted more teachers than just those in experimental groups to incorporate activities from the curriculum into their lessons which may have impacted results. Providing this training for the teachers not in the experimental group at a later date following the intervention may have been helpful to avoid this possibility.

Smith and Motsenbocker (2005) studied a school garden program's effect on science achievement of fifth grade students (n=119). A total of six classes at three schools were divided in two groups of three with one group serving as the control (n=57 students) and the other serving as the experimental group (n=62 students). Schools were chosen based on whether or not they had space for a garden, cooperative teachers/principal, two mainstream fifth grade classes, and were within close vicinity to the university. Students in the experimental classes participated in lessons from the first four chapters of Junior Master Gardener, Level One (Texas Agricultural Extension Service, 1999a) 1.5 hours per week during the school day. These lessons were led by volunteers. Thirty minutes per week was also spent gardening. Each experimental site had three four feet by ten feet garden beds. Some of the herbs and vegetables grown were mint (*Mentha* x *piperita*), rosemary (*Rosmarinus officinalis*), parsley (*Petroselinum crispum*), basil (*Ocimum bascilicum*), broccoli (*Brassica oleracea* var. *italica*), radish (*Raphanus sativus*), lettuce (*Lactuca* spp.), carrot (*Daucus carota*), and potato (*Solanum tuberosum*). Participants and teachers were responsible for maintaining this space. The duration of this study was fourteen weeks. Participants at control and experimental sites were evaluated pre and post intervention with a science achievement tool (Klemmer, 2002).

Results from this study reported that students in the experimental group significantly increased their science achievement scores from pre to posttest. When analyzed by chapter within the curriculum, the scores were only significantly increased for one of the four chapters taught. When analyzed by school site, only one of the sites showed significant increases in science achievement scores in the experimental group. After analyzing the data by chapter and site, two of the experimental sites showed increases in science achievement scores for two of the four chapters taught. One of those experimental sites showed a significant decrease in science achievement for information taught in a third chapter. Authors of this study concluded that there can be some improvement in science achievement scores with the incorporation of a once per week gardening session.

This study had some level of implementation consistency as the activities were conducted on a weekly basis for a designated amount of time. However, beyond the weekly lessons lead by volunteers, teachers were inconsistent with incorporating activities into the curriculum. It is unclear whether or not the volunteers were trained in using the program guide. Additionally, the authors report that while the volunteers had a background in horticulture, they tended to lack experience teaching which may have affected the instruction of the material. The control group didn’t complete the pretest until eight weeks after the experimental group and completed the posttest one week after the experimental group. This caused the testing to be only approximately seven weeks apart for the control group while the experimental group was tested approximately fourteen weeks apart. Designation of the sites as control and experimental was not random but was based on a variety of variables including feasibility of establishing a garden and how cooperative the principal and teachers were. While this may facilitate compliance with the project, it could also lead to bias.

Pigg, Waliczek, and Zajicek (2006) studied the effects of a school garden program on the math and science achievement scores of students in the third through fifth grades. This study was done during the regular school hours at one elementary school with 196 students participating. This site was chosen because the teachers were recently trained to use the curriculum which was also planned to be used for this study. The assignment to control or experimental groups was based on whether or not the teacher of each class was already using the curriculum. The control group (n=102 students) were taught math and science by their teacher using the regular curriculum. The experimental group was made up of 94 students whose teachers incorporated a garden curriculum into the regular math and science curriculum. Teachers were instructed to incorporate the Junior Master Gardener, Level One curriculum (Texas Agriculture Extension Service, 2001) as much as possible throughout the academic school year. In addition, a garden and small greenhouse were located at the elementary school site but use of these spaces varied among the teachers. To measure the participants' math achievement, teachers administered a state assessment, Texas Assessment of Knowledge and Skills (Texas Education Agency, 2005). Science achievement was measured by a test developed for evaluating science achievement for programs using the JMG curriculum (Klemmer et al., 2005a). Teachers administered both of these assessments at the end of the school year. No significant differences were seen in science achievement between the experimental and control groups. The control group participants scored significantly higher on the math achievement test, however, the researchers acknowledge that math is not a focus of the JMG curriculum. When analyzed by grade level, the fourth grade students in the experimental group scored significantly higher on the science achievement test than those in the control group. Fifth grade students in the experimental group scored significantly lower on both math and science achievement tests than the control group students. No significant differences were found among the third grade students for science or math nor the math scores of the fourth grade students. The authors concluded from these results that incorporating a gardening program into the traditional curricula may benefit some students but there is room for development of garden curricula to better match specific content areas.

As with several other studies, this study has the strength of using the classroom teachers as the program leader. This is a more likely model for the garden program to be sustained as opposed to having the program run by volunteers. However, the flexibility given to the teachers to incorporate the garden activities at their discretion leaves room for variability in implementation from one classroom to the next. Perhaps in these cases teachers should fill out an implementation record to report when the activities were incorporated throughout the week and to what extent they were taught according to the lesson plan. Having this record would give the researchers a better understanding of the results. Secondly, having the experimental classes and control classes at one site, where the garden was located could affect the results as students may be influenced by being exposed to this environment regardless of whether or not they spent any time gardening on site. Classes were not randomly assigned to treatment groups, but were assigned based on whether or not the teachers were following the gardening curriculum through which they had recently been trained. Without conducting a pretest it is difficult to understand whether the control and experimental groups were similar at the beginning of the evaluation year.

Attitude and Self-Development Focused School Garden Programs

Waliczek, Bradley, and Zajicek (2001) performed a study to determine how and if the integration of the Project GREEN (Waliczek & Zajicek, 1996) garden program affected the participants' relationships and attitudes towards school. This study took place during the school day at seven elementary schools. Students volunteered to participate but it is not reported how the schools were chosen nor how the experimental and control groups were assigned. Participants were divided into control and experimental groups. Although the number of students in the groups was not specified in this report, the total number of participants was 598 in second through eighth grades. The students in the experimental group were exposed to the Project GREEN Activity Guide Book 1 (Waliczek & Zajicek, 1996) which was incorporated into their regular math and science lessons. Teachers of experimental classes were allowed to utilize the activities from this guide as they saw appropriate. It is not specified in this report whether or not students at the experimental site spent any time gardening. The duration of this study was one semester. Assessments of the participants were done pre and post intervention using the Behavior Assessment System for Children (Reynolds & Kamphaus, 1992). This tool is used as a psychological inventory which measures personality by self-report as it relates to interpersonal relationships and attitudes toward school.

Results from this assessment showed no significant differences in scores between the control and experimental groups, but there was a significant change pre to post of experimental participants' attitude toward school. Students participating in the garden program received scores indicating a more negative attitude toward school at posttest than what was recorded on the pretest. Authors mention that the timing of the posttest may have played a role in this result as it took place at the end of the school year when students may have been experiencing burnout. Females had significantly more positive attitudes toward school than males from pretest to posttest. Seventh grade students were reported to have significantly more positive interpersonal relationships by posttest than the other grade levels evaluated. Finally, when analyzed by school site, it was concluded that students participating in a garden program at a site that enabled the students to work independently in the gardens had significantly more positive attitudes toward school. The authors have concluded from this study that a school garden program can psychologically impact children.

This study adds to this field of research by showing benefits for children in school garden programs in various areas of their life which may in turn benefit their progress in school. Pretesting the students provides a baseline measure to better enable the researchers to make conclusions from the results. Implementation of the Project GREEN activity guide could have been evaluated to help researchers make conclusions of potential reasons why there were no statistical differences measured between the control and experimental groups. The use of instrumentation to evaluate interpersonal relationships and attitudes towards school for an intervention that uses activities targeting math and science is questionable. This illustrates the need for theoretical models to guide research.

Aguilar, Waliczek, and Zajicek (2008) evaluated how effective a garden program was at changing the participants' attitudes of the environment as well as environmental locus of control. This study took place at seven schools with participants in the third through fifth grade. The experimental (n=461 students) and control (n=193 students) groups were formed by classes volunteered by the teachers. Students at the experimental sites were exposed to the Junior Master Gardener Level One (Texas Cooperative Extension Service, 1999a) curriculum during the school day throughout an entire academic year. Teachers were told to use activities from the curriculum, but how many and which activities they used were left up to the teacher. These activities were designed for implementation in either the classroom or in a garden setting; however this study does not specify whether or not any teachers utilized a garden. Three assessments were compiled and administered by teachers for a posttest. The Children's Environmental Response Inventory (Bunting & Cousins, 1983) was used to measure the participants' environmental personality which refers to an individual's attitudes toward the environment and behaviors in various environments. The second assessment used measured the participants' environmental attitude (Cammack, Waliczek, & Zajicek, 2002). The third assessment measured environmental locus of control (Smith-Sebasto, 1992).

Results from this study showed no significant differences between the experimental and control groups for either environmental attitude or environmental locus of control. Females had a significantly higher score than males for environmental attitude and locus of control. Caucasians scored significantly higher than African Americans for environmental attitude and locus of control. Caucasians also scored significantly higher than Hispanics for environmental attitude. Students with previous gardening experience scored significantly higher for environmental attitude and locus of control than students without previous gardening experience. Researchers concluded from this study that the school gardening guide followed did not influence the participants' environmental attitude or locus of control. However, the researchers do acknowledge that a majority of the students in their study had some previous gardening experience. There was only one question on their survey that asked about gardening experience and it is unclear whether this question quantifies the amount of gardening experience. Participants' environmental attitude and locus of control scores were relatively high for both groups when evaluated. For this study a pre-test could have helped to determine a baseline measurement. Documenting the amount of time the classes spent in the garden could have also been an interesting component to this study to determine if spending more time with hands-on lessons created more positive environmental attitudes and locus of control.

Robinson and Zajicek (2005) studied changes in elementary students' life skills after participation in a school garden program for one academic year. Five schools with students in the third through fifth grade participated in this program. Teachers volunteered their classes for participation. The control students (n=91) participated in the pre and posttest but underwent no further intervention. The experimental students (n=191) participated in the pre and posttests and were also exposed to the Junior Master Gardener, Level One (Texas Agricultural Extension Service, 1999a and 1999b) program. Teachers were trained to implement the activities. Although the timing of when and how often activities were integrated into the curriculum was left to the teachers, they were instructed to include at least one activity from each concept. This totaled 44 group activities, 44 individual activities, and eight community activities. As mentioned previously, this program does offer opportunities to utilize a garden with the activities; however, this study does not report any time spent actually gardening. Pre and posttests were administered by the classroom teachers. The Youth Life Skills Inventory (adapted from Townsend & Carter, 1983) and the 4-H National Youth Assessment Survey (Peterson, Gerhard, Hunter, Marek, Phillips, & Titcomb, 2001) were used to evaluate the participants.

At pretest the control group had significantly higher scores than the experimental group for overall life skills. This was no longer a significant difference at the posttest measurement. Therefore, the experimental and control groups' scores were not significantly different after the intervention. Students within the experimental group did significantly improve their score for working with groups and self-understanding from pretest to posttest. Authors concluded that youth can improve their life skills through a school garden program. Using a pretest and posttest showed the researchers a baseline of how the two groups were different/similar enabling them to recognize significant improvements in scores made by the experimental group. Providing the teachers with a minimum number of activities they needed to incorporate into their curricula throughout the year gave them better guidelines to follow than instructing the teachers to just incorporate activities at their discretion. Going one step further to hold them a bit more accountable would be to have them submit records of which activities they actually completed and to what extent. Again, all teachers within the district were encouraged to participate in the training of the garden program guide. The authors claim they don't believe this caused any bias but by providing this training as an option after completing the intervention they could further eliminate this possibility.

Gardening Focused School Garden Programs

Poston, Shoemaker, and Dzewaltowski (2005) did a study of an after-school garden program aimed at increasing the participants' gardening knowledge and self-efficacy in gardening. The goal was that increasing these two outcomes would consequently increase the participants' willingness to try vegetables, self-efficacy for fruit and vegetable consumption, as well as preference for fruit and vegetables. There were two groups in this study, although no control was used. One group (n=11) was taught during the summer using the Professor Popcorn (Purdue University Cooperative Extension, 2005) activities. The other group had a summer (n=7 students) and fall (n=11 students) program which used eight lessons from the Junior Master Gardener Health and Nutrition from the Garden (Genzer, et al., 2001). Participants in the summer program ranged from third through fifth grade; participants in the fall program were in the fourth grade only at one site. Students were recruited to participate from an after-school childcare center. Lessons for each group were taught once per week for approximately 90 minutes at each session. The Professor Popcorn group had lessons focusing on healthy behaviors including eating and food handling as well as physical activity. This program lasted five weeks during the summer. The JMG group had lessons that were a combination of nutrition and gardening topics. In addition, the participants of this group spent about 10 to 15 minutes each week gardening. During the gardening time in the summer, students planted cucumbers (*Cucumis sativus*), sweet corn (*Zea mays* var. *esculentum*), eggplant (*Solanum melongena* var. *esculentum*), peppers (*Capsicum annuum* var. *annum*), squash (*Cucurbita pepo* var. *melopepo*), watermelon (*Citrullus* *lanatus*), and harvested carrots (*Daucus carota* var. *sativus*), potatoes (*Solanum tuberosum*), radishes (*Raphanus sativus*) and tomatoes (*Lycopersicon lycopersicum*). During the fall program participants grew broccoli (*Brassica oleracea* var. *botrytis*), cabbage (*Brassica oleracea* var. *capitata*), green onions (*Allium fistulosum*), lettuce (*Lactuca sativa*), radishes, and spinach (*Spinacia oleracea*), and harvested lettuce and radishes. This program lasted eight weeks during the summer and fall. Both programs provided the participants with a healthy snack at each session. The programs were implemented by the researchers. Pre and post-tests were administered. Nutrition knowledge was evaluated by a 10-item test created based on the concepts from the JMG lessons and questions provided by the two organizations where the curricula originated. Fruit and vegetable preference was measured with an adapted version of a previously validated tool (Domel, et al., 1993). Self-efficacy was evaluated by a questionnaire developed by the researchers based on previously developed self-efficacy tools (Domel, et al., 1996 & Ryan & Dzewaltowski, 2002).

Results show no significant change in nutrition knowledge or fruit and vegetable preference. Based on the baseline data, the researchers commented that students already had relatively high nutrition knowledge prior to this intervention. In the JMG group, garden self-efficacy increased significantly during the summer but decreased significantly in the fall. Researchers commented that during the summer students were able to grow and harvest more vegetables than during the fall which may have affected this result. Fruit and vegetable self-efficacy did not change significantly. The authors concluded from these results that further research is needed to determine effects of the duration of the program as well as effects of the time spent gardening, methods of gardening, and the season when the program is implemented on the targeted outcomes. The researchers noted the small sample size, short duration of the program, and short amount of time spent gardening may have contributed to their results. This is a strength as it provides other researchers with information to move forward with future studies. This study was strengthened by the reports of duration regarding gardening time, and overall program length.

Lautenschlager and Smith (2007) used the Theory of Planned Behavior model (Ajzen, 1991) to determine whether or not a garden program could influence the participants' eating and gardening behaviors. Specifically, researchers looked at the participants' intention and behavior for gardening and eating and how they are related. This study used no control. The program followed was the Youth Farm and Market Project (YFMP, 2005) which educates youth about environmental responsibility, empowerment, and cultural expression in a garden setting. Participants were exposed to a nutrition curriculum which was led by a nutrition educator. The participants met three days a week for ten weeks. Each week a new nutrition topic and gardening lesson were introduced to the participants. A cooking curriculum was also incorporated which included a focus on ethnic foods and kitchen skills. Although this report does state that the students were actively involved with gardening including planting and harvesting, the amount of time spent gardening is not clear. Participants were recruited based on ethnicity, income, and residency and were evaluated prior to the intervention (n=96 students) as well as after the intervention (n=66 students). The ages of the participants ranged from eight to fifteen years old. Surveys were self-administered although a researcher was available to answer questions. Participants completed a 24-hour food recall journal as well as a survey created using procedures developed by Ajzen (1991) for the Theory of Planned Behavior. There were also twelve questions regarding the participants' behavior including gardening and eating.

Results showed that boys were consuming significantly fewer fruits and vegetables than girls at the pretest. However, at posttest there were no significant differences in fruit and vegetable consumption, indicating the boys significantly increased their fruit and vegetable consumption. For boys, attitude was the most predictive of intention although their intentions at pre-survey did not predict their behaviors at post-survey. For girls, attitude did predict their intentions at the pre-survey; however, their pre-survey intentions did not predict their post-survey behaviors. Girls' perceived behavioral control was a slight predictor of their behavior. On the pre-survey, boys who indicated that they were planning to learn more about planting/weeding a garden reported following through with those intentions. However, boys at pre-survey who planned to help their family garden did not follow through. Girls pre-survey intentions of learning about ethnic foods, cooking skills, selling vegetables/fruits/flowers, helping their family garden and eat three servings of vegetables daily did not result in a change in their reported behaviors. The authors of this study concluded that a garden program is capable of encouraging modest changes to behavior in urban youth. In addition, youth behavior is affected by many factors including the individual's intentions, attitude, subjective norm, and perceived behavioral control.

This study contributes greater understanding for research on school garden programs targeting changing youth behavior. The authors articulate the difficulty of recording the dose of the program received by the participants as attendance at the sessions was voluntary and clearly not all participants were present for all meetings.

Discussion

Results of these sixteen studies are varied and contradicting in some cases. Fruit and/or vegetable preference have been shown to increase (Morris & Zidenberg-Cherr, 2002; Lineberger & Zajicek, 2000) but have also been shown to not change after participation in a garden program (Lineberger & Zajicek, 2000; Poston, et al., 2005; Morris, et al., 2001; O'Brien & Shoemaker, 2006). Fruit and/or vegetable consumption has been shown to increase (Hermann, et al., 2006; McAleese & Rankin, 2007; Lautenschlager & Smith, 2007; Parmer, et al., 2009), but also have shown no change after participating in a school garden program (Lineberger & Zajicek, 2000). While the understanding of the benefits of gardening at school has increased, the wide range of results from these studies highlights areas where improvements can be made to the field of research of school gardening.

Based on the studies reviewed, school garden programs can have an effect on students' interactions with fruits and vegetables. It is still unclear though what exactly that interaction is and how it is achieved because most of the studies do not clearly state how much time the participants are exposed to the intervention. The dose of the intervention received could be a key factor affecting the results (O'Brien & Shoemaker, 2006; Poston, et al., 2005). Although these are studies of school garden programs, it is unclear in many studies, how much/if any gardening the students are doing. Furthermore, the instrumentation used to measure the interactions is varied making it impossible to develop a large enough base of results for generalization to a larger population. The use of a consistent assessment tool that has been previously validated (Morris, et al., 2001) can enable this area of research to progress. Design of the experiments is another area for improvement in methodology. Allowing teachers to choose their treatment and only using classrooms that volunteer for participation can result in bias and greatly affect the results. Providing interventions within the constraints of school district protocol can be challenging and may often influence decisions regarding participants and treatment assignment. However, using random selection (Parmer, et al., 2009; McAleese & Rankin, 2007) of participants is important to eliminate bias and provide results that can more likely be generalized to other populations.

Offering school garden programs during the school day versus after-school is an area requiring further research (O'Brien & Shoemaker, 2006). The school garden programs evaluated here occur in both settings but do not compare the same curriculum/activities used during school versus after-school. While offering a school garden program during the school day could potentially benefit from having better attendance and interaction with the staff, it may be difficult to find time within the other core content for this type of program. The after-school environment provides a way to offer additional programming for students who are interested in gardening but also need care during these hours. However, discipline during this time can be a challenge and getting staff involvement to retain a school garden program may become an issue. Researchers have yet to determine which setting can provide more beneficial and sustainable outcomes.

Further development of school garden curricula which targets a specific outcome rather than utilizing pre-existing curricula because of convenience is essential. Curricula used for a program targeting a change in behavior should focus on the factors affecting the behavior to be changed. Curricula should also include notation of the key activities to be included in each session. Key activities are those which address the targeted factors. Leaders who will be implementing the program should be trained to use and teach the curriculum. It should not be assumed that someone who works with children will know how to teach a new curriculum. It should also not be assumed that someone who knows how to garden will know how to implement a gardening curriculum with children.

In conclusion, youth and adult overweight and obesity remain a problem in the United States. It is more difficult for older adolescents and adults to change their behavior which makes the younger youth population, pre-adolescence, a prime target for intervention. School garden programs have been shown to be effective at changing eating behavior, attitudes for fruits and vegetables, and increasing levels of physical activity among many other beneficial outcomes. Consistency is needed in the field of school gardening research. This includes consistency in evaluation, reporting, and experimental design. School garden programs are lacking a theoretical framework to guide the interventions. Without an understanding of what affects youth behavior, it is difficult to design an intervention that can result in a change in behavior. To better understand youth health behavior and how school gardens can be effectively used, a theoretical basis and common research protocol is needed.

Objectives of Dissertation

1. Create a theory-based school garden curriculum for overweight prevention that incorporates physical activity through non-elimination games and gardening and targets increasing fruit and vegetable consumption also through gardening.

2. Investigate the amount of moderate to vigorous physical activity youth obtain during an after-school garden club.

3. Investigate the amount of energy expended by youth as they perform four gardening tasks.

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Table 1.1 Overview of sixteen school garden programs[1]

Author, Date	**Outcome Measured**	**Sample**	**Results**
Nutrition Focused School Gardening Programs offered during the school day			
Morris & Zidenberg-Cherr, 2002	N knowledge V pref	4th grade (n=213)	From pre- to posttest: NG & N higher V pref & N knowledge than control; pref for some V maintained at follow-up
Lineberger & Zajicek, 2000	FV Attitudes; FV pref; N behavior	3rd-5th grade (n=111)	From pre- to posttest: V pref increased; F pref did not increase; No change in FVC
Parmer, Salisbury-Glennon, Shannon, Struempler, 2009	FV Knowledge; FV pref	2nd grade (n=115)	From pre- to posttest: NG & N had greater increases in nutrient-food association knowledge, nutrient-job association knowledge, & FV identification than control; No change in FV pref; Control decreased FVC, NG increased FVC; No change in FVC for N
Morris, Neustadter, & Zidenberg-Cherr, 2001	Food group identification; V pref; V willingness to try	1st grade (n=97)	From pre- to post: Exp improved ability to identify food groups compared with control; Exp increased willingness to try V compared with control; V pref and ability to correctly identify V did not change
McAleese & Ranking, 2007	Nutrition Behavior	6th grade (n=99)	From pre- to posttest: NG increased FVC, Vitamin A, C, & fiber intake more than N & control
Academic Achievement Focused School Gardening Programs offered during the school day			
Pigg, Waliczek, & Zajicek, 2006	Science achievement; Math Achievement	3rd-5th grade (n=196)	No difference in science achievement between exp and control; control scored higher than exp on math achievement
Klemmer, Waliczek, & Zajicek, 2005	Science Achievement	3rd-5th grade (n=647)	Exp scored higher on science achievement than control
Smith & Motsenbocker, 2005	Science Achievement	5th grade (n=119)	From pre- to posttest: increase in science scores for exp
Attitude and Self-Development Focused School Gardening Programs offered during the school day			
Waliczek, Bradley, & Zajicek, 2001	Attitude toward school; interpersonal relationships	2nd-8th grade (n=598)	From pre- to posttest: Decrease in attitude toward school; females had more positive attitude toward school at end of program compared with males; 7th grade sts had most positive interpersonal relationships
Aguilar, Waliczek, &	Environmental	3rd-5th grade	No difference for environmental attitude or locus of control between

Zajicek, 2008	Attitude; Environmental Locus of Control	(n=654)	control and exp at end of program
Robinson & Zajicek, 2005	Life skills	3rd-5th grade (n=281)	From pre- to posttest: exp increased scores of overall life skills; exp increased scores for working with groups & self-understanding
Nutrition Focused School Gardening Programs offered after-school			
O'Brien & Shoemaker, 2006	N Knowledge; FV pref; SE; OE	4th grade (n=38)	From pre- to posttest: No change in N knowledge, FV pref, G SE, OE for G; FVC SE increased for control and exp; Control increased G OE; FVC OE decreased for exp
Physical Activity Focused School Gardening Programs offered after-school			
Hermann, Parker, Brown, Siewe, Denney, & Walker, 2006	N Behavior; PA Behavior	3rd-8th grade (n=43)	From pre-to posttest: increase in proportion of sts who reported eating V & being physically active every day
Phelps, Hermann, Parker, & Denney, 2010	PA Behavior	3rd-5th grade (n=31)	From pre- to posttest: greater proportion of sts self-reported as spending time "moving"
Gardening Focused School Gardening Programs offered after-school (*Time of day offered not-specified)			
Poston, Shoemaker, & Dzewaltowski, 2005	N Knowledge; FV pref; SE	3rd-5th grade (n=29)	From pre- to posttest: No change in N knowledge, FV pref, or FV SE; G SE increased for summer JMG group but decreased for fall JMG group
*Lautenschlager & Smith, 2007	Nutrition Behavior; Gardening Behavior; Intentions for Behaviors	Children aged 8-15 years (n=96)	From pre- to posttest: boys increased FVC; attitude was most predictive of intention for behavior at pretest; intention did not always result in behavior change

[1]SE=Self-Efficacy; OE=outcome expectations; F=fruit; V=vegetable; FV=fruit and vegetable; FVC=fruit and vegetable consumption; JMG=Junior Master Gardener; sts=students; N=nutrition; G=garden; NG=nutrition and garden; exp=experimental; pref=preference; PA=physical activity

Chapter 2 - Theory-Based Development of an After-School Garden Club Curriculum

Abstract

Although many garden club activity guides and some garden curricula exist, there is a lack of theoretically-based program material. For curriculum targeting behavior change through an organized program, a theoretical basis is necessary to ensure the lessons and activities are addressing the factors affecting the targeted behavior(s). This paper provides rationale for developing, implementing, and evaluating an after-school garden club curriculum based on Social Cognitive Theory and aimed at overweight prevention. The strategies presented here were designed to increase outcome expectations and self-efficacy for eating fruits and vegetables, being physically active, gardening, and decreasing the amount of time sedentary while decreasing barriers for these behaviors. Evaluation approaches are presented and recommended to be carried out through formative research to measure implementation of the curriculum and to identify portions of the curriculum that need to be altered to help participants progress towards program goals. A curriculum developed based on this guide would incorporate the constructs of Social Cognitive Theory to target behavior change in the after-school setting of a garden club during an academic year.

Theory-Based Curriculum

School gardens have been used to target many youth behaviors such as improving fruit and vegetable consumption and learning outcomes such as science education. Research results on school gardens are varied and contradicting in some cases. For example, fruit and/or vegetable preference have been shown to increase (Morris & Zidenberg-Cherr, 2002; Lineberger & Zajicek, 2000) but have also been shown to not change after participation in a garden program (Lineberger & Zajicek, 2000; Poston, Shoemaker, & Dzewaltowski, 2005; Morris, Neustadter, & Zidenberg-Cherr, 2001; O'Brien & Shoemaker, 2006). When a school garden is intended to target youth health behaviors, the garden curriculum should use current health behavior change models to inform development of the intervention strategies.

Using a school garden curriculum is important as it defines the steps that will be taken to reach a desirable end result. A curriculum is a planned document that includes specific objectives to guide teaching. This enables the teacher/leader to choose a curriculum based on common objectives between the program and the curriculum. However, to target health behavior change, interventions must take into consideration factors affecting individuals beyond personal factors (Brug, Kremers, van Lenthe, Ball, & Crawford, 2008). Without understanding the many factors that contribute to a person's decisions an intervention targeting behavior change may be ineffective. This illustrates the importance of using theory in the development of curriculum for health behavior interventions. Theory provides a basis of understanding behaviors. A curriculum developed around a well-researched theory will use techniques to target the factors believed to affect the behavior. Simply providing information does not always result in sustainable changes in behavior (Brug, et al., 2008).

The purpose of this paper is to demonstrate how the Social-Cognitive Theory can be used to develop an after-school garden curriculum for overweight prevention.

Targeted Behaviors for Overweight Prevention

When developing a curriculum for an after-school gardening program for overweight prevention using Social Cognitive Theory, it is necessary to identify the behaviors that contribute to being overweight as well as the factors that affect an individual's ability to change those behaviors. Overweight is caused primarily by an imbalance in the amount of energy consumed with the amount of energy expended. Behaviors that contribute to this include excessive time spent sedentary, insufficient time spent physically active, and an improper diet. Whether or not a person changes their own health behaviors is affected by their belief in their ability to adopt a given behavior, which is referred to as self-efficacy. Self-efficacy is one construct of Social Cognitive Theory which explains the relationship between personal factors that affect behavior change.

Social Cognitive Theory

Social Cognitive Theory (SCT) is described by "five core determinants" (Bandura, 2004, pg. 4) including knowledge, self-efficacy, outcome expectations, goals, and facilitators/barriers. These determinants will vary from one individual to another. By examining and targeting these determinants, health promotion researchers can design an intervention that will be more likely to have sustainable effects.

Self-Efficacy

Self-efficacy is a person's belief in their ability to do something. A person's self-efficacy is variable depending on the task and situation they face (Resnicow, Davis-Hearn, Smith, Baranowski, Lin, Baranowski, Doyle, & Wang, 1997). Self-efficacy scores have been shown to improve amongst students after participating in a physical activity intervention based on social cognitive theory (Annesi, Westcott, Faigenbaum, & Unruh, 2005). A person with low self-efficacy is more likely to either not set goals or set very low goals. Furthermore, a person with low self-efficacy has a more negative expectation of what will result from working towards a goal making it harder for him/her to progress. Any barriers that come along while a person of low self-efficacy is working towards a goal will significantly impede their success (Bandura, 2004) due to a lack of motivation to overcome obstacles.

A person's behavior can be affected directly by his/her self-efficacy, but also by individual goals, outcome expectations, and sociostructural factors as illustrated in Figure 2.1 (Bandura, 2004). This figure demonstrates the necessity for a health promotion to identify and address not only self-efficacy but also the factors affecting self-efficacy which ultimately impacts behavior. There is a direct path from self-efficacy to behavior justifying the need to target this component in health interventions. An individual with a higher self-efficacy for a given behavior is more likely to adopt that behavior, while the opposite is also true. However, behavior can also be affected by the other factors illustrated in this figure.

Outcome expectations are a person's expectation of what will result from a behavior. If he/she has expectations for a positive result, whether they have a low or high self-efficacy he/she may adopt the behavior. If he/she expects a negative result it may be more difficult to adopt the behavior. Individuals with high self-efficacy tend to set higher goals and maintain positive outcome expectancies for the effort they put into achieving goals. An individual with low self-efficacy is more likely to either not set goals for behavior change and is less likely to work towards goals for behavior change over long periods of time.

Sociostructural factors include both facilitators and impediments. Facilitators are things that could make it easier for a person to work towards a goal. These are beneficial to individuals with high and low self-efficacy. Impediments are things that create a barrier keeping an individual from reaching a goal. High self-efficacy individuals are better able to monitor their own behaviors and make necessary changes to overcome barriers. Beliefs in their own abilities to succeed facilitate overcoming obstacles encountered as they progress towards their goals (Bandura, 2004). However, those with lower self-efficacy have more difficulty overcoming barriers and are more likely to dismiss their goals when difficulty arises.

There are many ways to target a change in child behavior through self-efficacy. One method is to help the child be successful with the behavior. Another is to provide leaders who model the behavior. If the child sees success for someone else, he/she may view success as a possibility for himself/herself as well. A third way is role-playing by enabling the child to act out what he/she could do to overcome an obstacle prior to the real life event. This gives the individual an opportunity to develop strategies and may increase his/her belief that he/she can move beyond any barriers (Bandura, 2004).

Developing problem-solving skills can increase the child's self-efficacy to resolve problems which may encourage him/her to set and achieve higher goals.

Overweight youth may not participate in moderate to vigorous physical activities when the games are competitive and allow exclusion of students (Dzewaltowski, Rosenkranz, Gellar, Coleman, Welk, Hastmann, & Milliken, 2010; Trost, Rosenkranz, & Dzewaltowski, 2008) since children who perceive barriers to their success in physical activity are less likely to try (Sallis, Prochaska, & Taylor, 2000). By providing enjoyable physical activity options that youth can choose from, there is a greater possibility of increased participation of overweight students (Trost, et al., 2008; CDC, 1997; Sallis & Patrick, 1994). This is an example of enabling students to overcome a barrier to physical activity and consequently improve their self-efficacy.

Preferences for fruits and vegetables have been shown to be more strongly associated with fruit and vegetable intake on weekdays than on weekends (Resnicow, et al., 1997). It is possible that children have more food options available during the weekends which are competing with fruits and vegetables. By increasing a child's self-efficacy for eating fruits and vegetables, they are better equipped to choose a fruit and/or vegetable to eat instead of another competing option. One way to increase a child's self-efficacy for eating fruits and vegetables is for him/her to see a role model, such as a teacher or parent, eating fruits and vegetables.

Children have been reported to be less active when they are at home, which could be the result of having numerous sedentary options available (Sleap & Warburton, 1992). Many homes have televisions, computers, and video games that can be more attractive to youth than healthier activities. These screen-based activities are barriers preventing children from decreasing the amount of time they spend sedentary because they are fun and popular choices. One option to overcome these barriers is to introduce youth to other fun activities that can be done individually and with friends. This process of teaching children to overcome their barriers to spending less time sedentary by replacing a sedentary activity with a non-sedentary activity that is just as much fun, is one way to increase their self-efficacy for this behavior.

Certain behaviors will require assistance from outside sources. Self-efficacy relates primarily to behaviors that can be controlled by the individual being targeted.

When a behavior is not able to be controlled by the individual, a high self-efficacy does not ensure the individual will adopt the behavior (Resnicow, et al., 1997). The individual becomes reliant on an outside source for assistance in these situations.

Proxy Self-Efficacy

Proxy self-efficacy is a person's belief in their ability to get someone to act on their behalf. This is relevant when an individual lacks certain skills, time, or other essential element to do something. Children typically rely on parents for food, shelter, transportation, and other provisions. In this scenario, parents serve as the proxy agent. When using a proxy agent an individual's outcomes depend on another person. Using a proxy agent may be elective or essential as in the case of a young child relying on his/her parents to provide food. Proxy agency could help or hinder the growth of the reliant individual depending on the choices of the proxy agent (Bandura, Barbaranelli, Caprara & Pastorelli, 2001).

Parental proxy self-efficacy is a child's belief in their own abilities to get their parent(s) to act on their behalf. A child with high parental proxy self-efficacy believes he/she can get his/her parents to help him/her achieve desired outcomes. A child with low parental proxy self-efficacy is less certain that his/her parents will help him/her achieve the desired outcomes and may therefore avoid asking for help. In order to help children increase their parental proxy self-efficacy, they need to learn how to engage their parents in conversations about the desired outcomes.

When children do not have direct control over behaviors, such as fruit/vegetable availability and physical activity opportunities, it is essential that interventions to increase these behaviors are not focused entirely on the youth (Gellar & Dzewaltowski, 2010). In these cases, interventions need to incorporate the proxy agents directly or equip the youth with asking skills to encourage the proxy agents to act on their behalf.

Targeting Self-Efficacy for Being Physically Active

While gardening itself can provide physical activity, incorporating physical activities into an after-school garden club serves multiple purposes. Getting the students active after spending the day in school can enable them to release some excess energy and help students to re-focus on the program lessons. It can help them make progress towards meeting the physical activity recommendations. Furthermore, it provides another activity students can rotate through to aid with student management.

To target self-efficacy, physical activities incorporated into the club should be non-elimination games so everyone can experience success. Students should be allowed to take turns choosing which physical activity to do. To encourage the students to participate, the games should be fun. Leaders should be trained to serve as role models and participate in the physical activities with the students. Providing non-competitive and fun physical activities within the structure of an after-school gardening program may be particularly effective for students with low self-efficacy for physical activity who may be less likely to participate in competitive sports or physical activity programs.

To encourage students to take the learning home, at the end of each week have them chose a physical activity they want to do with their family over the weekend. The following week leaders should ask the students what they did for physical activity with their families. If the students said they were not physically active, the leaders can help the students identify ways to overcome any barriers that prevented the students from being physically active over the weekend. This is an example of helping the students develop problem solving skills.

Targeting Self-Efficacy for Spending Less Time Sedentary

Rather than targeting sedentary behavior directly, an after-school garden club can equip participants with an active, fun hobby to replace time spent sedentary by teaching them to garden. With this new hobby participants will ideally want to go outside and work in the garden instead of being sedentary inside. Once outside and away from the indoor technology temptations and after gardening, they may stay outside and do other leisure-time physical activities. Additionally, physical activity games can be used to teach students to enjoy being physically active and increase the likelihood they will choose active behaviors over sedentary ones.

Targeting Self-Efficacy for Eating More Fruits and Vegetables

Increasing participants' exposure to fruits and vegetables is one strategy for targeting self-efficacy for eating fruits and vegetables. Successfully growing fruits and vegetables can provide students repeated exposure to healthy produce, but careful garden planning is needed to insure students have opportunities to enjoy the harvest within a traditional school schedule. However, there are many other strategies that can be naturally incorporated into an after-school garden program to target fruit and vegetable self-efficacy. For example, feature a fruit or vegetable each week of the after-school garden club. The produce can be featured by having leaders explain why the produce is healthy in kid terms. A "featured produce" page (Figure 2.2) can be used to provide fun facts about the fruit or vegetable. Students can be allowed to take turns reading the facts and answering questions to share their knowledge and/or experience with the fruit/vegetable.

Along with verbal exposure to fruits and vegetables, students should be given opportunities to taste the different fruits and vegetables. Some weeks this may be produce they harvest from their gardens, while other weeks it may need to be purchased. Students should be instructed to at least try the snack and not share opinions until everyone has finished so other's opinions aren't influenced. As role models, leaders should also eat the healthy snack. If students don't like the snack, they should be asked what they could do to make it taste better next time. If students don't like a raw vegetable provided, leaders may suggest the students try it cooked. Dislike for a particular fruit/vegetable could create a barrier for consuming fruits/vegetables in the future so it is important to help the students develop strategies to overcome this.

For produce that is typically less favorable among children, the snack should include a fun activity. For example, during a week when tomatoes are featured, the students could first play with their snack by creating "tomato bugs" using cherry tomatoes as a body, raisins for feet and toothpicks to make legs. If leafy greens are featured one week leaders could implement a "leafy green taste test" to turn the healthy snack consumption into an interactive event. For this activity, students could blindly sample a variety of leafy greens and try to match the sample with the name. Afterwards, they can use the leafy greens to make a salad for their snack.

Targeting Self-Efficacy to Garden

Self-efficacy for gardening is the belief in one's abilities in the skills necessary to garden. Helping students have success with hands-on gardening activities is one strategy to target this self-efficacy. Plants chosen for the students to grow should be hardy and at least some should germinate quickly so students can experience success soon after planting or sowing. If possible, each student should have an individual garden to maintain their own plants and a community garden for students to maintain together. This gives the students an opportunity to have individual and group success. If resources exist to allow students to grow inside a greenhouse or high tunnel (unheated greenhouse) this will further their chances of success while also extending the growing season.

Targeting Self-Efficacy to Overcome Barriers to Gardening

Barriers to gardening include obstacles such as pest infestation, not having a yard at the individual's residence, and financial cost, among many others. Many children may not have gardens at home and may lack gardening experience. It is important to help students develop strategies so the obstacles won't keep them from gardening.

Incorporating "Teachable Moments" into the curriculum is one technique to help students overcome barriers. "Teachable Moments" are discussion topics the leaders can initiate with the students. These are opportunities to help the students apply the lessons to their own lives. If students are learning about container gardening, the "Teachable Moment" might suggest the leaders discuss with the students potential containers that could be used for gardening if they couldn't afford to buy pots at a garden center. Helping the students recognize affordable alternatives while still having garden success will increase their efficacy to overcome these barriers and others.

Targeting Parental Proxy Self-Efficacy for Physical Activity Opportunities

Using a "Take Home" question is one strategy for targeting parental proxy self-efficacy. A "Take Home" question is a slip of paper with a question on it which relates to a topic/activity from the garden club session that day. The students should give the slip of paper to their parents and in response the parents should ask the question to their child. This is done to encourage a discussion about the lessons. At the end of the week the "Take Home" question can include a space for the students to fill in what physical activity they would like to do with their parent(s) over the weekend. Students with low parental proxy self-efficacy may hesitate to ask their parents to do physical activities with them so giving them a tool to prompt this conversation can help them reach the outcome of being physically active.

Targeting Parental Proxy Self-Efficacy for Gardening

The “Take Home” question can also provide opportunities to target parental proxy self-efficacy for gardening by helping the students begin discussions with their parents about the gardening activities done during club meetings.

Plants similar to what are being grown during garden club can be sent home with students. The students should already be familiar with the plants but care sheets can also be included to inform the parents. Providing the plants at no cost to the families helps to overcome the financial barrier to gardening. It also may prompt discussions about what is happening in garden club and help the children express their desire to garden at home.

Targeting Parental Proxy Self-Efficacy for Fruit and Vegetable Availability

This parental proxy self-efficacy can be targeted through the time spent discussing the featured produce at each meeting. The questions asked to the students relating to the featured item can encourage students to look for different varieties of the produce the next time they are at the grocery store. This can be done to help students develop an interest in trying different fruits and vegetables while encouraging them to ask their parents to buy produce.

Students should also be allowed to take produce home from the garden to overcome the barrier of financial cost of produce. Another positive consequence of this is it will show the parents that their child likes fruits and vegetables which may encourage parents to purchase produce at the store.

An After-School Garden Curriculum

Tables 2.1 and 2.2 provide examples of possible topics and objectives related to a garden-based curriculum. A garden-based curriculum may use activities that seem focused on gardening while incorporating key health objectives as well. This is illustrated by the overarching goals and objectives explained at the top of these two figures. The learning of the gardening objectives is secondary and in support of the primary objectives for healthy behaviors. Table 2.3 provides examples of applications of the SCT constructs to specific intervention activities.

The Garden Club would operate at multiple levels to provide messages, opportunities, and supports to garden leaders, students, and families to positively influence gardening, sedentary behavior, physical activity, and fruit and vegetable consumption for youth. The curriculum should provide the resources to insure the garden leaders can provide an enjoyable experience while targeting self-efficacy as an intra-personal mediator for behavior change.

Evaluation

A curriculum that incorporates numerous topics such as physical activity, gardening, and nutrition, should be developed by a multi-disciplinary team of researchers from fields related to the subjects targeted in the curriculum. This team should work together to identify important topics from each field as they are relevant to the targeted outcomes and theoretical constructs. This team should also develop process and outcome evaluation plans to determine the extent of delivery and effectiveness of the implementation. Process evaluation is useful during the formative stages and in determining the contributors to intervention failure or success.

Process variables of interest are the extent of implementation and dose received. Evaluating these variables during the formative stages will help determine the feasibility of successfully implementing the curriculum as intended and evaluating these variables during implementation will help explain the outcomes. Useful evaluation methods for these variables are garden-leader checklists, observation, and attendance. The checklist should include the activities from each of the garden club sessions and an area for leaders to indicate which activities were done during the garden club session as well as how much time was spent on each activity. Leaders should complete these checklists as soon after the completion of the garden club session as possible to ensure the information is being accurately recalled. A similar checklist could be completed by a trained observer during a garden club session. This component of evaluation is valuable as it can provide an indication of the extent of exposure the students had to the strategies targeting the various outcomes. Another measure to determine exposure of the curriculum is garden club attendance data. This should be recorded for students and leaders to give a record of how much exposure to the curriculum is necessary to gain desirable outcomes.

Along with the feedback from the leaders related to implementation, receiving feedback specific to the curriculum is helpful during the formative process. Leaders should be given an opportunity to describe areas of the curriculum that were successful and unsuccessful for each lesson. Not only will this increase the involvement of the leaders, but it gives valuable information about components of the lessons that need to be altered for future implementation. Focus groups composed of parents, teachers, and students can be used to test creative themes and messages as well as activities. This feedback can be used to guide the curriculum development. Students can be surveyed on their perceptions of the curriculum. This information can be used to make adjustments to the curriculum for future implementation. Parent surveys can be used to evaluate the home components of the curriculum. Parents can provide feedback about the curriculum components based on information they gather from their children participating in the club. This information again can be used to make changes as necessary for future use of the curriculum.

Outcome variables to be measured would be the behaviors and intra-personal mediators (self-efficacies) targeted in the curriculum. Direct and indirect methods are available. For example, the use of accelerometers (measure motion) is a direct method of measuring physical activity. Several scales have been developed to measure self-efficacy constructs that could be included in a written questionnaire given before and after the garden program was implemented.

Conclusion

Evidence of the effects of gardening on youth health behaviors is promising. A number of reports begin to build a link between gardening and children’s preferences, willingness to try, and consumption of fruit and vegetables. Yet, there are other reports showing no link between gardening and these fruit and vegetable factors. Additionally, many of the studies are limited in scope and experimental rigor. To our knowledge, none of the published studies to date, have tested a gardening curriculum or program that was based on a current health-behavior theory. Given the promising evidence of the benefits of youth gardening for health, developing and testing a theory-based gardening curriculum will further our understanding of how gardening can be used to effect youth health behaviors.

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Tables and Figures

Table 2.1 Overview of the topics and objectives of a 10-week fall after-school garden club curriculum

Overarching Goals:

- Drink more water
- Cut back on TV and video games
- Be physically active every day
- Eat fruits and vegetables at every meal or snack

Objectives: Each garden club meeting had three objectives in common. They were:

- Try the healthy snack
- Be physically active for at least 10 minutes
- Garden

In addition there were typically one or two objectives relating to the specific theme for that day, which are presented below.

Week	Theme	Day 1 Objectives	Day 2 Objectives
One	Garden Club Kick-Off	• learn how garden club operates • learn the basics about the high tunnel (unheated greenhouse) structure	• create rules for garden club • learn the goals of garden club (overarching goals listed above)
Two	Creating Community	• learn the importance & benefits of community • learn the benefits of gardening in a high tunnel	
Three	Which came first, the seed or the plant?	• learn about the purpose of seeds and plants	• learn about the purpose of seeds and plants
Four	Plant Parts	• learn the basic parts of plants and the role of each	• review the parts of the plant and roles of each
Five	Reduce,	• learn the concept of	• review the concept of

	Reuse, Recycle	"Reduce, Reuse, & Recycle" • learn the definition & purpose of composting	"Reduce, Reuse, & Recycle" • learn about vermicomposting
Six	The Water Cycle	• learn the four main points of the water cycle • create a terrarium to view the water cycle	• review the water cycle • be able to describe the movement of water within the water cycle
Seven	Go, Slow, Whoa	• learn about the nutritional value of foods	• review "Go, Slow, Whoa" foods
Eight	Open House Preparation	• assist in preparing for the high tunnel open house	• prepare for open house
Nine	Careers in Horticulture	• learn about studying horticulture in college • prepare for the high tunnel open house	• learn about careers in horticulture • continue preparing for the high tunnel open house
Ten	Open House	• prepare for the high tunnel open house	• wrap up garden club for the semester

Table 2.2 Overview of the topics and objectives of a 12-week spring after-school garden club curriculum

Overarching Goals:

- Drink more water
- Cut back on TV and video games
- Be physically active every day
- Eat fruits and vegetables at every meal or snack

Objectives: Each garden club meeting had three objectives in common. They were:

- Try the healthy snack
- Be physically active for at least 10 minutes
- Garden

In addition there were typically one or two objectives relating to the specific theme for that day, which are presented below.

Week	Theme	Day 1 Objectives	Day 2 Objectives
One	Welcome Back	• learn how the garden club operates	• learn the rules and goals of garden club
Two	Planning	• learn the basic experiment design • learn the importance of planning	• plan and design a garden for a space at home
Three	Propagation	• learn what propagation is • learn how to take cuttings from plants	• learn about planting seeds as a form of propagation
Four	Container Gardening	• learn the purpose & technique of transplanting seedlings	• learn a creative way to garden
Five	Is your Soil Alive?	• set up an experiment to learn about soil	• learn about soil texture • observe and discuss results from week 2 planting experiment

Six	Decorate the Garden	• make a stepping stone to decorate the garden	
Seven	Edible Plant Parts	• learn about the different parts of plants that are edible	• identify the different parts of plants
Eight	Harvest and Post-Harvest	• learn about ethylene	• learn how to store produce properly
Nine	Other Uses for Plants	• learn how to use plants to make a dye • learn how to preserve plant parts by pressing them	• continue working on creating plant dyes
Ten	Annuals and Perennials	• learn the difference between annuals and perennials • identify plants as either an annual or perennial	• identify reasons why gardening is environmentally friendly
Eleven	Gardening: What to do next?	• make a plan for the extra produce from the garden	• write a newsletter article for the students newsletter
Twelve	Earth Day: Going Green	• participate in an Earth Day activity	• participate in an Earth Day activity

Table 2.3 Sample intervention strategies for an after-school gardening curriculum based on a social cognitive theory framework

Social Cognitive Theory Determinants	Strategies to target the Social Cognitive Theory Determinants for each respective behavior			
	Sedentary Behavior	Physical Activity (PA)	Fruit and Vegetable (F&V) Consumption	Gardening
Knowledge	Discuss activities that should only be done occasionally because they are mostly sedentary	Inform students about PA recommendations and benefits of being physically active	Include 'Fun Facts' about the snack	Include lessons on how to garden
Self-efficacy	Have those students who have been able to decrease time spent sedentary share strategies with others	Offer fun, non-competitive, non-elimination PA Train leaders to model PA	Offer healthy F&V snacks Train leaders to model eating F&V	Offer a variety of gardening opportunities
Outcome Expectations	Have students role play scenes where they can recognize benefits of	Highlight benefits of regular PA as it relates to youth Show students	Explain benefits of eating F&V in terms students will	Help students see gardening as a fun activity with a rewarding

	spending less time sedentary	how they are improving skills as they continue doing physical activities	understand and value	harvest
Goals	Encourage students to target reducing time spent in one of their sedentary behaviors	Encourage students to ask their parent(s) to be physically active with them so they have support to obtain their goals	Encourage students to try a F&V at each meeting and then to ask their parents to provide that F&V at home	Give students time to garden at each meeting
Facilitators/barriers	Teach students alternatives to sedentary activities that are fun and fulfilling such as gardening	Provide students with descriptions of physical activities they can do at home and with friends; help students develop strategies to encourage their parents to be physically active with them	Help students think of a variety of ways to prepare F&V Allow students to sample F&V they have grown in the garden	Send plants home with students Provide inexpensive gardening activities to do at home

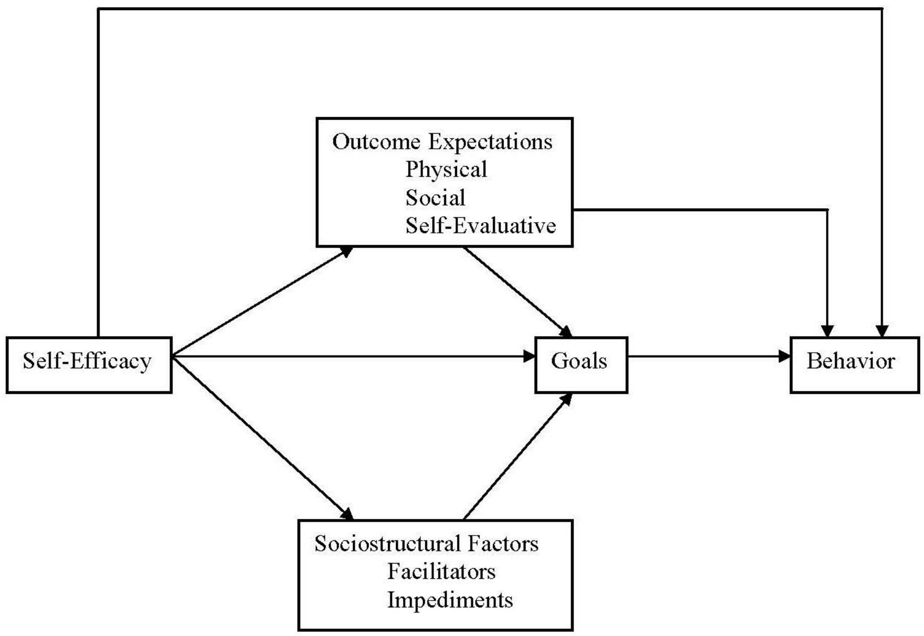

Figure 2.1 Paths influencing behavior by self-efficacy (Taken from Bandura, A. (2004). Health promotion by social cognitive means. *Health Education Behaviors, 31*(2), 143-164).

Featured Produce of the Week:

Celery

Day 1:

- There is a town in Ohio named Celeryville that was settled by a celery farmer from Kalamazoo, Michigan.
- California is the leading producer of celery followed by Florida, Texas and Michigan.
- When you eat celery, you burn more calories chewing than the number of calories that are actually in the celery.

Questions to ask everyone:

1.) How many of you like eating celery raw?

2.) What are some other ways you can eat celery?

Day 2:

- Celery was first used for medicinal purposes, then as a seasoning and finally as a food.
- Celery should be stored away from apples, onions and pears because it will absorb those odors.
- Americans eat about nine to ten pounds of celery per person per year.

Questions to ask everyone:

1.) Which way did you prefer having celery between our two celery snacks this week?

2.) Will you teach your family about eating celery?

Figure 2.2 Example of 'Fun Facts' to use while Garden Club participants are having a celery snack

Chapter 3 - An After-School Gardening Club as Physical Activity for Youth

Abstract

Youth are not meeting the national recommendations for physical activity which can have a negative effect on their health. Gardening has been shown to be a moderate form of physical activity in older adults and could potentially be a desirable option for those students who are less likely to be involved in organized competitive physical activities. An after-school garden club was implemented at four elementary schools in the Manhattan/Ogden, Kansas school district for an entire academic year. The garden clubs were offered to all the fourth and fifth graders at each site. The clubs incorporated regular physical activities in the form of non-elimination games and typical gardening tasks. Participants' physical activity intensity was measured during the after-school hours on one garden club day and the after-school hours of non-garden club days using accelerometers for six days in the fall (n=26) and six days in the spring (n=18) semesters. Students completed an activity log during that time to record their activities and when the device was put on and taken off each day. Results show that students were able to obtain significantly more minutes of moderate to vigorous physical activity on days they attended garden club (29.4 minutes) than their regular after-school hours on non-garden club days (15 minutes). During the after-school hours on garden club days, students were obtaining an average of 22 minutes of moderate and 6.6 minutes of vigorous physical activity which is significantly higher than what was obtained during the after-school hours of non-garden club days. When at garden club during the after-school hours students spent significantly less time sedentary (35 minutes) compared with the after-school hours of non-garden club days (50 minutes). These results show that an after-school garden club can provide a significant amount of moderate to vigorous physical activity and can help youth reach the national recommendations.

Youth Physical Activity

Current recommendations by the Centers for Disease Control and Prevention (U. S. Department of Health and Human Services, 2009) state that youth should be physically active for at least 60 minutes each day made up primarily of aerobic activities with vigorous intensity activities at least three days per week. Muscle and bone strengthening activities should be done three days per week. A physically active lifestyle provides many health benefits. It helps strengthen bones and muscles and retain bone and muscles mass (U. S. Department of Health and Human Services, 2009). Regular physical activity helps to maintain weight and consequently reduces the risk of becoming obese. Lower blood pressure, higher HDL cholesterol and more positive well-being, confidence and self-esteem are other benefits of physical activity (American Heart Association, 2011). Individuals who are physically active are less likely to be diabetic or suffer from cardiovascular disease (U. S. Department of Health and Human Services, 2009).

Only 18.4% of youth in the ninth through twelfth grade reported meeting the recommendation of sixty minutes per day of physical activity while 23.1% reported not meeting the recommendation on any of the previous seven days (Eaton, Kann, Kinchen, Shanklin, Ross, Hawkins, Harris, Lowry, McManus, Chyen, Lim, Whittle, Brener, & Wechsler, 2010). Studies have shown that adolescent physical activity levels will often track into adulthood (as reviewed by Malina, 1996). Adolescents have been shown to decrease the amount of time they spend in physical activity (Sallis & Patrick, 1994) and increase the amount of time spent sedentary with age (Gordon-Larsen, Adair, Nelson, & Popkin, 2004). If individuals can learn to meet physical activity recommendations at a young age, they will be more likely to continue these habits into adulthood which illustrates the importance of targeting a young audience (Sallis, 2000) for improving health behaviors.

To overcome the appeal of sedentary choices such as television and video games, and to increase the likelihood that children will sustain an active lifestyle, programs need to incorporate physical activities which are enjoyed and valued by the participants (Sleap & Warburton, 1992). This includes offering physical activity options that meet the needs of female and overweight students, as both of these groups tend to decline more rapidly in physical activity participation (Trost, Rosenkranz, & Dzewaltowski, 2008). Games used in physical activity programs should allow all students to participate regardless of their skill level. Elimination games should be altered to enable students to remain active (Trost, et al., 2008).

Being outside has been shown to be an important factor positively associated with the amount of time children spend in physical activity (Sallis, Prochaska & Taylor, 2000; McKenzie, Feldman, Woods, Romero, Dahlstrom, Stone, Strikmiller, Williston, & Harsha, 1995). The amount of time children spend outside tends to decline with age (Cleland, Timperio, Salman, Hume, Baur, & Crawford, 2010). Another factor influencing time spent in physical activity, particularly for girls, is enjoyment (DiLorenzo, Stucky-Ropp, Vander Wal, Gotham, 1998). Girls also preferred having the opportunity to socialize during physical activity (DiLorenzo, et al., 1998) which may be discouraged during organized sports.

Although gardening can be done indoors, it is commonly an outdoor activity with many opportunities to socialize. Gardening has been reported as a low to moderate intensity physical activity for older adults (Park, Shoemaker, & Haub, 2008). Gardening may be an activity that can be enjoyed by youth while simultaneously contributing to youth physical activity however, research using objective measurements of physical activity of youth while gardening is limited. Since the after-school hours have the opportunity to provide a significant amount of moderate to vigorous physical activity and reach a large number of students (Trost, et al., 2008) an after-school gardening program was developed that targeted healthy lifestyle choices, including being physically active. The purpose of this study was to objectively measure physical activity to determine the intensity of an after-school garden club for youth.

School garden programs have been credited with increasing participants' preference for (Morris & Zidenberg-Cherr, 2002; Lineberger & Zajicek, 2000), consumption of (Hermann, Parker, Brown, Siewe, Denney, & Walker, 2006; McAleese & Rankin, 2007; Lautenschlager & Smith, 2007), and willingness to try fruit and/or vegetables (Parmer, Salisbury-Glennon, Shannon, & Struempler, 2009; Morris, Neustadter, & Zidenberg-Cherr, 2001). Physical activity has been reported to increase for students in a garden program (Phelps, Hermann, Parker, & Denney, 2010; Hermann, et al., 2006) however, these studies relied on self-reported data from the students, lacked control groups, and had small sample sizes making it difficult to confirm significant outcomes as a result of the garden program.

The purpose of this study was to objectively measure the intensity and amount of time participants spend in physical activity during an after-school garden club that followed a curriculum promoting physical activity. An additional purpose was to compare the amount of time and intensity of physical activity participants acquired during the after-school hours while at garden club with the after-school hours of non-garden club days. We hypothesized that participants would accumulate at least ten minutes of light to moderate intensity physical activity while at garden club and would be significantly more physically active when at garden club during the after-school hours than when not at garden club during the after-school hours.

Methods

Project PLANTS (Promoting Lifelong Activity and Nutrition Through Schools) was an overweight prevention after-school garden club program designed for fourth and fifth grade students. A curriculum was created for this program to encourage healthy living through fruit and vegetable consumption, gardening, and physical activity lessons and activities. The garden club met two times each week for approximately 90 minutes at each session. Each garden club session included a healthy snack, at least 10 minutes of organized physical activity, and at least 10 minutes of gardening time. A typical garden club session began in a classroom-type setting where students were provided with a healthy snack while they listened to facts about the snack and announcements for the upcoming garden club sessions. The time indoors lasted between 20 to 25 minutes. While inside, students were separated into three groups and directed outside by club leaders. Each group of students was taken to one of three stations, physical activity, gardening, or the third station in which the topic varied from session to session. Every 10 to 15 minutes the students rotated with their leaders to the next station until they completed all three stations. The ten week fall garden club ran from October until December. The twelve week spring garden club ran from January until April. At least three trained volunteers led the garden club meetings.

For one portion of a larger study, Actigraph GT1M (Pensacola, Florida) accelerometers were used to objectively measure participant physical activity achieved during the garden club meetings. The use of these biaxial accelerometers with youth has been validated in previous work (Trost, McIver, & Pate, 2005; Plasqui & Westerterp, 2007). They have been used widely to measure physical activity of children (McClain & Tudor-Locke, 2009). The monitors were initialized to record fifteen second epochs to account for the short bursts of activity typical for youth (Baquet, Stratton, Van Praagh, & Berthoin, 2007; Trost, et al., 2008; Treuth, Schmitz, Catellier, McMurray, Murray, Almeida, Going, Norman, & Pate, 2004; Trost, et al., 2005; Welk, Corbin, & Dale, 2000). The Kansas State University Committee for Research Involving Human Subjects (IRB) approved this study.

Students in the four Project PLANTS garden clubs were invited to participate in this study. One researcher went to each garden club to explain the study and distribute informed consents. The one page consent form detailed the purpose of the study along with a picture of the accelerometer. This form was sent home to the guardians of the students at the beginning of the fall 2009 school year. Students were told to return their signed informed consent by a specified date. Based on the schools' availability, the garden clubs were divided into two waves with two clubs in each wave. The clubs within each wave had the same start and stop dates.

On the start date (Wave 1-October 2009; Wave 2-November 2009), one researcher went to the school sites and showed each participating student how to attach the accelerometer. Accelerometers were numbered and participants were given a five digit identification code to ensure confidentiality and tracking. Accelerometers were worn on an adjustable elastic belt that clipped in the back. The accelerometer device was worn over the right hip (Trost, Pate, Freedson, Sallis, & Taylor, 2000; Trost, et al., 2005) with the belt tightened around the waist to avoid shifting. Students were instructed to wear their accelerometer during the waking hours each day except when getting wet. Additionally, each participant was asked to complete a daily activity log. This one page document had a place for the student to respond to three questions each day and to fill in the time they put on and took off their accelerometer each day. The questions the students responded to related to the type of activities they did that day including whether or not they participated in physical education and what they did after school. On the reverse side of the log were detailed instructions for using the accelerometer and the protocol of the study along with the contact information of the graduate research assistant working on the project. Participants wore their accelerometers over a six day period ensuring two weekend days, two weekdays, and at least one garden club day were recorded. This number of days has been recommended in previous research (Trost, et al., 2005). Due to the differences in the days of the week the garden clubs met and the desire to capture physical activity on at least one garden club day and two weekend days, the dates accelerometers were worn differed slightly between the two waves.

One day prior to the stop date the researcher emailed the teachers to ask them to remind their participating students to bring their daily activity log and wear their accelerometer to school the following day. The next day the researcher went to each site, collected accelerometers and activity logs, and recorded the time each accelerometer was removed from the student. Students who returned their materials were allowed to choose a small prize. Students who forgot their materials were asked to bring them the next day and the researcher returned to collect them.

In the spring (April) of 2010 this study was replicated with students from the same garden clubs. A form was sent home with all of the students who participated the previous semester to remind them about the study. The form was to be returned signed only if the parents did not want their child to participate during the spring semester. Students who did not participate during the fall were still eligible for the spring study.

The same protocol was followed. All participants were instructed to wear their accelerometer over a six day period in April of 2010.

Participants of the accelerometer study who were also given permission to participate in the larger Project PLANTS study completed a survey that included demographic information as well as questions of physical activity, sedentary behavior, gardening behavior, efficacy, and fruit and vegetable consumption. Height and weight were measured with a portable stadiometer (Seca Corp, Model 214, Hamburg, Germany) and digital scale (Seca Corp, Model 770, Hamburg, Germany) respectively. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared and then computed into a BMI-Z score using growth charts as recommended by the Centers for

Disease Control and Prevention (Kuczmarski, Ogden, Grummer-Strawn, et al., 2000) to reflect growth for age and gender. BMI-Z scores were converted into percentiles to determine weight status (5^{th} to $<85^{th}$ percentile=normal weight; $\geq 85^{th}$ percentile=overweight/obese).

The accelerometer data were processed using standard processing methods. The Freedson, Melanson, and Sirard (1998) prediction equation was used to convert counts into MET levels (METs = $2.757 + (0.0015 \cdot \text{counts} \cdot \text{min}^{-1}) - (0.08957 \cdot \text{age [yr]}) - (0.000038 \cdot \text{counts} \cdot \text{min}^{-1} \cdot \text{age [yr]})$ and the estimated METs were then allocated into four activity zones based on standard thresholds (Light: 1.5 – 2.9 METs, Moderate: 3-6 METs, and Vigorous: > 6.0 METs). A value to incorporate both moderate and vigorous physical activity (MVPA) was also calculated as ≥ 3 METs. This value is important as it relates to the physical activity recommendations for youth. Count values less than 100 for the after-school time period of 90 minutes were coded into the sedentary category to avoid misclassifying the amount of light activity in the day and METs were estimated at 1.5 for these periods. The total minutes of Sedentary, Light, Moderate, Vigorous, and Moderate and Vigorous (MVPA) activity were computed for the after-school component of the day. Garden club lasted from the time school was dismissed (about 3:30 PM) until 5:00 PM so these were the hours analyzed for garden club and non-garden club after-school hours. The data were reported as the percentage of time spent in each category to avoid bias due to the length of the school day or the length of the after-school sessions. Analyses for this study were conducted to determine physical activity obtained from the garden club students participating in the accelerometer study at the after-school garden club compared with physical activity of these students during the after-school hours on non-garden club days.

The data files were screened for compliance to ensure that participants were wearing the monitors as intended during the week. Cases with reported days absent from garden club or reported times with the monitor removed during garden club were excluded from the analyses. Files with 100% of the time in the sedentary category were assumed to be days in which the monitor was not working since it isn't possible to have this type of recording if the child was at school.

Data Analysis

This experiment has a single group within subjects design with the fixed treatment factor of garden club (garden club/no garden club). Additional factors include gender (male/female) and weight status (normal weight/overweight). Students nested within additional factor effects are considered random. The responses are the physical activity intensity measurements including: metabolic equivalents (METs), sedentary, light physical activity, moderate physical activity, vigorous physical activity, and moderate to vigorous physical activity (MVPA).

Data were analyzed with Statistical Analysis System (SAS) version 9.2 for Windows (SAS Institute Inc, Cary, NC, USA) using PROC MIXED by analysis of variance (ANOVA). A significance level of p=0.05 was used for all analyses. Means and standard errors for all main effect and factor combinations were calculated. A Scheffe adjustment was utilized to control for Type 1 error. Satterthwaite degree of freedom adjustment was also used.

Results

Subject Characteristics

In the fall of 2009, of 84 students in garden club, 32 students returned informed consents (38% response rate). Six students were excluded from this data set due to missing data resulting in a total of 26 students included in the fall dataset. Twenty-five students participated in the spring 2010 study out of a total of 55 students in garden club (47% response rate). Seven students were excluded from this dataset because of missing data and non-compliance. A total of eighteen students remained in the spring 2010 dataset. Participant demographics for fall and spring are provided in Table 3.1. The mean age was 9.8 and 10.3 years in the fall and spring respectively. In both semesters there were more female than male participants and a higher percentage of overweight female participants than overweight male participants.

Physical activity of garden club

Moderate to vigorous physical activity (MVPA) was significantly higher during garden club than non-garden club days in both fall and spring garden club sessions (Table

3.2, Figures 3.1 & 3.2). When at garden club students obtained an average of 29.4 minutes MVPA in the fall and 26.3 minutes MVPA in the spring. During the non-garden club after-school hours in the fall and spring students obtained approximately 15 minutes MVPA on average.

No significant differences were found for light intensity physical activity. Garden club provided approximately 22 minutes of moderate intensity physical activity while the non-garden club after-school hours provided approximately 13 minutes during each semester which was significantly different. Vigorous physical activity was significantly higher during garden club for the fall semester only. Students accumulated an average of 6.6 minutes of vigorous intensity physical activity when they were at garden club in the fall compared with 2.4 minutes during the fall non-garden club after-school hours.

Time spent sedentary in the after-school hours was similar in the fall and spring, with students being sedentary about 35 minutes during garden club and about 50 minutes sedentary during the after-school hours on non garden club days (Table 3.2, Figures 3.1 & 3.2). The amount of time spent sedentary during the after-school hours was significantly lower on garden club days than on non-garden club days.

Significant gender differences were found during the fall semester only (Table 3.2, Figures 3.3 & 3.4). Girls and boys were significantly more sedentary during non-garden club after-school hours spending an average of 51.6 and 50.3 minutes sedentary respectively. For boys, (Table 3.2, Figure 3.3) time spent in moderate and vigorous intensity physical activity was significantly higher at garden club than the after-school hours of non-garden club days. Boys spent an average of approximately 12 additional minutes in moderate and 5 minutes in vigorous intensity physical activity when they were at garden club. Girls and boys both accumulated significantly more MVPA when at garden club. Girls (Table 3.2, Figure 3.4) obtained an average of 25.6 minutes MVPA and boys an average of 33.2 minutes MVPA when they attended garden club.

Significant differences were also found for weight classification during the fall semester only (Table 3.2, Figure 3.5). Normal weight students were significantly less sedentary when they were at garden club. During the non-garden club after-school hours, normal weight students spent an additional 16 minutes sedentary. Garden club provided normal weight students with an additional 9.4 minutes of moderate and 4.1 minutes of vigorous physical activity than the non-garden club after-school hours. Normal weight students spent an average of 29.5 minutes in MVPA when they attended garden club which is significantly higher than minutes these students spent in MVPA during non-garden club after-school hours (16.0 minutes). No significant differences were found for overweight/obese students (Table 3.2).

Discussion

The Project PLANTS after-school garden club was shown to provide students with a significantly higher amount of moderate, vigorous, and MVPA compared with the amount of physical activity obtained during non-garden club after-school hours. Additionally, students at garden club spent significantly fewer minutes sedentary than when they were not at garden club during the after-school hours. At the beginning of each garden club meeting students gathered in a classroom setting to have a healthy snack. During this time leaders explained what the activities would be for the day and discussed the healthy snack. This was done to promote fruit and vegetable consumption. This initial time likely contributed to a majority of the time spent sedentary during the club meeting.

Time spent in physical activity during non-garden club after-school hours was not significantly different for boys and girls. However, during garden club boys had significant increases in time spent in moderate, vigorous, and MVPA while girls showed significant increases for MVPA only. MVPA has previously been reported to increase during after-school physical activity interventions (Trost, et al., 2008). Boys have also previously been shown to be more active than girls (McKenzie, et al., 1995; Armstrong, Welsman, & Kirby, 2000; Trost, et al., 2008). These differences may be due to the preference of girls for socialization during physical activity (DiLorenzo, et al., 1998). It is possible that while gardening in this study, girls were doing more socializing than boys resulting in less intense physical activity for girls. Regardless, girls were still able to significantly increase their overall time spent in MVPA.

During the fall semester significant differences were found for weight class but only for normal weight students. The physical activities used during the Project PLANTS garden club may not have been as appealing to the overweight/obese students. Although all students were encouraged to participate, they were not forced to participate. This was an after-school club and leaders tried to maintain a fun environment so students would continue attending. Therefore, if students did not want to participate in the physical activity they didn't have to. Overweight students have been reported to have significantly more barriers to participating in physical activity than normal weight students (Deforche, De Bourdeaudhuij, & Tanghe, 2006; Zabinski, Saelens, Stein, Hayden-Wade, & Wilfley, 2003) and to have lower levels of vigorous physical activity (Trost, et al., 2008). In a review of the correlates of physical activity, perceived barriers were the most consistent negative correlate of physical activity for four to twelve year olds (Sallis, et al., 2000). Although the physical activities used in the Project PLANTS clubs were designed to be non-elimination, it is possible that leaders may have allowed students to choose games that were more competitive which could have discouraged overweight students from participating. This intervention was designed as an overweight prevention program so it primarily targeted normal weight students. It is encouraging to have measurements that show positive physical activity outcomes for the normal weight students.

A possible explanation for the more dramatic results in physical activity achieved during garden club in the fall versus the spring is timing. The spring wave of this study was done toward the end of the semester. Students were preparing for summer and may have taken less interest in the garden if they weren't going to help with maintenance and harvest during summer. Additionally, this was the second year of the larger study. The same curriculum was used during both years so some of the students could have participated in the activities during the prior year. This may have resulted in some students losing motivation to participate as intensely as before. The fall wave of this study was done earlier in the semester when students may have been more motivated. The fall garden club day measurement occurred on a sunny day while the spring garden club data was collected on a rainy day. Students still went outside and did the activities since the rain was light, but the weather may have affected how intensely they participated.

Conclusions

Decreasing the amount of time the participants spent sedentary is an important result of this study. Sedentary time contributes to the amount of energy individuals expend and therefore directly relates to weight. Developing an intervention that can reduce the amount of time children spend sedentary could potentially decrease the imbalance between energy consumed and expended and slow the increase of BMI.

It is recommended that youth spend at least 60 minutes a day in moderate to vigorous physical activity (U. S. Department of Health and Human Services, 2009). This can be done in segments of time. This after-school garden club was shown to provide a significant contribution to the total recommendation for daily physical activity for youth. The curriculum developed for this program stated that an organized physical activity from the provided selection of activities was to be done for at least 10 minutes at each meeting. The average amount of MVPA at garden club for fall and spring was almost 30 minutes. This indicates that students were accumulating an additional 20 minutes of MVPA aside from the organized game. This time was likely made up of gardening activities and transition time. This suggests that some gardening tasks can be considered MVPA.

After-school programs have been reported as an opportunity to reach large numbers of children for physical activity promotion (Trost, et al., 2008). Future research in this area should provide additional protocol for the physical activity component to allow males and females to take turns choosing the activity. Allowing the girls to have a turn to choose the physical activity may encourage them to participate (Trost, et al., 2008).

A limitation of this study is the small sample size; however significant results were still detected. A study with a larger sample size could likely measure additional differences and provide further insight into the physical activity that can be accumulated during an after-school garden club. The results from this study cannot be generalized to a larger population but can provide evidence supporting the use of an after-school garden club to promote and increase physical activity of youth.

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Tables and Figures

Table 3.1 Demographics of 4th and 5th grade after-school garden club participants

Variable	Fall 2009			Spring 2010		
	Males (n=8)	Females (n=18)	Total (n=26)	Males (n=4)	Females (n=14)	Total (n=18)
Demographics						
Mean age, years (SD)	9.7 (0.43)	9.8 (0.57)	9.8 (0.52)	10.5 (0.63)	10.3 (0.43)	10.3 (0.47)
Gender (%)	30.8	69.2	100	22.2	77.8	100
Anthropometric, mean (SD)						
Height (cm)	136.7 (5.01)	138.9 (6.90)	138.2 (6.36)	139.3 (7.36)	141.7 (6.19)	141.1 (6.32)
Weight (kg)	31.9 (3.91)	35.1 (7.66)	34.1 (6.82)	34.2 (6.22)	40.3 (9.42)	38.9 (9.03)
BMI	17.1 (1.96)	18.0 (2.83)	17.7 (2.59)	17.6 (2.67)	20.0 (4.38)	19.5 (4.12)
Normal Weight[a] (%)	87.5	72.2	76.9	75	50	55.6
Overweight[b] (%)	12.5	27.8	23.1	25	50	44.4

[a]Normal weight is classified as a BMI-Z score within the 5^{th} to $<85^{th}$ percentile as determined by CDC growth curves.

[b]Overweight is classified as a BMI-Z score $\geq 85^{th}$ percentile as determined by CDC growth curves.

Table 3.2 Physical activity intensity during after-school hours for garden club and non-garden club days in the fall and spring semesters

Variable	Fall 2009					Spring 2010				
	Sed (min)	Light (min)	Mod (min)	Vig (min)	MVPA (min)	Sed (min)	Light (min)	Mod (min)	Vig (min)	MVPA (min)
After-School non Garden Club Days	51.0[a]	23.5	13.4[a]	2.4[a]	15.8[a]	51.6[a]	23.2	13.7[a]	1.8	15.5[a]
Boys	50.3[a]	23.8	13.6[a]	2.2[a]	18.9[a]	51.2[a]	23.8	13.9[a]	1.2	15.1[a]
Girls	51.6[a]	23.1	13.2[a]	2.6[a]	15.8[a]	51.9[a]	22.5	13.5[a]	2.4	15.9[a]
Normal Weight	51.2[a]	23.2	13.4[a]	2.5[a]	16.0[a]	52.7[a]	17.8	14.5[a]	2.0	16.5[a]
Overweight	51.3[a]	23.8	13.0[a]	2.4[a]	15.4[a]	50.2[a]	25.6	12.1[a]	2.5	14.6[a]
After-School Garden Club Day	34.8[b]	26.0	22.8[b]	6.6[b]	29.4[b]	35.8[b]	28.1	22.5[b]	3.7	26.3[b]
Boys	31.7[b]	25.3	25.6[b]	7.5[b]	33.2[b]	34.1[a]	26.8	25.8[a]	3.3	29.1[a]
Girls	38.0[b]	26.7	19.9[a]	5.7[a]	25.6[b]	37.5[a]	29.3	19.3[a]	4.2	23.5[a]
Normal Weight	35.0[b]	26.0	22.8[b]	6.7[b]	29.5[b]	37.3[a]	22.4	21.5[a]	4.4	25.9[a]
Overweight	39.9[a]	26.9	17.5[a]	4.8[a]	22.3[a]	36.0[a]	30.8	19.9[a]	3.4	23.3[a]

Note. [ab]Means in each column sharing a common letter are not significantly different by Differences of Least Squares Means at p=.05. Sed, Light, Mod, Vig, MVPA, indicate average number of minutes spent sedentary (< 100 counts per minute), in light physical activity (1.5 – 2.99 Metabolic equivalents (METs)), in moderate physical activity (3-5.99 METs), in vigorous physical activity (≥ 6.0 METs), and in MVPA (moderate and vigorous physical activity) (≥ 3 METs) respectively. Normal weight is classified as a BMI-Z score within the 5th to <85th percentile as determined by CDC growth curves.

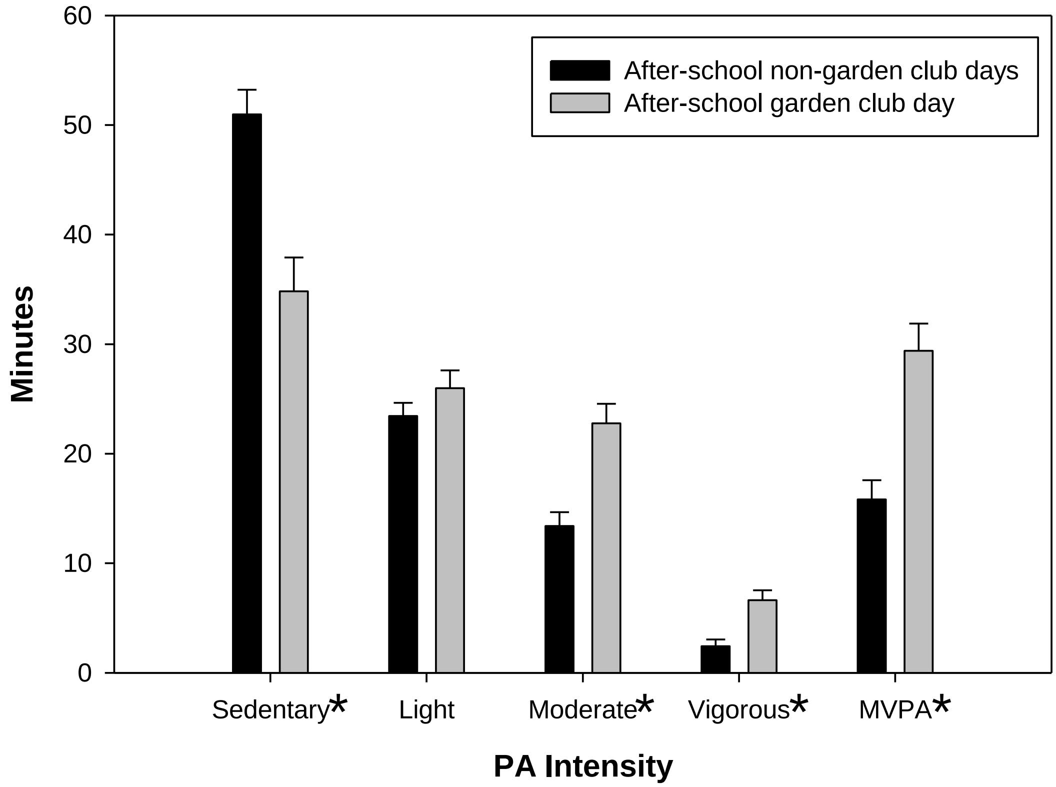

Figure 3.1 Physical activity intensity during after-school hours for garden club and non-garden club days during the fall 2009 semester

Note. * indicates a significant difference, at p=0.05, between the measurements of "After-school non garden club days" and "After-school garden club day" for the physical activity intensity level indicated. MVPA represents a summative measure of moderate and vigorous physical activity.

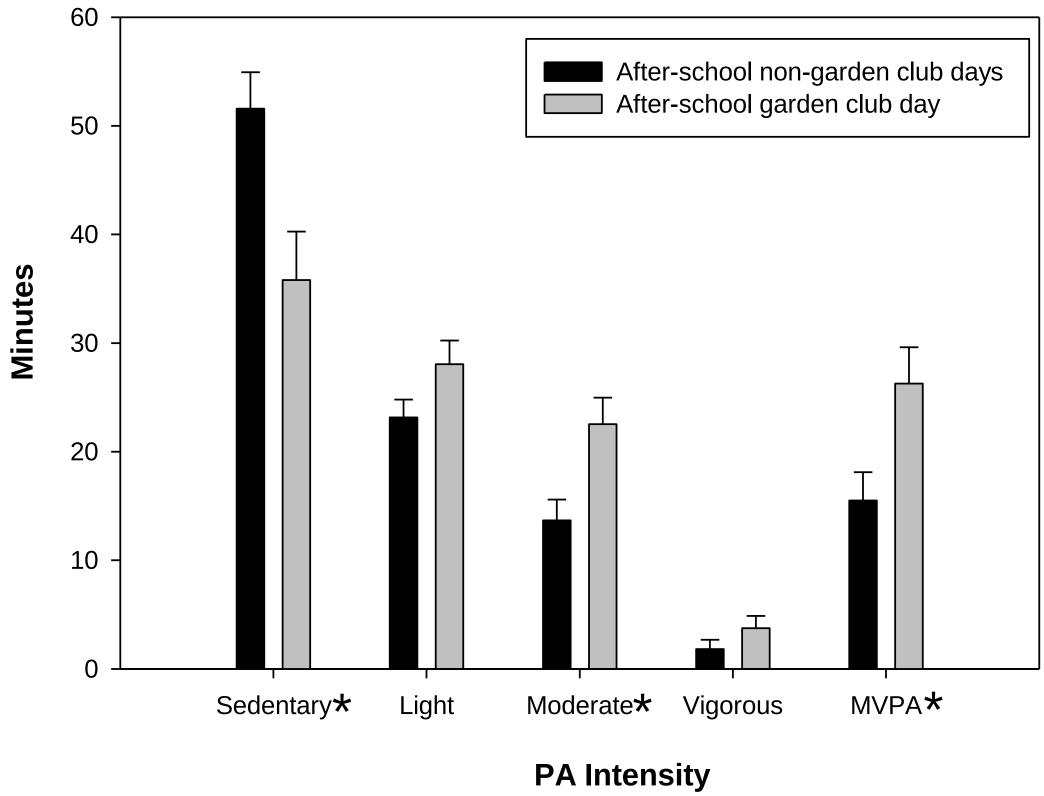

Figure 3.2 Physical activity intensity during after-school hours for garden club and non-garden club days during the spring 2010 semester

Note. * indicates a significant difference, at p=0.05, between the measurements of "After-school non garden club days" and "After-school garden club day" for the physical activity intensity level indicated. MVPA represents a summative measure of moderate and vigorous physical activity.

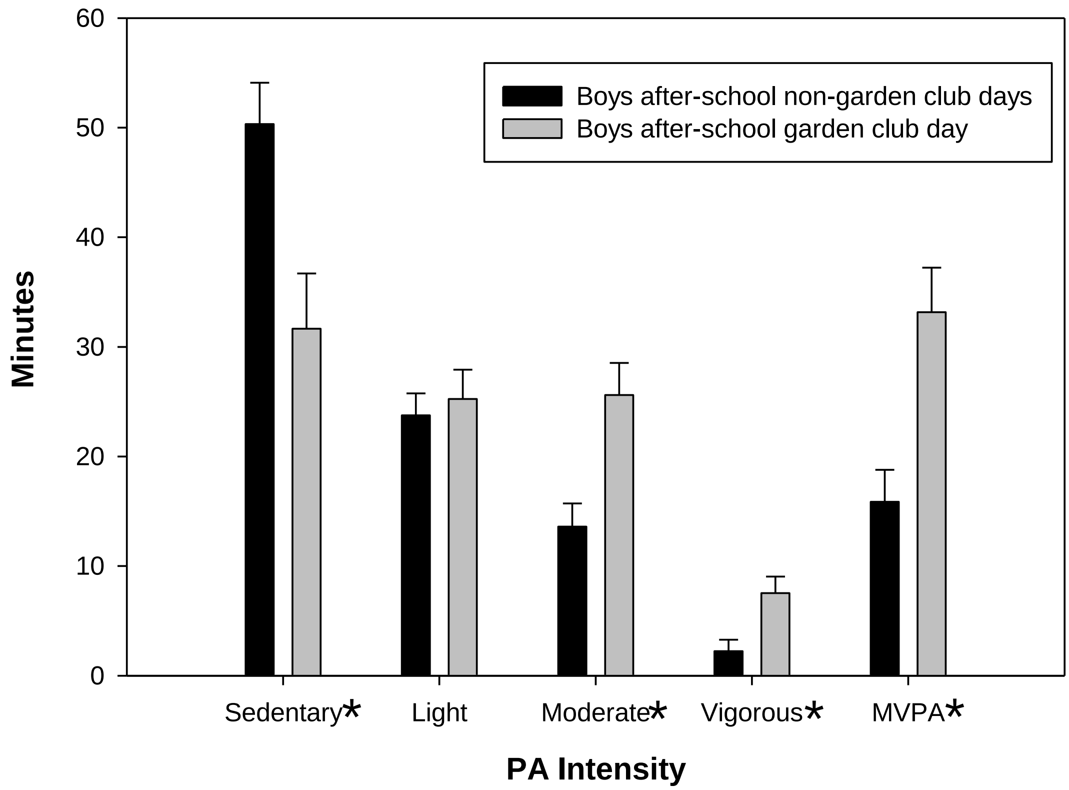

Figure 3.3 Physical activity intensity for boys during after-school hours for garden club and non-garden club days during the fall 2009 semester

Note. * indicates a significant difference, at p=0.05, between the measurements of "Boys after-school non garden club days" and "Boys after-school garden club day" for the physical activity intensity level indicated. MVPA represents a summative measure of moderate and vigorous physical activity.

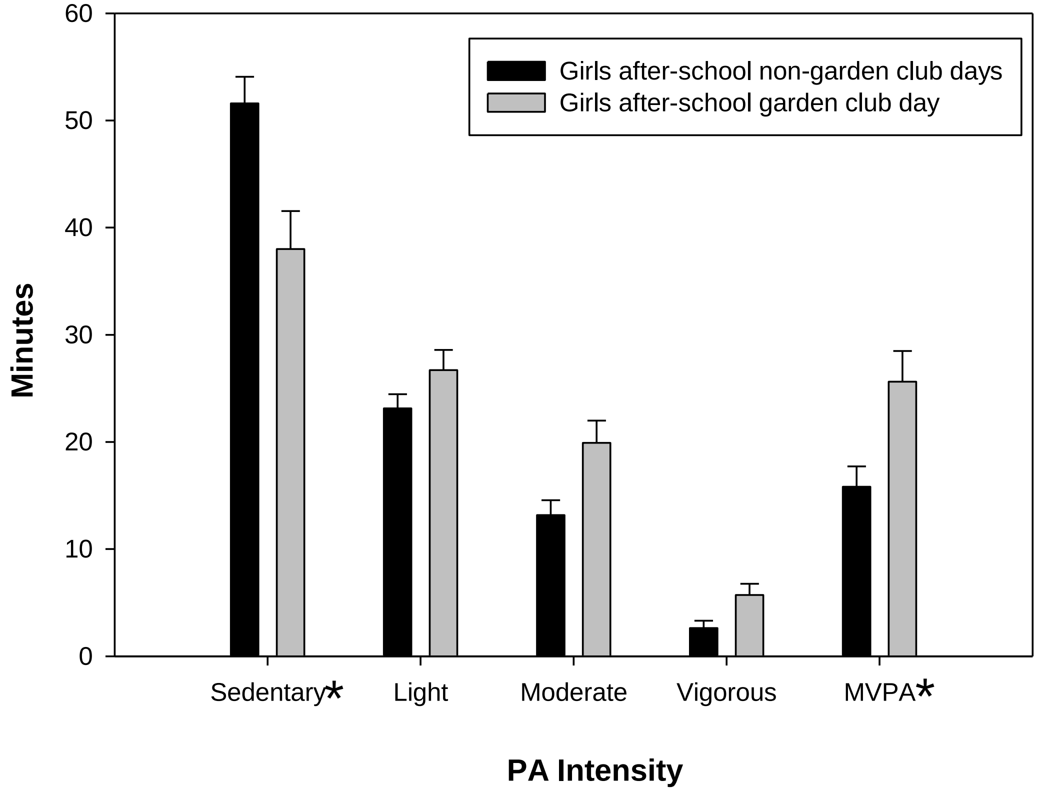

Figure 3.4 Physical activity intensity for girls during after-school hours for garden club and non-garden club days during the fall 2009 semester

Note. * indicates a significant difference, p=0.05, between the measurements of "Girls after-school non garden club days" and "Girls after-school garden club day" for the physical activity intensity level indicated. MVPA represents a summative measure of moderate and vigorous physical activity.

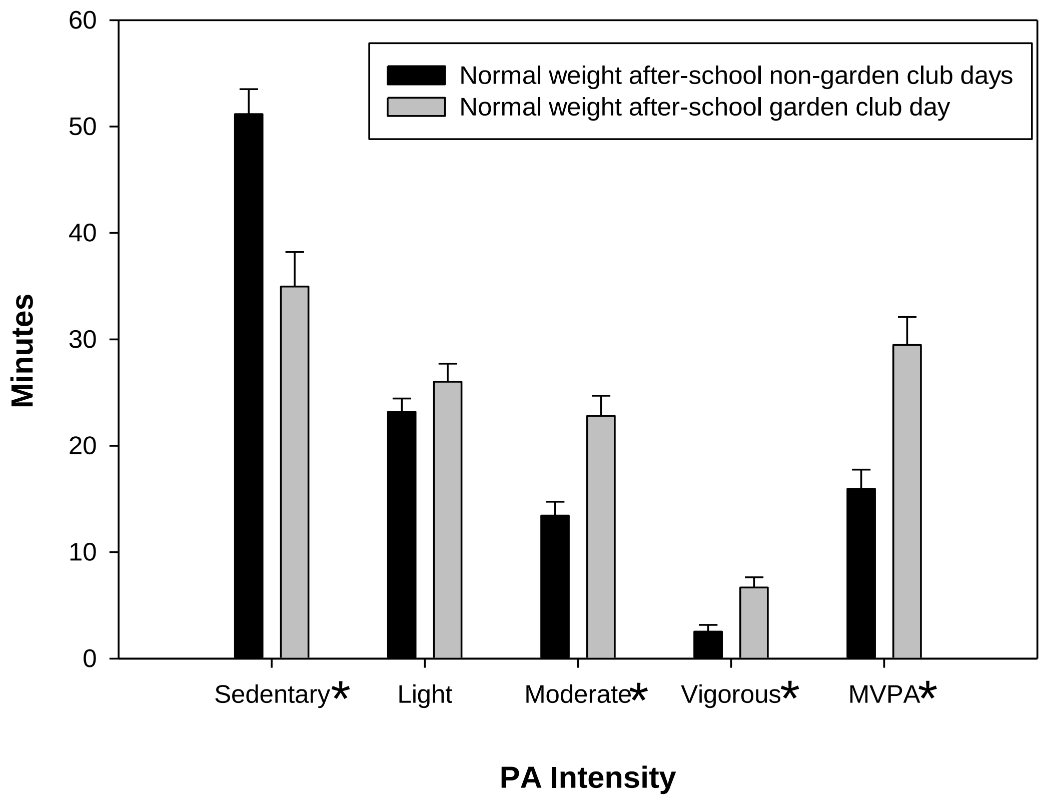

Figure 3.5 Physical activity intensity for normal weight students during after-school hours for garden club and non-garden club days during the fall 2009 semester

Note. * indicates a significant difference, at p=0.05, between the measurements of "Normal weight after-school non garden club days" and "Normal weight after-school garden club day" for the physical activity intensity level indicated. Normal weight is classified as a BMI-Z score within the 5^{th} to <85^{th} percentile as determined by CDC growth curves. MVPA represents a summative measure of moderate and vigorous physical activity.

Chapter 4 - Energy Expenditure of Youth while Gardening

Abstract

Physical activity recommendations state that youth should participate in at least sixty minutes of moderate to vigorous physical activity each day. These recommendations were created to help youth obtain numerous health benefits associated with physical activity, including a decreased risk of becoming overweight. However, many reports show these guidelines are not being met and the rate of overweight youth continues to rise. Gardening has been shown as a form of physical activity and may be an appealing option for youth who struggle to meet these recommendations through traditional sports. The objective of this study was to determine the amount of energy expended by youth while performing four gardening tasks. Fourth and fifth grade students were recruited from eight elementary schools in the Manhattan/Ogden, Kansas school district in May of 2010. The study was conducted at the K-State Gardens on the campus of Kansas State University during July of 2010. One participant was scheduled during each time slot and the study was done in the morning to avoid the heat of the day. When participants arrived at the garden, body mass index was measured and students completed a brief survey. While participants (n=20) performed the gardening tasks (transplanting, weeding, cultivating, and raking) energy expenditure was measured with a portable gas analyzer. Heart rate was monitored simultaneously. Each of the tasks was performed for ten minutes with a five minute rest in between to allow heart rate to lower. Analyses of the data show that these four gardening tasks were moderate intensity physical activities for youth (3 to 5.99 METs). Raking required a significantly higher amount of energy expenditure (4.02 Kcal/min) than the other three tasks. Transplanting, weeding, and cultivating were not significantly different from each other for energy expenditure. Participants had a significantly higher heart rate while raking (140.69 bpm) than transplanting (114.31 bpm) and weeding (113.88 bpm). In conclusion these four gardening tasks provided moderate intensity physical activity for the participants. Gardening may be a form of physical activity that can help youth meet the national recommendations of sixty minutes of moderate to vigorous physical activity each day.

Introduction

Physical activity provides many health benefits including strengthening and retaining bones and muscles (U. S. Dept. of Health and Human Services, 2009). Regular physical activity helps maintain weight and consequently reduces the risk of becoming obese. Lower blood pressure, higher HDL cholesterol and more positive well-being, confidence and self-esteem are other benefits of physical activity (American Heart Association, 2011). Individuals who are physically active are less likely to be diabetic or suffer from cardiovascular disease (U. S. Department of Health and Human Services, 2009).

Current recommendations by the Centers for Disease Control and Prevention (U. S. Department of Health and Human Services, 2009) state that youth should be physically active for at least 60 minutes each day primarily doing aerobic activities but incorporating vigorous intensity activities at least three days per week. Muscle and bone strengthening activities should be done three days per week.

A report from 2002 showed that 22.6% of youth age 9-13 reported not participating in any form of free-time physical activity (CDC, 2003). Only 18.4% of youth in the ninth through twelfth grade reported meeting the recommendation of sixty minutes per day of physical activity (Eaton, Kann, Kinchen, Shanklin, Ross, Hawkins, Harris, Lowry, McManus, Chyen, Lim, Whittle, Brener, & Wechsler, 2010). This is concerning as studies have shown adolescent physical activity levels continuing into adulthood (as reviewed by Malina, 1996). Adolescents have been shown to decrease the amount of time they spend physically active and increase the amount of time spent sedentary with age (Gordon-Larsen, Adair, Nelson, & Popkin, 2004). Therefore, adolescents who are already not meeting physical activity recommendations may further decrease the amount of time they spend physically active as they enter adulthood. However, if individuals can learn to meet the physical activity recommendations at a young age, they will be more likely to continue these habits into adulthood. This illustrates the importance of targeting a young audience for improving health behaviors.

To overcome the appeal of sedentary choices competing for physical activity time, such as television and video games, health promotions should incorporate physical activities that are enjoyed and valued by the participants (Sleap & Warburton, 1992). This includes offering physical activity options that meet the needs of female and overweight youth, as both of these groups tend to decline more rapidly in physical activity participation (Trost, Rosenkranz, Dzewaltowski, 2008). Targeting these youth requires incorporating physical activities that allow all students to participate regardless of skill level. Elimination games, which are common physical activities, should be altered to enable students to remain active (Trost, et al., 2008).

Being outside has been shown to be an important factor positively associated with the amount of time children spend in physical activity (Sallis, Prochaska & Taylor, 2000; McKenzie, Feldman, Woods, Romero, Dahlstrom, Stone, Strikmiller, Williston, & Harsha, 1995). The amount of time children spend outside tends to decline with age (Cleland, Timperio, Salmon, Hume, Baur, & Crawford, 2010). Another factor influencing time spent in physical activity is enjoyment. This was particularly true for girls (DiLorenzo, Stucky-Ropp, Vander Wal, Gotham, 1998).

Gardening can be done indoors, but is commonly an outdoor activity. Gardening has been reported as a low to moderate intensity physical activity for older adults (Park, Shoemaker, & Haub, 2008). Gardening is a non-competitive, enjoyable activity that may help youth increase their physical activity levels. Physical activity intensity of gardening for youth is not well researched.

Studies that have reported gardening to increase physical activity levels of youth often lack objective measurements of physical activity (Hermann, Parker, Brown, Siewe, Denney, & Walker, 2006; Phelps, Hermann, Parker, & Denney, 2010) relying on self-report. Children are not as developed in their cognitive skills which makes the use of an objective measurement of physical activity more reliable and preferable over self-report (Welk, Corbin, & Dale, 2000; Guinhouya, Lemdani, Vilhelm, Durocher, & Hubert, 2008). The purpose of this study was to objectively measure energy expenditure to determine the exercise intensity of four garden tasks performed by youth.

Methods

Participants

In May of 2010, a flier describing this study was sent to all fourth and fifth grade students at eight Manhattan, KS elementary schools. Attached to the flier was a form parents were instructed to complete and return in an attached pre-paid envelope if their child was interested in participating in the study. On this form parents were asked to include their child’s name, grade level, gender, parent contact information, and dates available to participate in the study over the summer. Parents were also asked to indicate whether a morning or afternoon time would be preferable.

Of the approximately 720 packets distributed to the fourth and fifth grade classrooms, 24 forms were signed and returned. One student was lost due to schedule conflicts and two students served as cases in the pilot study. Twenty-one students participated in the study, however data from one participant was removed during analysis due to abnormally high energy expenditure values (EE total >1,000 kilocalories) resulting in an n of 20 students. The low return rate is likely a result of the timing of the flier distribution. May is at the end of the school year and there were potentially several school-related forms sent home at this time as well. Researchers did not make announcements of the study in the elementary classrooms due to time constraints but explained the study to the teachers and gave each teacher a letter requesting assistance with distribution of the forms. Some teachers may not have sent home the forms; others may have distributed the forms without an explanation to the students. These feasible scenarios may have resulted in parents not receiving the forms. However, our goal of a sample of at least 20 students was met.

Students who returned a form stating their interest in participating in this study were contacted via telephone during June of 2010 to schedule their test session for a morning in July. Due to the availability of only one portable indirect calorimeter, one participant could be measured at a time. Each participant was scheduled for a two and one half hour time slot. The study was done outdoors in a garden setting so, to avoid the afternoon heat, participants were only scheduled during the morning hours of 7:00 AM to 10:00 AM. Participants were sent an email reminder of their scheduled date and time one day before they were to appear. They were reminded to wear close-toed shoes, comfortable clothing for being outdoors gardening, and to meet the researcher at the Kansas State University Gardens. Each student was assigned a five digit identification number to ensure confidentiality. The Kansas State University Committee for Research Involving Human Subjects (IRB) approved this study.

Procedures

Upon arrival at the gardens the parent completed an informed consent. The participant was then taken indoors where the researchers recorded their height and weight. Height was measured to the nearest 0.1 centimeter using a portable stadiometer (Seca Corp, Model 214, Hamburg, Germany) and weight was measured to the nearest 0.1 kilogram with a digital scale (Seca Corp, Model 770, Hamburg, Germany). The scale was calibrated with predetermined weights at the beginning of each collection day. These measurements were used to compute body mass index (BMI) by dividing the participant's weight (kilograms) by their height (meters) squared. BMI raw data were computed into BMI-Z scores to reflect growth for age and gender using the CDC growth curves. These scores were used to determine whether the participants were in the normal weight category (5^{th} to $<85^{th}$ percentile) or overweight/obese ($\geq 85^{th}$ percentile).

Participants completed a brief survey compiled by the researchers. Demographic questions included date of birth, age, grade level just completed, gender, and ethnicity. Twenty six questions were taken from a previous survey (Robinson, 1999) to measure the participants' time spent doing various activities over the past 24 hours as well as the previous Saturday. These questions were used to help determine the amount of time spent sedentary. Two questions were used (Prochaska, Sallis, & Long 2001) to measure number of days the participant was physically active over the past seven days and a typical week. These questions were adapted to also determine the number of days the participant gardened over the previous week and a typical week. Boys and girls were given identical surveys except the final page which measured pubertal development (Carskadon & Acebo, 1993 as developed by Crockett, 1988). The use of self-report of pubertal development has been validated for studies that are interested only in estimates of pubertal status (Petersen, Crockett, Richards, & Boxer, 1988) as was the case for this study. Participants were asked not to eat any food and to drink only water during the three hours prior to their scheduled data collection time due to the thermal effect of food on energy expenditure (Puhl, 1989). Participants were asked to record anything they had consumed within the last three hours on the survey to determine if they had complied with the protocol. Upon completion of the survey, participants were fitted with the portable $K4b^2$ device (Cosmed $K4b^2$, Cosmed, Rome, Italy) and heart rate monitor (Model POLAR, Port Washington, NY).

Once fitted with the monitors, participants were taken outside to wander through the gardens for 10 minutes. This was to help reduce the effect of the novelty of the instruments on the participants while performing the various tasks (Boyd, Fatone, Rodda, Olesch, Starr, Cullis, Gallagher, Carlin, Nattrass, & Graham, 1999). No measurements were taken during this time.

After completing the walk, participants were taken indoors and seated in a cool and quiet room to relax for 15 minutes. The first 10 minutes participants rested with the portable device on without the facemask (Hans-Rudolph, Kansas City, MO). For the final 5 minute rest the researcher attached the facemask to the participant. The participant sat upright in a comfortable chair with the lights dimmed. Using a ten minute rest in the seated position prior to measuring energy expenditure has been used as the resting protocol in previous research (Horswill, Lawrence-Kien, & Zipf, 1995).

After the rest, researchers took the participant to the gardens. There were four gardening tasks to be completed for 10 minutes each. Prior to starting the first task and in between each of the remaining tasks the participant was instructed to sit in a chair in the shade and rest for 5 minutes. The four gardening tasks are detailed in table 4.1. Participants were told what to do for each task but were not given detailed instructions on how to perform the tasks unless they specifically asked. This was done to ensure participants were gardening as they would under normal conditions and weren’t influenced by adult gardening behaviors. The four tasks were chosen because they are common to gardening, were hypothesized to offer a variety of intensities and incorporate upper and lower body movements. The order of the four tasks was consistent for each participant and was chosen based on preliminary work to reflect increasing heart rate with each task (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008).

Two researchers took detailed observation notes while each participant gardened to record how he/she was doing the tasks throughout the activity. At the start and end of each gardening task and rest period, one researcher pushed the “mark” button on the portable device to make a record on the $K4b^2$ output of when an activity changed. These times were also manually recorded on a separate log by one of the researchers.

When the participant finished all four activities he/she was taken back inside to remove the portable device. The participant was given a snack and a $10 gift card for participating in the study. Outside temperature, wind, rain, and relative humidity were recorded.

Dependent Variables

A portable indirect calorimeter, $K4b^2$, (Cosmed $K4b^2$, Cosmed, Rome, Italy) was used to measure energy expenditure of the participants with a breath by breath analyzer. Energy expenditure was calculated based on the Weir equation (de Weir, 1949): Energy expenditure (kcal/min) = [(VO_2 L/min)(3.941) + (VCO_2 L/min)(1.11)] where VO_2 represents oxygen consumed in liters per minute and VCO_2 represents carbon dioxide produced in liters per minute. This tool has been previously validated for measuring energy expenditure (McLaughlin, King, Howley, Bassett, & Ainsworth, 2001). The $K4b^2$ simultaneously measures numerous metabolic variables. For this study the following responses are reported: energy expenditure (EE), carbon dioxide output (VCO_2), relative oxygen consumption (VO_2), heart rate (HR) and metabolic equivalents (METs). METs were used to categorize each of the gardening tasks based on intensity: Sedentary <1.5 METs, Light physical activity 1.5-2.99 METs, Moderate physical activity 3.0-5.99 METs, Vigorous physical activity >6.00 METs, and Moderate and Vigorous physical activity (MVPA) >3.0 METs. METs were calculated automatically using the equation METs=VO_2/3.5 mL/kg/min, where VO_2 represent oxygen consumed in milliliter per kilogram per minute.

The $K4b^2$ was calibrated prior to each participant as described in the user manual. Data were stored in the portable device and then downloaded to a personal Windows-based computer after each day of data collection.

The $K4b^2$ portable unit (PU) was attached to the front of the participant on a harness with the battery pack attached to the harness on the back of the participant. The unit weighs less than one kilogram. A child-size face mask, which covers the nose and mouth, was held in place on the patient with a harness worn over the participant's head. This mask was attached to the PU by a flowmeter which measures each breath of the participant and transmits the data to the PU through the attached cables (Cosmed $K4b^2$, Cosmed, Rome, Italy). Each participant wore a heart rate monitor (Model POLAR, Port Washington, NY) underneath their clothing just below their sternum. The monitor was tightened to ensure it would not slip during the tasks.

Data Analysis

This experiment has a completely randomized design with the fixed treatment factor of gardening task (transplanting, weeding, cultivating, and raking). Additional factors include grade (fourth/fifth), gender (male/female), age (years), weight status (normal weight/overweight), and pubertal development (pre-pubertal/pubertal). Students nested within additional factor effects are considered random. The responses are the physical activity parameters measured by the portable unit including the calculated measurements of: energy expenditure (EE) (kcal/min) and metabolic equivalents (METs) and the direct measurements of: relative oxygen consumption (VO_2) (ml/kg/min), carbon dioxide output (VCO_2) (ml/min), and heart rate (HR) (bpm).

Data were analyzed with Statistical Analysis System (SAS) version 9.2 for Windows (SAS Institute Inc, Cary, NC, USA) using PROC MIXED by analysis of variance (ANOVA). A significance level of $p=0.05$ was used for all analyses.

Gender was expected to significantly impact a number of the recorded factors. We investigated which of the other additional factors had the most significant impact of the responses of interest. Analyses using PROC MIXED were conducted by adding one additional factor at a time to a model that included the main effects and two way interactions of treatment (gardening task) and gender (Tables 4.2 and 4.3).

From these initial analyses it was concluded that grade should be included in the model with treatment and gender. It was determined that some measure of the participants' maturity should be included in the model to allow for the variability seen in the responses related to the maturity of the participants. A choice was made between the related factors of age, pubertal development and grade. Age was not a practical choice due to the small sample size that covered four ages of participant. Pubertal status was determined by self-report from the participants. Those who reported to be pubertal were early in that development so it could be difficult to distinguish the level of development. Because of the relationship between grade and pubertal development, grade was used in the model which is consistent with other research (McMurray, Harrell, Bangdiwala, Deng, & Baggett, 2003). Weight classification is of interest in the study and is relevant to the research objectives, but few participants were in the overweight classification so these results were considered in the study but were not practical to include in the SAS analysis.

A final analysis was conducted in SAS using PROC MIXED. The model included the factors treatment, gender, grade and the two way interactions between these three factors. A Kenward-Rogers denominator degrees of freedom adjustment was used. Participants were considered random subjects with repeated measurements taken on each. A separate variance was estimated for each treatment group after initial scatter plots of responses by treatment group indicated differing variability for some of the treatment groups. An unstructured variance covariance structure was chosen based on preferable fit statistics. LSMeans was used to obtain mean estimates for treatment, gender, grade, treatment*gender interaction, treatment*grade interaction, and treatment*grade*gender interaction as well as the estimates for pairwise comparisons between these factors. As a conservative measure to protect against inflation of Type I error, a Scheffe adjustment was used. Confidence intervals and standard errors were also obtained.

Results

Subject Characteristics

A total of 20 students were used in the final analysis. Table 4.4 provides participant demographic characteristics. The mean age of this sample was 10.1 years old. Participants were primarily Caucasian (50 %) and normal weight (70 %). There were an equal number of males and females. Half of the sample was determined to be pre-pubertal.

Exercise intensities of garden tasks

Figure 4.1 shows the average of the participants' heart rates at rest and during each gardening task. The five minute rests between each of the tasks allowed the participants' heart rate to decrease prior to beginning a new task. Transplanting, weeding, and cultivating were not significantly different based on heart rate (Table 4.5). Heart rate during raking and cultivating were not significantly different from each other. Raking was the task that resulted in the highest heart rate for these participants and was significantly higher than the heart rate obtained while transplanting and weeding.

The four gardening tasks were moderate intensity activities (3.0-5.99 METs) for youth based on the MET classifications (Table 4.5). While all gardening tasks were moderate intensity, raking was significantly greater than transplanting across all reported variables. Raking, cultivating, and weeding were not significantly different in relative oxygen uptake or METs. However, raking resulted in a significantly higher amount of energy expenditure and carbon dioxide output than cultivating, weeding and transplanting.

Grade and gender were not found to significantly impact the reported parameters based on the resulting p-values (Table 4.3).

Discussion

The four tasks chosen for this study were determined to be moderate physical activities for children (3.55-5.65 METs). Although participants were allowed to perform each of the tasks as they preferred, one of the tasks required the use of both upper and lower body movement throughout the activity. Raking was the only task that the participants stood throughout the ten minute measurement period and used their arms and legs. This task was the most intense of the four gardening tasks. Garden tasks requiring upper and lower body movement providing more intense physical activity has been reported elsewhere (Park, et al., 2008) with older adults.

These results suggest that children may be able to benefit from gardening as they would from participating in other forms of physical activity. This is particularly relevant for this age group since this is the typical age when physical activity levels may begin to decline. Gardening is a non-competitive activity which may encourage individuals who are deterred from playing elimination games. A previous report showed girls have a preference for being able to socialize while participating in physical activity (DiLorenzo, et al., 1998). Girls are also shown to decline in their participation in physical activity more rapidly than boys (Trost, et al., 2008). Enjoyment is an important factor determining whether or not girls will be active (DiLorenzo, et al., 1998). Some gardening tasks are moderate physical activity and can be done while socializing which may make this a more enjoyable physical activity option for girls.

Youth who are overweight may be less likely to participate in vigorous intensity physical activities. Higher intensity activities require more effort for an overweight individual than for one of normal weight. Additionally, organized physical activities for youth are often competitive and have an elimination component. An overweight child who has more difficulty keeping up with the normal weight children may see this as a barrier to their participation (Trost, et al., 2008). Research has shown that overweight children are less likely to be chosen as a friend (Strauss & Pollack, 2003). Gardening can offer moderate physical activity in a non-competitive, non-elimination style while offering children a chance to make friends with other children who garden.

Teaching children to garden gives them an activity that they can do throughout their life. Organized sports which are common for youth are not as available for adults, which may contribute to the decline in physical activity seen for adolescents (Sallis, 2000).

Gardening can provide moderate intensity physical activity for youth. If a gardening program is offered at school it has the potential to encourage relationships among students and faculty and increase the amount of physical activity obtained by the students.

Due to the age of the participants of this study, only four tasks were chosen to avoid exhaustion and ensure the participants were able to complete each task. Further research should be done to determine energy expenditure of additional gardening tasks. One advantage of this study was that it measured energy expenditure of gardening for youth as the youth would typically garden. Detailed instructions for each task were not given which allowed the researchers to capture how the youth would garden outside of the study. A limitation of this study was the small sample size. However, the results provide valuable information and insight into future areas of research.

Future Studies

For future research in this area, studies should be done during different times of the year to ensure no effect because of outdoor temperature. This study was strengthened by allowing participants to garden in a real garden situation outdoors rather than creating the set-up inside. However, this resulted in the potential of temperature affecting the results of participant energy expenditure.

A future study should follow a similar design but take place over multiple days. Participants of this age were only feasibly able to complete four gardening tasks on a single day without becoming fatigued. However, it would be relevant to have participants complete additional gardening tasks, particularly tasks with upper and lower body movement, divided over multiple days to add to the knowledge of energy expenditure in this area. Furthermore, if participants are available for more than one day, they could spend a portion of the first day familiarizing themselves with the instrumentation. This would help ensure the novelty of the device does not affect the results.

Another option is to take observational notes of the participants while gardening without wearing the $K4b^2$ to get a preliminary understanding of how they perform the designated tasks before energy expenditure measurements are taken. This data could support the results by demonstrating whether or not their gardening performance differed while they were wearing the device.

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Tables and Figure

Table 4.1 Descriptions of gardening tasks performed by 4th and 5th grade youth

Task*	Description
Transplanting	Provided with gloves, hand trowel (0.086 kg), and a kneeling pad, participants transplanted small pepper plants from cell packs into a 12 foot by 4 foot raised planter bed.
Hand Weeding	With the option of using gloves and a kneeling pad, participants pulled weeds from a 10'x 2' plot. No tools were provided.
Cultivating	Using a hand cultivator (0.142 kg) and the option of gloves, participants cultivated the compacted soil in a 12 foot by 4 foot raised planter bed by hand.
Raking	Using a long handled rake (1.0 kg) and the option of gloves, participants raked mulch into piles in an 11.5 foot by 27.5 foot area.

*Each task was performed for ten minutes. Participants were not given instructions about how to perform each task unless they specifically asked. Participants were allowed to perform each task standing/sitting/kneeling or however they were comfortable.

Table 4.2 Response p-values for factors not included in final model to determine energy expenditure of gardening tasks performed by 4th and 5th grade youth*

	Response p-value				
Factor	HR (bpm)	VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	VCO_2 (ml/min)	EE (Kcal/min)	METs
Age	0.0010	0.0026	0.0017	0.0066	0.0026
Weight Classification	0.0398	<0.0001	0.0043	0.0008	<0.0001
Pubertal Development	0.4522	0.0200	0.0223	0.1436	0.0200

Note: HR=heart rate; VO_2=oxygen uptake; VCO_2=carbon dioxide production; EE=Energy Expenditure; METs=Metabolic Equivalents.

* Four age groups were represented in this study. Due to the small sample size, age was determined to be impractical for inclusion in the final model. Few participants were in the overweight classification, so these results were considered in the study but were not practical to include in the SAS analysis. Pubertal status was determined by self-report and those who reported to be pubertal were early in that development. It could be difficult to distinguish the precise level of development so this factor was removed from the final model.

Table 4.3 Response p-values from Type III Test of Fixed Effects for factors included in final model to determine energy expenditure of gardening tasks performed by 4th and 5th grade youth

	Response p-value				
Effect	HR (bpm)	VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	VCO_2 (ml/min)	EE (Kcal/min)	METs
Treatment	0.0009	0.0114	<0.0001	<0.0001	0.0091
Gender	0.0234	0.1676	0.0998	0.2141	0.1776
Treatment*Gender	0.9894	0.9204	0.7506	0.7949	0.8543
Grade	0.6800	0.0511	0.4225	0.8944	0.0527
Treatment*Grade	0.9791	0.9214	0.8110	0.7932	0.9257
Grade*Sex	0.0297	0.6066	0.8303	0.8807	0.6492

Note: HR=heart rate; VO_2=oxygen uptake; VCO_2=carbon dioxide production; EE=Energy Expenditure; METs=Metabolic Equivalents.

Table 4.4 Characteristics of 4th and 5th grade youth participating in a gardening energy expenditure project (n=20)

Variable	Males (n=10)	Females (n=10)	Total (n=20)
Demographics			
Mean age, years (SD)	10.3 (0.2)	9.9 (0.2)	10.1 (0.6)
Race/Ethnicity (%)			
White	40%	60%	50%
Not-White	40%	30%	35%
Don't Know	20%	10%	15%
Gender (%)	50%	50%	
Pubertal Development (%)			
Pre-Pubertal	50%	50%	50%
Pubertal	50%	50%	50%
Anthropometric, mean (SD)			
Height (cm)	146.1 (2.5)	146.1 (2.1)	146.1 (7.4)
Weight (kg)	43.9 (5.3)	41.5 (3.5)	42.7 (13.9)
BMI	20.2 (1.7)	19.2 (1.2)	19.7 (4.6)
Normal Weight[a] (%)	70%	70%	70%
Overweight[b] (%)	30%	30%	30%
Behavior, mean (SD)			
Sedentary Minutes (daily)	244.5 (42.5)	290.3 (20.2)	267.4 (105.0)
Screen time Minutes (daily)	186.0 (47.2)	129.0 (23.7)	157.5 (118.6)
Garden Minutes (daily)	18.0 (6.9)	6.8 (3.4)	12.4 (17.8)
Days Physically Active (weekly)	3.0 (0.5)	5.1 (0.5)	4.1 (1.9)
Days Gardening (weekly)	1.6 (0.5)	1.0 (0.4)	1.3 (1.4)

[a]Normal weight is classified as a BMI-Z score within the 5th to <85th percentile as determined by CDC growth curves.

[b]Overweight is classified as a BMI-Z score ≥85th percentile as determined by CDC growth curves.

Table 4.5 Metabolic measurements for gardening performed by 4th and 5th grade youth

	Factor	HR (bpm)		VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)		VCO_2 (ml/min)		EE (Kcal/min)		METs	
		M	SE	M	SE	M	SE	M	SE	M	SE
Task	Transplanting	114.31[a]	2.45	12.21[a]	1.18	413.87[a]	29.82	2.49[a]	0.22	3.55[a]	0.27
	Weeding	113.88[a]	4.22	13.41[ab]	1.28	466.73[a]	33.92	2.74[a]	0.19	3.83[ab]	0.37
	Cultivating	124.07[ab]	3.89	15.00[ab]	1.36	534.48[a]	38.65	3.09[a]	0.21	4.29[ab]	0.39
	Raking	140.69[b]	5.58	19.78[b]	1.78	688.08[b]	33.83	4.02[b]	0.19	5.65[b]	0.51
Gender	Male	118.35[a]	2.23[a]	16.09[a]	0.74[a]	554.35[a]	18.67[a]	3.21[a]	0.11[a]	4.60 [a]	0.21[a]
	Female	128.13[a]	3.54[a]	14.11[a]	1.21[a]	497.23[a]	28.65[a]	2.96[a]	0.17[a]	4.06 [a]	0.33[a]
Grade	Fourth	124.11[a]	1.82[a]	16.51[a]	0.60[a]	511.98[a]	15.24[a]	3.07[a]	0.09[a]	4.72[a]	0.17[a]
	Fifth	122.37[a]	3.77[a]	13.69[a]	1.28[a]	539.60[a]	30.61[a]	3.10[a]	0.18[a]	3.94[a]	0.35[a]

Note: M=mean; SE=standard error; HR=heart rate; VO_2=oxygen uptake; VCO_2=carbon dioxide production; EE=Energy Expenditure; METs=Metabolic Equivalents. [abc]Means in a column within each category (task, gender, or grade) sharing a common letter are not significantly different by Differences of Least Squares Means at p=.05.

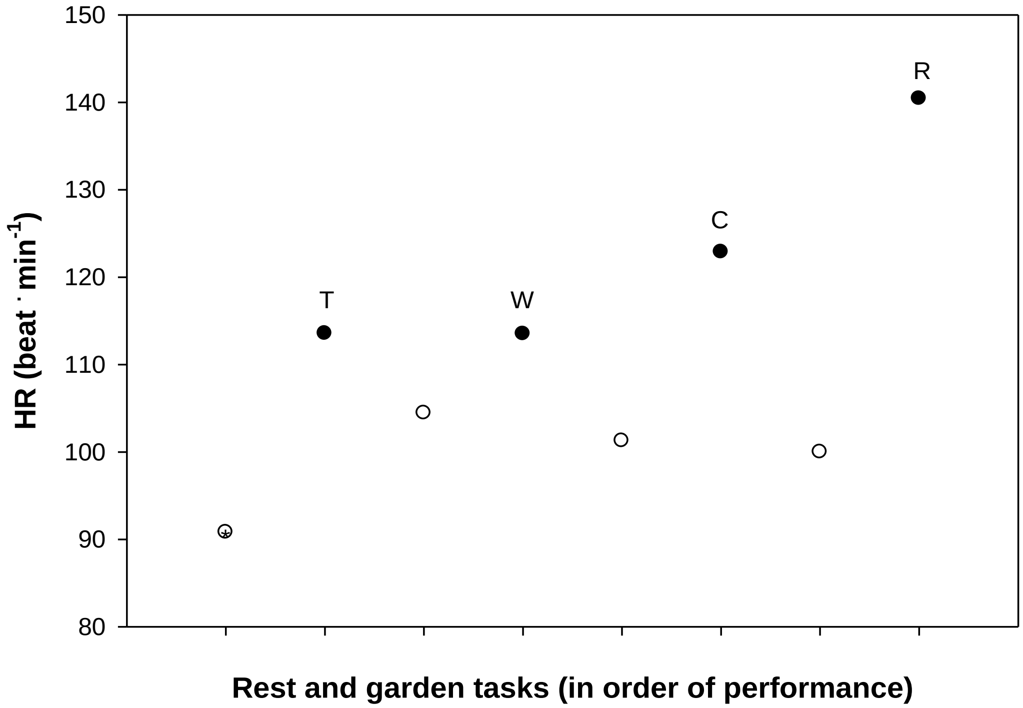

Figure 4.1 The average heart rate (HR) of 20 participants for four different gardening tasks

T, W, C, and R indicate each of the gardening tasks transplanting, weeding, cultivating, and raking, respectively. The symbol ● indicates the average heart rate for ten minutes while each garden task was performed. The symbol ○ indicates the average heart rate during the five minute rest period between each gardening task. The symbol ⊕ indicates the average heart rate during the five minute rest prior to beginning the first gardening task.

Appendix A - Support Material for Chapter 3

Informed Consent

ActiGraph worn on the waist with an Elastic Belt

ActiGraph worn on the waist with the Belt Clip

Project Information: Project PLANTS is a multi-school study designed to promote gardening, healthy eating, and physical activity in children. This project is directed by the Department of Horticulture, Forestry, and Recreation Resources and the Community Health Institute at Kansas State University, and is funded by a grant from the United States Department of Agriculture. The Department of Horticulture, Forestry, and Recreation Resources has funded participating schools to support the project. Results from this project will be used to create school garden programs for healthy living.

What is involved? A new component of Project PLANTS is looking at the physical activity of children, and we are asking for your child to participate. Children will be asked to wear an accelerometer from the time they wake up until the time they go to bed for five consecutive days. An accelerometer is a small device that measures physical activity and is worn on the hip like a beeper or pedometer. Children will also fill in a brief activity log at the end of each day stating what they did that day. At the end of the five days the child will bring the accelerometer back to school and receive a reward for participating. School records will be used to link physical activity with demographic information (age, sex, ethnicity, free and reduced lunch status).

Information is confidential. All information will be completely confidential. Student names will be replaced with ID numbers. No one will be allowed to connect student names with their accelerometer data.

Potential benefits and concerns. As stated above, your child's information will be kept completely confidential. Distribution and collection of accelerometers are during school time but in a way that students will miss very little of their school activities. This project will provide resources to your child's school.

Participation is voluntary. Your child's participation in this study is completely voluntary. There will be no penalty if you do not wish for your child to participate. They may withdraw at anytime.

Questions/comments? Your child's school and the Institutional Review Board at Kansas State University (Dr. Rick Scheidt, Chair, 785-532-3224, 1 Fairchild Hall, Kansas State University) approved this project; they can answer any questions you may have about the rights of participants in research. If you have any other questions about the project, please feel free to call Dr. Candice Shoemaker at 785-532-1431 or cshoemak@ksu.edu.

- -

Please check one box, sign, and return the bottom portion to your child's teacher by _______________.

We thank you.

- ☐ I give permission for my child to participate in the accelerometer portion of this study.
- ☐ I do not want my child to participate.

Parent Name (please print): ____

Parent Signature: ____Date: ______________

Child's name: ____

Child's Signature: ____

K-STATE Kansas State University Research and Extension

Daily Activity Log

Thank you for agreeing to allow your child to participate in this important research project. The project will help us better understand your child's physical activity levels and learn more about his or her patterns of activity in a day.

As a participant in the study, your child will wear a small physical activity monitor during a normal week (at the waist), Wednesday to Tuesday (10/13/10 to 10/19/10). The monitor picks up physical movement and can be used to evaluate normal physical activity levels. We encourage you to help your child keep the monitor, worn at the waist, on all day so we can learn about physical activity patterns at home as well as at school. This removable monitor should be worn at the waist in line with the thigh, and can be worn during any play activity (with the exception of swimming). We are interested in obtaining measures of typical physical activity, so <u>it is best if your child maintains his or her normal activity pattern during the week rather than doing more or less.</u> Parents, some important reminders about the study are listed below:

1) <u>Remember to wear the monitor all day, every day.</u>

Please remind your child to wear the activity monitors. We can only get accurate indicators of children's levels of physical activity if they are wearing the monitors each day. The monitor can be taken off at night for sleeping and for bathing, but please remind them to put it on the next day.

2) <u>Complete a Diary/Log of their physical activity</u>

To assist us in interpreting this information, it is important to know what your child was doing during the week. The diary will help us collect the most accurate information possible. See instructions on the next page.

3) <u>Return the monitors at your school</u>

The monitors and logs will be taken off on Tuesday, October 19, 2010 at school. It is important that your child wears the monitor and brings the log with them on Tuesday, October 19th so we can download the monitors and prepare them for another participant to wear in the future.

For additional information about the project please contact:

Cynthia Domenghini – Project Manager
ProjectPLANTS
2601 Throckmorton
Manhattan, KS 66506
(785) 532-3784
cdom@ksu.edu

Day 1: Wednesday **Date: 10/13/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Did you have P.E. at school today? Yes No

What did you do after school today? (circle one)

Went Home Went to a club Other ____

Day 2: Thursday **Date: 10/14/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Did you have P.E. at school today? Yes No

What did you do after school today? (circle one)

Went Home Went to a club Other ____

Day 3: Friday **Date: 10/15/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Did you have P.E. at school today? Yes No

What did you do after school today? (circle one)

Went Home Went to a club Other ____

Day 4: Saturday **Date: 10/16/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Day 5: Sunday **Date: 10/17/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Day 6: Monday **Date: 10/18/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Did you have P.E. at school today? Yes No

What did you do after school today? (circle one)

Went Home Went to a club Other ____

Day 7: Tuesday **Date: 10/19/10**

Time monitor was put on:________________ Time monitor was taken off:____________________

Did you take the monitor off at any other time today (other than bathing)? Yes No

Did you have P.E. at school today? Yes No

Spring Reminder Assent Form

Dear Parents,

Last fall you gave permission for your child to participate in the Project PLANTS accelerometer study through Kansas State University. This is just a notice that it's time for the second round of that study. Your child will be asked to wear an accelerometer again for about a week during the month of April. The procedure will be the same as last time. They will have a daily activity log to fill in each day by answering a few brief questions. Students are asked to wear the accelerometer all day and only take it off when they will be getting wet and when they go to bed. Students who bring their accelerometer and daily activity log back on the specified date will be given a small reward for their participation.

If you **would NOT** like your child to participate during this round of the accelerometer study please complete the bottom portion of this page and return it to your child's teacher by: ________________. Otherwise your child will continue to be included in the study. If you have any questions you can contact Cynthia Domenghini with Project PLANTS at cdom@ksu.edu or 785.532.3784. Thank you!

*Please fill out and return the below section **ONLY** if you **DO NOT** want your child to participate in the spring Project PLANTS accelerometer study.*

I **DO NOT** want my child to participate in the spring Project PLANTS accelerometer study.

Child Name (First, Last):____

Parent Signature: ____

Accelerometer Tracking Sheet

	Participant Name	Accel. #	Time On	Time Off	ID #
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Appendix B - Support Material for Chapter 4

Study Recruiting Flier Information

We will be conducting a study during June in the K-State Gardens that aims to determine the level of intensity of various gardening tasks performed by children. Your child will get to learn about some cool equipment that will measure their energy use while gardening. By helping us they will receive a $10 gift card. Participants will be asked to come to the K-State Gardens for a 2-hour period of time. The attached form provides information on how to sign up. Please return the completed form in the prepaid envelope as soon as possible. Thanks!

“Willingness to Participate” Form

Please return this form in the self-addressed stamped enveloped as soon as possible.

Please complete your contact information and availability below. Once we receive this we will schedule a time for your child to come to the K-State Gardens. While at the Gardens your child will complete a survey, have their height and weight measured, and perform various gardening tasks while having their oxygen uptake, heart rate, and motion monitored. We estimate this should take no more than two hours.

I would like for my child to participate in the Garden Project study.

CHILD NAME (Please Print): ____

First, Last

CHILD SIGNATURE: ____

CHILD’S GRADE LEVEL *(grade just completed)* 4th 5th *(circle one)*

CHILD’S GENDER Male Female *(circle one)*

PARENT/GUARDIAN SIGNATURE: ______________________________________

CONTACT INFORMATION: EMAIL: ____________________________

PHONE #: ____________________________

MAILINGADDRESS: ____

Please Circle Time of Day on dates your child may be available to participate in this study: *Although your child will only need to be present for one 2-hour block of time on one day, please circle all dates/times that your child can be at the K-State Gardens for our scheduling purposes. A morning time slot will require the child to be at the Gardens by 10:00 AM; an afternoon time slot will require the child to be at the Gardens by 3:00 PM. You will be contacted once your child has been assigned to a date and time that is convenient for you.*

June, 2010

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 MORNING AFTERNOON	**2** MORNING AFTERNOON	**3** MORNING AFTERNOON	**4** MORNING AFTERNOON	**5**
6	**7** MORNING AFTERNOON	**8** MORNING AFTERNOON	**9** MORNING AFTERNOON	**10** MORNING AFTERNOON	**11** MORNING AFTERNOON	**12**
13	**14** MORNING AFTERNOON	**15** MORNING AFTERNOON	**16** MORNING AFTERNOON	**17** MORNING AFTERNOON	**18** MORNING AFTERNOON	**19**
20	**21** MORNING AFTERNOON	**22** MORNING AFTERNOON	**23** MORNING AFTERNOON	**24** MORNING AFTERNOON	**25** MORNING AFTERNOON	**26**
27	**28** MORNING AFTERNOON	**29** MORNING AFTERNOON	**30** MORNING AFTERNOON	**1 (July)** MORNING AFTERNOON	**2** MORNING AFTERNOON	

Informed Consent

Gardening and Physical Activity for Children

PARENTAL PERMISSION SLIP

Project Information: This study examines the intensity of common garden tasks to determine if they can be considered low-to-high intensity physical activity. This project is directed by the Department of Horticulture, Forestry, and Recreation Resources at Kansas State University. Results from this project will be used to assist adolescents in developing and maintaining their health through gardening.

What is involved? Children will complete a survey and be measured on height and weight in a private setting by trained research assistants. The survey should take about 10-15 minutes. The survey asks about gardening, physical activity, and demographic information. Oxygen uptake, heart rate, and motion will be continuously measured with a portable device, heart rate monitor, and accelerometer, respectively, while the children complete a variety of gardening tasks in the K-State Gardens. Participants' images may be taken strictly for use in the research, educational and promotional programs, and printed or electronic publications.

Information is confidential. All information will be completely confidential. Student names will be replaced with ID numbers. At no time will names be associated with answers or with the results of this study. No individual cases will be singled out for examination; only group data will be presented so your name will never be identified.

Potential benefits and concerns. As stated above, your child's information will be kept completely confidential. The benefit of being in this project is an opportunity for your child and your family to become more informed about gardening and the health benefits from gardening. Physical fatigue during gardening may happen, although not likely because activities are common garden tasks.

Participation is voluntary. Your child's participation in this study is completely voluntary. There will be no penalty if you do not wish for your child to participate in the study. They may withdraw at anytime during the study and refuse to answer any of the questions.

Questions/comments? The Institutional Review Board at Kansas State University (Dr. Rick Scheidt, Chair, 785-532-3224, 1 Fairchild Hall, Kansas State University) approved this project; they can answer any questions you may have about the rights of participants in research. If you have any other questions about the project, please feel free to call Dr. Candice Shoemaker at 785-532-1431 or cshoemak@ksu.edu or Cynthia Domenghini at 785-532-3784 or cdom@ksu.edu.

Please check the boxes you agree with:

- ☐ I have read the informed consent and give my permission for my child to participate in the study. I understand that participation in this study is completely voluntary and that my child may withdraw from the study at any time without penalty.
- ☐ I authorize Kansas State University or their assignees to photograph and record my child's image and/or voice for use in research, educational and promotional programs, and printed or electronic publications. I also recognize that these audio, video, and image recordings are the property of K-State.

Parent Name (please print): ____

Parent Signature: __________________________________Date: _____________

Child's Name: ____

Child's Signature: ____

Participant Survey

Child Name ____

(Last Name) (First Name)

This cover sheet will be torn off by the researchers so that your name will not be on the questionnaire.

Instructions:

- Read all of the instructions and questions carefully.
- Do not put your name on any part of the survey on the following pages.

Child ID # ☐☐☐☐☐

Instructions: In the space below, please provide information about you.

1.) What is your date of birth? (for example: 04/15/1995)

☐☐ / ☐☐ / ☐☐☐☐

2.) How old are you?

☐☐

3.) What grade were you in during the 2009-2010 school year? (choose one)

☐ 4th grade

☐ 5th grade

4.) What is your gender? (choose one)

☐ Boy

☐ Girl

5.) How do you describe yourself? (select one or more)

___ American Indian or Alaska Native

____ Asian

____ Black or African American

____ Hispanic or Latino

____ Native Hawaiian or Other Pacific Islander

____ White

____ Don’t Know/Not Sure

____ Prefer not to answer

6.) Did you have anything to eat or drink within the last 2 hours?

☐ No

☐ Yes ⇨ What did you have to eat or drink?

____

____

	0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
7.) Over the past 7 days, on how many days were you physically active for a total of at least **60 minutes** per day?	○	○	○	○	○	○	○	○
8.) Over a typical or usual week, on how many days are you physically active for a total of at least **60 minutes** per day?	○	○	○	○	○	○	○	○
9.) Over the past 7 days, on how many days did you garden for a total of at least **30 minutes** per day?	○	○	○	○	○	○	○	○
10.) Over a typical or usual week, on how many days do you garden for a total of at least **30 minutes** per day?	○	○	○	○	○	○	○	○

Yesterday how much time did you spend… *(Please put a mark in only one box per question.)*	**Minutes**			**Hours**					
	none	**15 +**	**30 +**	**1**	**2**	**3**	**4**	**5**	**6 +**
1.) Watching television (not including videos on a VCR or DVD player?									
2.) Watching movies/videos on a VCR of DVD player?									
3.) Playing video games (like XBOX, Wii, or Playstation, not including games on a computer)?									
4.) Playing on a computer?									
5.) Reading a book or magazine?									
6.) Listening to music on CDs, iPods, other MP3 players, or the radio?									
7.) Playing a musical instrument?									
8.) Doing artwork or crafts (like drawing, painting, or making things)?									
9.) Playing quiet games indoors (like playing with toys, puzzles, or board games)?									
10.) Playing outside?									
11.) At classes or clubs (like Brownies, Cub Scouts, religious school, or Judo classes)?									
12.) Gardening or doing lawn care (like planting, weeding, or mowing the lawn)?									
13.) Youth sports (like soccer, swimming, basketball, gymnastics, or football)?									

Last Saturday, all day long, how much time did you spend… *(Please put a mark in only one box per question.)*	**Minutes**			**Hours**					
	none	**15 +**	**30 +**	**1**	**2**	**3**	**4**	**5**	**6 +**
1.) Watching television (not including videos on a VCR or DVD player?									
2.) Watching movies/videos on a VCR of DVD player?									
3.) Playing video games (like XBOX, Wii, or Playstation, not including games on a computer)?									
4.) Playing on a computer?									
5.) Reading a book or magazine?									
6.) Listening to music on CDs, iPods, other MP3 players, or the radio?									
7.) Playing a musical instrument?									
8.) Doing artwork or crafts (like drawing, painting, or making things)?									
9.) Playing quiet games indoors (like playing with toys, puzzles, or board games)?									
10.) Playing outside?									
11.) At classes or clubs (like Brownies, Cub Scouts, religious school, or Judo classes)?									
12.) Gardening or doing lawn care (like planting, weeding, or mowing the lawn)?									
13.) Youth sports (like soccer, swimming, basketball, gymnastics, or football)?									

Pubertal Development Scale-Boys

At your age, boys usually begin to have many physical changes. These questions are about those changes. Please answer the questions about the changes you have noticed.

1.) Have you noticed any skin changes like oily skin, pimples, or acne?

___ a.) My skin has not yet started showing changes.

___ b.) My skin has barely started showing changes.

___ c.) My skin changes are definitely underway.

___ d.) My skin changes are completed.

2.) Boys your age often experience a sudden increase in their height called a "growth spurt". Would you say your growth spurt…

___ a.) Has not yet begun

___ b.) Has barely started

___ c.) Is definitely underway

___ d.) Seems completed

3.) Have you noticed a deepening of your voice?

___ a.) My voice has not yet started changing.

___ b.) My voice has barely started changing.

___ c.) My voice change is definitely underway.

___ d.) My voice change has been completed.

4.) And how about the growth of underarm and pubic hair? Would you say it has…

___ a.) not started growing yet

___ b.) has barely started

___ c.) is definitely underway

___ d.) seems completed

5.) Have you noticed an increase in your weight over the last few months?

___ a.) I have not noticed an increase in weight.

___ b.) I have barely noticed an increase in weight.

___ c.) An increase in my body weight is definitely underway.

___ d.) My body weight seems to have increased as much as it's going to.

6.) Have you begun to grow hair on your face?

___ a.) Not yet started growing hair

___ b.) Have barely started growing hair

___ c.) Facial hair growth is definitely underway

___ d.) Facial hair growth is complete

YOU ARE FINISHED. Thank you for completing this questionnaire.

Pubertal Development Scale-Girls

At your age, girls usually begin to have many physical changes. These questions are about those changes. Please answer the questions about the changes you have noticed.

1.) Have you noticed any skin changes like oily skin, pimples, or acne?

___ a.) My skin has not yet started showing changes.

___ b.) My skin has barely started showing changes.

___ c.) My skin changes are definitely underway.

___ d.) My skin changes are completed.

2.) Girls your age often experience a sudden increase in their height called a "growth spurt". Would you say your growth spurt…

___ a.) Has not yet begun

___ b.) Has barely started

___ c.) Is definitely underway

___ d.) Seems completed

3.) Have you noticed an increase in your weight over the last few months?

___ a.) I have not noticed an increase in weight.

___ b.) I have barely noticed an increase in weight.

___ c.) An increase in my body weight is definitely underway.

___ d.) My body weight seems to have increased as much as it's going to.

4.) And how about the growth of underarm and pubic hair? Would you say it has…

___ a.) not started growing yet

___ b.) has barely started

___ c.) is definitely underway

___ d.) seems completed

5.) Have your breasts begun to develop?

___ a.) Not yet started development

___ b.) Have barely started breast development

___ c.) Breast development is definitely underway

___ d.) Breast development is completed

6.) Have you had your first menstrual period?

___ a.) Yes

___ b.) No

7.) If yes, how old were you when you had your first menstrual period?

___ years old

YOU ARE FINISHED. Thank you for completing this questionnaire.

Height and Weight Data Sheet

Child ID #: __ __ __ __ __

Date of Birth (MM/DD/YYYY): __ __/__ __/__ __ __ __

Age: ___ ___

Height Data (in centimeters to 0.1 cm):

Measure #1: __ __ __. __ cm

Measure #2: __ __ __. __ cm

Measure #3: __ __ __. __ cm (if necessary)

Weight Data (in kilograms to 0.1 kg):

Measure #1: __ __ __. __ kg

Measure #2: __ __ __. __ kg

Measure #3: __ __ __. __ kg (if necessary)

Please indicate if there were any problems retrieving an accurate height and/or weight measurement.

__ hair __ jacket/coat __ other (explain below)

Comments:

Form Completed by: __ __ __ (initials)

Date (MM/DD/YYYY): __ __/__ __/__ __ __ __

Observation Form

Subjects Name: ____

(Last Name) **(First Name)**

Today's Date: ______________________

Observation Time: (such as 9 am – 10 am) ________________________

<u>Instructions:</u>

Please read all of the instructions and questions carefully.

Complete one of these forms each time you observe a gardener.

You will need a watch with minute markings to measure time spent on each activity.

Using the following table, write down each activity the gardener is performing and for how long throughout the entire observation time. Please explain how as well as what they are doing.

Rest (5 min)	Rest (5 min)
Task #1 Transplanting	Task #2 Hand Weeding

Rest (5 min)	Rest (5 min)
Task #3 Cultivating	Task #4 Raking Mulch