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Evaluating the impact of a high school garden in El Paso, Texas for fruit and vegetable intake using a valid biomarker

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EVALUATING THE IMPACT OF A HIGH SCHOOL GARDEN IN EL PASO,
TEXAS FOR FRUIT AND VEGETABLE INTAKE USING A VALID
BIOMARKER

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Master's Program in Public Health

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DEDICATION

To my parents, Vaughn and Linda, for their unconditional understanding and support throughout this degree. You instilled confidence when I questioned my path and provided me with the tools and resources necessary to keep me centered and persistent. Thank you for helping maintain security for my family during all the craziness.

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BIOMARKER

by

PATRICK HOPKINS, B.S.

THESIS

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ABSTRACT

Background: School gardens are an educational tool used to increase children's exposure to, and intake of, fruits and vegetables (F/V). Diets rich in F/V reduce the risk of heart disease, stroke, some cancers, and type 2 diabetes, and can aid in weight management as a strategy to reduce obesity prevalence. Objective data of the impact of school gardens on F/V intake are lacking, as most studies have relied on dietary self-reporting to validate F/V intake. Self-reporting of dietary intake is inherently an unreliable method for assessing F/V intake. Carotenoids, a family of phytochemicals, are a reliable biomarker of dietary intake of F/V. Reflectance spectroscopy (VEGGIE METER™) allows assessment of carotenoids in humans that is non-invasive, cost-effective, and efficient.

Purpose: The goal of this study was to evaluate the impact of a high school garden and its curriculum on F/V intake among participants from baseline to follow-up using carotenoids as a biomarker.

Methods: In this 9-month intervention, 149 high school students (99% Hispanic, 54% male, age 14-19y) residing in El Paso, TX participated in classrooms using a school garden and related curriculum or control classrooms. Measures included reflectance spectroscopy for skin carotenoids (OD, optical density) and self-efficacy for F/V intake. Means were compared by paired t-test. Multiple linear regression analysis was used to determine if participation in the garden intervention predicted a change in F/V intake or self-efficacy, while controlling for sex, age, and baseline carotenoid levels and self-efficacy.

Results: There was no significant change in skin carotenoid levels in response to the intervention or in the control group (% change, control vs. garden: 4.0% vs. -2.6%, $p = \text{NS}$). There was also no change in self-efficacy for F/V intake (% change, control vs. garden: -1.4% vs. 4.8%, $p =$

NS). Multiple linear regression analysis to predict change in skin carotenoids including three predictors (intervention, sex, and age) was not significant ($R^2 = .039$, adjusted $R^2 = .001$, $F(3, 77) = 1.037$, $p = 0.4$). The analysis to predict change in self-efficacy for F/V intake including three predictors (intervention, sex, and age) was not significant ($R^2 = .039$, adjusted $R^2 = .009$, $F(3, 95) = 1.297$, $p = 0.3$). A small effect size was calculated for change in skin carotenoids and change in self-efficacy for F/V intake using Cohen's f^2 ($f^2 = 0.041$). Further regression analyses showed significance ($p < 0.05$), but only baseline carotenoids and baseline self-efficacy were significant predictors. Post-hoc qualitative analysis discovered that the curriculum in use did not target nutrition knowledge or behavior change related F/V intake.

Discussion: This study found no impact on F/V intake (as measured by a valid biomarker) or self-efficacy to eat F/V from participation in school garden activities. However, curriculum did not sufficiently target nutrition knowledge or behavior change. It is important to use behavior change theory in curriculum design for school-based approaches to increase F/V intake; exposure to F/V and a school garden alone is unlikely to impact intake. The ability to non-invasively measure carotenoids provides an objective tool for assessment of the impact of school garden programs on F/V intake.

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CHAPTER 1. INTRODUCTION

1.1 SUMMARY

The use of school gardens, as an educational tool to increase children's exposure to fruits and vegetables (F/V), has spread across the United States in the past decade. While studies have documented that this exposure can improve children's attitudes, knowledge, and preferences toward F/V (Lineberger & Zajicek, 2000; Morris & Zidenberg-Cherr, 2002; Lautenschlager & Smith, 2007; Parmer, Salisbury-Glennon, Shannon, & Struempfer, 2009), typically the primary goal is to increase F/V consumption among children. The need to increase F/V intake in children is noted by the Dietary Guidelines for Americans (2015-2020), Health People 2020 objectives, and the CDC (DeSalvo, Olson, & Casavale, 2016; US Department of Health and Human Services, 2015; Kim et al., 2014). Diets rich in F/V reduce the risk of heart disease, stroke, some cancers, type 2 diabetes, and can aid in weight management as a strategy to reduce obesity prevalence (Moore & Thompson, 2015; DeSalvo et al., 2016; US Department of Health and Human Services, 2015).

Globally, school garden interventions have been extensive and robust since the turn of the century. However, objective data of the impact of school gardens on F/V intake is lacking. Most studies to date have relied on self-report of F/V intake. Self-reporting of dietary intake is inherently an unreliable method for assessing F/V intake (Livingstone, Robson, & Wallace, 2004; Natarajan et al., 2006; Schoeller, Bandini, & Dietz, 1990). Carotenoids are a family of phytochemicals which are a reliable biomarker of dietary intake of F/V (Krinsky et al., 2000). Recent technological advances now make assessing carotenoids in humans non-invasive, cost-effective, and efficient (Mayne et al., 2010; Jahns et al., 2014). Current studies evaluating the impact of a school garden on students' F/V consumption have excluded high school populations

and are limited to self-reporting of dietary intake. This study looks at the impact of exposure to a school garden and its curriculum on F/V intake among high school students using carotenoids as a biomarker.

1.2 BACKGROUND

1.2.1 FRUITS AND VEGETABLES

High dietary intake of F/V is recommended due to their broad health benefits. Dietary guidance for F/V was originally set based on their vitamin [especially A and C (Krisnsky et al., 2000)], mineral, fiber (Slavin & Lloyd, 2012), and electrolyte content. More recently, health benefits of F/V are attributed to phytochemicals (Liu, 2004), such as carotenoids (Krinsky et al., 2000), which contribute to dietary vitamin A (Krinsky et al., 2000) and function as antioxidants (Lademann, Meinke, Sterry, & Darvin, 2011; Fiedor & Burda, 2014; Liu, 2004)

Most United States residents, including children (Kim et al., 2014), consume low levels of F/V (Moore & Thompson, 2015; Erinosh, Moser, Oh, Nebeling, & Yaroch, 2012; Liu, 2013). Because of the health benefits of F/V, and the association between learned dietary patterns during childhood and dietary habits later in life, promoting consumption of F/V in children is a public health priority.

1.2.1A HEALTH BENEFITS

Eating more F/V is widely recommended for their high nutrient density (namely in the form of carotenoids) and health benefits (US Department of Health and Human Services, 2010; Slavin & Llyoy, 2012; Liu, 2013; Beoing et al., 2012). A recent review of studies assessing the protective benefits of high intake of F/V indicate a lower risk of chronic diseases, CHD, and stroke (Rao & Rao, 2007; Moore & Thompson, 2015; DeSalvo et al., 2016; HealthyPeople.gov,

2017). There is also evidence that diets high in F/V are inversely associated with cancer (Boeing, 2012; Liu, 2004), macular degeneration and cataracts (Krinsky et al., 2000, Fiedor & Burda, 2014), skin aging (Lademann et al., 2011), and cardiovascular disorders (Fiedor & Burda, 2014). Health benefits of F/V and other plant foods are also related to the synergy of bioactive compounds, such as phytochemicals (Liu, 2004; Liu, 2013; Guitart, Pickering, & Byrne, 2014), reduced incidence of hypertension (Rao & Rao, 2007), and reduced oxidative stress (Fiedor & Burda, 2014)

1.2.1B DIETARY GUIDELINES AND CURRENT INTAKES

The Dietary Guidelines for Americans (2015-2020, eighth edition) recommend 4-12½ (½c servings) of F/V per day, for most children and adults (US Department of Health and Human Services, 2016). Table 1 represents the first 7 of 12 calorie level recommendations, with need corresponding to age and gender (Dietary Guidelines Advisory Committee, 2015).

Table 1. Recommended Amounts of Fruits and Vegetables by Calorie Level

Calorie Level of Pattern	1,000	1,200	1,400	1,600	1,800	2,000	2,200
Food Group	Daily Amount of Food From Each Group (vegetables and protein foods subgroup amounts are per week)						
Vegetables	1 c-eq	1½ c-eq	1½ c-eq	2 c-eq	2½ c-eq	2½ c-eq	3 c-eq
Dark-green vegetables (c-eq/wk)	½	1	1	1½	1½	1½	2
Red and orange vegetables (c-eq/wk)	2½	3	3	4	5½	5½	6
Legumes (beans and peas) (c-eq/wk)	½	½	½	1	1½	1½	2
Starchy vegetables (c-eq/wk)	2	3½	3½	4	5	5	6
Other vegetables (c-eq/wk)	1½	2½	2½	3½	4	4	5
Fruits	1 c-eq	1 c-eq	1½ c-eq	1½ c-eq	1½ c-eq	2 c-eq	2 c-eq

Source: Dietary Guidelines Advisory Committee, 2015

According to a 2010 study (surveyed from 2005-2009), Americans are consuming less than half the recommended servings for F/V (1.4 serving fruits and 2.2 servings vegetables per person per day) (State of the Plate, 2010). A 2015 study reports that U.S. F/V intake has declined in the period 2010-2014 (Lui, 2013; Produce for a Better Health Foundation, 2015). National per capita vegetable consumption has decreased 7% and fruit consumption, excluding fruit juice, has decreased 2% from 2009 to 2014 (Produce for a Better Health Foundation, 2015). The percentage of Texas adults reporting eating F/V five or more times per day in 2013 was 14.3% (Texas Department of State Health Services, 2013). In El Paso, Texas, 19.5 % adults reported consuming F/V five or more times per day in 2011, and that number was 11.4% in 2013, (Texas Department of State Health Services, 2013). Of note, self-report of F/V intake is usually over-estimated (Dhurandhar et al., 2015; Natarajan et al., 2006), indicating that actual intakes are probably lower.

A study using 1999-2002 National Health and Nutrition Examination Survey (NHANES) data revealed a large proportion of children aged 2-18 years fell below recommended fruit and vegetable intakes (Lorson, Melgar-Quinonez, & Taylor, 2009). Another study, using NHANES, assessed mean intakes of F/V in cup equivalents per 1,000 kcals (CEPC), at two different time periods from 2003-2010 (T₁=2003-04, T₂=2009-10). The findings show that children aged 2-18 years consumed between 0.55 (T₁) to 0.62 (T₂) CEPC of fruit, where one-half a small apple is equal to 0.51 CEPC. Total vegetable intake for these children, from the same period, was 0.54 (T₁) and 0.53 (T₂) (Kim et al., 2014). The National Cancer Institute reports among children aged 1 to 18 years, more than 60% did not consume the recommended fruit intake, and 93% did not meet vegetable recommendations for the period 2007 to 2010 (Intakes, Usual Dietary 2007).

Healthy People 2020 (HP 2020) has two main objectives for increasing the contribution of F/V in the diet for the population aged 2 years and older. The mean daily HP 2020 target for F/V, age adjusted, cup equivalents per 1,000 calories (CEPC) is 0.93 fruit and 1.16 vegetable. Baseline data (2005-08 and 2009-12) for fruit and vegetable intake fell considerably short of HP 2020 targets at 0.53 & 0.56 CEPC and 0.76 & 0.77 CEPC respectively (Healthy People.gov, 2016).

Relating ethnicity to F/V intake, Lorson et al., (2009) found that Mexican Americans ate more F/V in cup-equivalents than non-Hispanic Whites and non-Hispanic African Americans. From the period of 1999-2002 (NHANES), total F/V (cup equivalents) were higher in Mexican Americans than their ethnic counterparts (Lorson et al., 2009). Mean intakes of F/V for Mexican Americans were also higher for the entire time period of NHANES 2003-2010 compared to Black and White non-Hispanics (Kim et al., 2014).

1.2.2 COMMUNITY GARDENS

Community gardens were introduced as early as the turn of the 20th century in response to food shortages from the world wars (Englander, 2001). In the 1990's, funding became available to non-profit organizations, churches, and neighborhood beautification interests to reduce neighborhood violence and promote cultural traditions (Reischl, Alaimo, & Hutchinson, 2002). One such program that arose from this ideal was the community garden. Neighborhood gardens soon arose from neighboring communities joining forces to promote and cultivate unused land in shared neighborhood spaces. These gardens have since been substantiated in benefitting not just community cohesion, the ecology, and the social characteristics of the neighborhood built environment, but also the health and nutrition status of its residents (Glover, 2004; Armstrong, 2000; Alaimo, Packnett, Miles, & Kruger, 2008).

The success of community gardens in health promotion (Alaimo et al., 2008, Guitart et al., 2014), and the advent of public health interventions in schools to promote children's health, have prompted the introduction of school gardens and gardening curriculums in schools (Lautenschlager & Smith, 2007). Such efforts work to combat a series of issues related to children's health, including the overwhelming incidence of childhood obesity starting in the late 1990s (Cunningham, Kramer, & Narayan, 2014), the low intake of F/V among children (Lorson et al., 2009), and the research supporting that children's dietary habits are developed early in childhood (Craigie, Lake, Kelly, Adamson, & Mathers, 2011).

1.2.3 SCHOOL GARDENS

1.2.3A INTERVENTIONS

School gardens became popular in the 1990's (Blair, 2009) with mixed impact on F/V intake (Evans et al., 2012). For example, evidence suggests pre-school-age children (Nanney,

Johnson, Elliott, & Haire-Joshu, 2007; Calabra, Rayco-Solon, Solon, & Solon, 2011), elementary-age children (Parmer et al., 2009; Lautenschlager & Smith, 2007; Wang et al., 2010), and middle-school-age children (McAleese & Rankin, 2007; Lautenschlager & Smith, 2007) eat more F/V when they are exposed to school gardens. School garden interventions have spanned nearly all age groups of school-age children, with the exception of high school. Schools face increasing demands to improve students' academic performance and to intervene in promoting healthy living education. School garden interventions offer the opportunity to meet both demands simultaneously (Berezowitz, Bontrager Yoder, & Schoeller 2015). However, most school garden interventions study F/V intake predictors (attitudes, preferences and increased knowledge) as outcomes (Lineberger & Zajicek, 2000; Morris & Zidenberg-Cherr, 2002; Lautenschlager & Smith, 2007), rather than improve dietary intake of F/V (Parmer et al., 2009; McAleese et al., 2007; Wang et al., 2010).

1.2.3B CURRICULUM

School gardens are evolving as nutrition education tools in child academic settings. Study investigators use existing curricula such as, Pyramid Café and Health, Nutrition from the Garden (Parmer et al., 2009) and Nutrition in the Garden (Lineberger & Zajicek, 2000; McAleese & Rankin, 2007) to tie tangible garden experiences with nutrition education. Other interventions simply incorporate gardening components to nutrition lessons ('Garden-enhanced'), where the curricula rests with the nutrition education and not necessarily with an associated garden or hands-on garden instruction (Morris & Zidenberg-Cherr, 2002). Finally, Christian et al. evaluated a school garden intervention, led by the London-based Royal Horticultural Society (RHS), which believes that gardening activities, not integrated with nutrition education, can reinforce healthy messages about eating (Christian, Evans, Nykjaer, Hancock, & Cade, 2014).

Despite the curricula used, these intervention outcomes do not often equate to statistically significant increases in dietary F/V intake. Similarly, reliance on dietary self-reporting to validate school garden interventions is inherently biased and therefore lacks merit. School garden interventions that report increases in F/V intake among children are most often integrated with some level of nutrition education (NE) curriculum, where the garden (G) plus nutrition education (NE + G) resulted in increased F/V intake (Parmer et al., 2009; McAleese & Rankin, 2007; Wang et al., 2010).

1.2.3C BEHAVIOR CHANGE THEORY

Today, prominent contributors to morbidity and mortality are nutritionally-related behaviors that contribute to coronary heart disease, obesity, and type II, diabetes prevalence. Many effective public health interventions are therefore employing social and behavioral science theory to increase the effectiveness of health promotion practices. A growing body of evidence suggests that public health interventions designed around a strong theoretical framework are far more successful than those interventions lacking a theoretical base (Ammerman, Lindquist, Lohr, & Hersey, 2002; Glanz & Bishop, 2010). Although no single theory dominates current health promotion research, two theoretical models seem consistent among school garden curricula research: the theory of planned behavior (TPB) (Lautenschlager & Smith, 2007) and the social cognitive theory (SCT) (O'Brien & Shoemaker, 2006; Christian et al., 2014). The basic premise of SCT is that people learn not just from their own experiences but also from observing the experiences and actions of others. According to TPB, human action is guided by three beliefs (considerations): behavioral beliefs, normative beliefs, and controls beliefs. Specifically, behavioral beliefs produce a favorable or unfavorable attitude toward the behavior; normative

beliefs result in perceived social pressure or subjective norm; and control beliefs give rise to perceived behavioral control.

Of particular interest is the finding that while some studies using behavioral change theory (BCT) had no intervention success, the idea of success was not tied to the use of BCT in the intervention methodology. For example, O'Brien and Shoemaker (2006) assessed SCT in promoting F/V intake [also included were nutrition knowledge, F/V preference, self-efficacy, and outcome expectations for gardening] among student participating in an after-school gardening club. Conclusions of the study stated "This study did not increase vegetable preference, which contradicts reported research." The study cites other reported research that show increased vegetable preference but none used SCT in the methodology. It's therefore plausible to suggest that, according to O'Brien and Shoemaker (2006), success of such a study of this sort is not inclusive of BCT (SCT in this case) (O'Brien & Shoemaker, 2006). Further findings upon review of the literature are that BCT is not a common component of school-garden interventions.

1.2.4 EDIBLE EDUCATION

1.2.4A ORIGINATORS

Founded in Berkley, CA in 1995, the model of edible education was introduced on a one-acre garden and kitchen classroom for urban public school students at Martin Luther King, Jr. Middle School. This Edible Schoolyard Project was one of the first to apply the aspects of growing, harvesting, and preparing nutritious seasonal produce during the academic day and in after-school classes. Edible Education curriculum places the student at the center of learning, where developing knowledge, behavior, and skills is the focus from five core areas:

sustainability, communication, nourishment, academics, and life skills (Edibleschoolyard.org, 2017).

The Edible Education Framework has piloted and tested lessons and best practices for over 20 years. The curriculum of 62 lessons, designed for middle-school children, empowers students with the knowledge, skills, and opportunities to make healthy food choices while bringing academic subjects to life. Today, Edible Education 101, from UC Berkley, and the Edible Schoolyard Academy are the result of a world-renown, student-centered health promotion intervention that continues to shape the way children feel and behave about gardening and healthy food choices. Since 2009, more than 700 educators from 300 programs in 14 countries and 40 U.S. states have trained at the Edible Schoolyard Academy. Together, they teach over one million students each year (Edibleschoolyard.org, 2017).

1.2.4B LA SEMILLA FOOD CENTER

La Semilla Food Center was established in 2010 in Anthony Texas. Its conception evolved from a two-year community garden pilot project (2008-2009) that was funded by both a USDA grant and Youth Conservation Corp grant to purchase and build a large greenhouse. According to a La Semilla staff member, the projects goal was to promote youth development and food system education in Anthony and Chaparral, NM by paying youth stipends for work in the greenhouse. She added that the success of this pilot project evolved into La Semilla Food Center, a 501(c)3 nonprofit corporation, to advance as a garden-based educating entity, when it was awarded a seed money grant by the W.K. Kellogg Foundation (personal communication, March 9, 2017).

La Semilla uses the term Edible Education to describe their school-based garden and cooking activities; though the term is not entirely drafted from Berkley originators. However,

founders of La Semilla Food Center attended teacher workshops from Berkley's Edible Schoolyard and adapted and standardized the curriculum to meet the needs of the Border Region. These workshops, along with various gardening and curriculum methods from other sources, have led to the garden-based education curriculum that La Semilla uses today (personal communication, March 9, 2017). The goal of Edible Education is to increase students' excitement about food and education while inspiring healthier foods choices via lesson plans rooted in garden, nutrition, and cooking (La Semilla Food Center.org, 2017).

1.2.5 DIETARY REPORTING

1.2.5A SELF-REPORTING BIAS

Bias is “The lack of internal validity or correct assessment of the association between an exposure and an effect in a target population” (Delgado-Rodriguez & Llorca, 2004). Bias results in the overestimation or underestimation of the association between exposure and disease or outcome. Self-reporting of dietary intake has long been cause for concern among researchers due to inherent biases and stigma correlated to energy/nutrient intake reporting (Natarajan et al., 2006; Dhurandhar et al., 2015)

Social desirability responding is the tendency for participants to present favorable images of themselves (Johnson, Fendrich, & Hubbell, 2002). Social desirability responding is most often associated with socially sensitive questions. The conscious or subconscious need for social approval when reporting dietary intakes can lead to both under reporting of energy dense foods and/or over reporting of healthy foods, such as F/V. Energy intake (EI) under-reporting is most common among obese, dieting, and weight conscious subjects (Livingstone et al., 2004). More specifically, given the social stigma correlated with body weight and image, often pervasive among adolescents, especially girls, there is an overwhelmingly high level of EI under-reporting

among obese teens and adolescents than obese children. The extent of this age-related bias in reporting is highlighted in the following: 40% of EI in obese adolescents may go unreported (Bandini, Schoeller, Cyr, & Dietz, 1990) compared with 25% in 10-year-olds (Champagne, Baker, DeLANY, Harsha, & Bray, 1998), and 14% in 6-year-olds (McGloin et al., 2002). According to Fisher, Johnson, Lingquist, Birch, and Gorman (2000), Champagne et al. (1998), and McGloin et al. (2002), body fatness is a predictor of under-reporting. Conversely, when reporting EI, those that over-reported were lighter in body weight and had less body fat (Fisher et al., 2000).

The long-standing prevalence of obesity and its associated social stigma has prompted researchers to stay abreast of the psychological forces inherent among certain populations when reporting dietary intake. However, self-reporting bias can affect all study participants in all age groups (Livingstone et al., 2004; Natarajan et al., 2005). Unfortunately, reporting instruments like 24-hour recall, diet history, and food frequency questionnaire (FFQ) are lengthy, time-consuming tools. Consequently, other biases in reporting are notable, such as the effects of age on reporting validity. For example, the age, and thus cognitive ability of children is not developed enough to accurately estimate food amounts or recall foods eaten outside 24 hours (Livingstone et al., 2004). Additionally, the responsibility of a child's reporting is often left to parents and caregivers that have less access to unsupervised eating both in and out of the home. The later could lead to a willful failure by anyone, including parents and caregivers, to misrepresent children's dietary intake due to inconvenience or time constraints (Livingstone et al., 2004).

1.2.5B BLOOD BIOMARKERS OF FRUITS AND VEGETABLES

Carotenoids are a family of pigmented compounds synthesized by organisms such as bacteria, fungi, and plants that are capable of conducting photosynthetic processes (Landrum, 2009). Therefore, carotenoids are only found in human tissues via dietary intake and almost exclusively from F/V and other plant foods (Lademann et al., 2011). Although there are between 40-50 commonly consumed carotenoids found in U.S. F/V, there is a select group of carotenoids normally found in human tissues (Khachik, 2006). Carotenoids most prevalent in the North American diet and of particular interest in this study include: α -carotene, β -carotene, lycopene, lutein, zeaxanthin, and β -cryptoxanthin (Figure 1). In humans, carotenoids function as antioxidants and serve as a source of vitamin A (Krinsky et al., 2000). Beta carotene is enzymatically converted into vitamin A, which impacts diseases specific to vitamin A deficiencies (Landrum, 2009). Also, carotenoids are photo protectors for all living organisms. This quality is specific to their ability to absorb light and is related to their extensive system of conjugated double bonds within their chemical structure (Fiedor & Burda, 2014). Carotenoids have been associated with antioxidant activity. For example, as quenchers of singlet oxygen, they are protectors of UV light exposure (Fiedor & Burda, 2014; Lademann et al., 2011; Landrum, 2009). Studies show that high antioxidant activity in humans, found often with high levels of blood carotenoids, exhibit a lower risk of some chronic diseases due to their chemical quenching for oxygen radicals (Figure 2) (Fiedor & Burda, 2014; Rao & Rao, 2007; Landrum, 2009). Blood concentrations of carotenoids are the best biological biomarker of F/V intake (Krinsky et al., 2000). Typically, F/V of a yellow to red color range and many dark green vegetables are rich in such carotenoids.

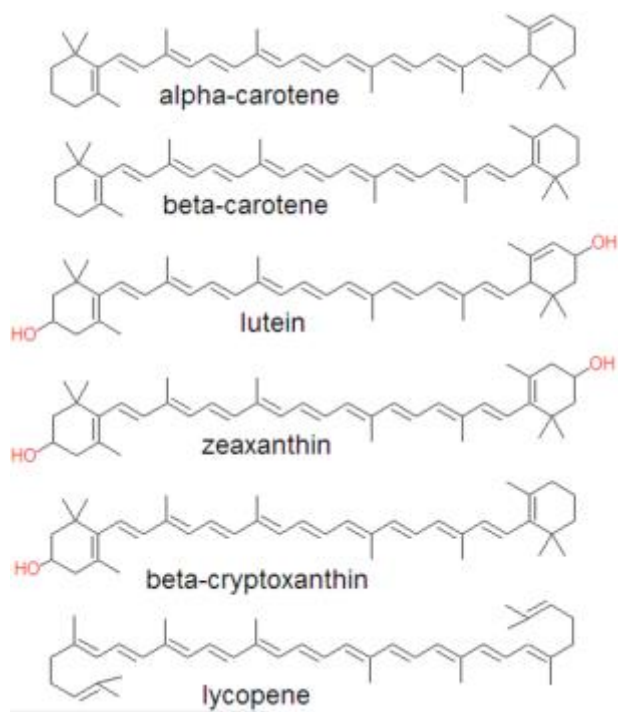


Figure 1. Common Carotenoids of North America (Image Source: David E. Volk)

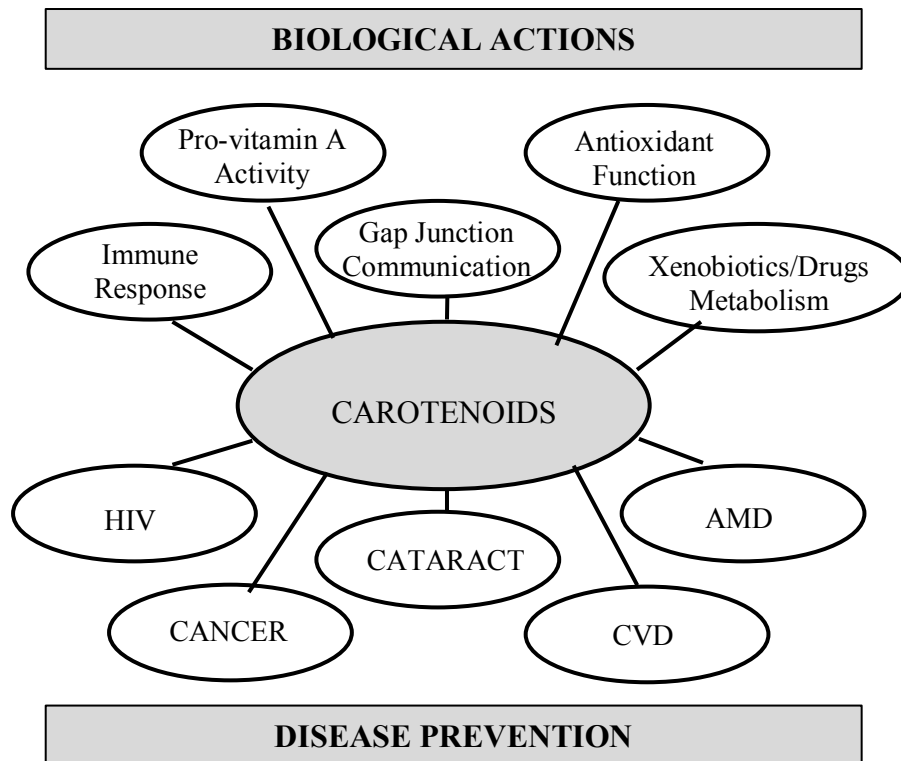


Figure 2. Role of carotenoids in the prevention of chronic diseases (Landrum, 2009).

1.2.5C SKIN BIOMARKERS OF FRUITS AND VEGETABLES

Of increasing importance for community-based and population-level interventions are objective, non-invasive, and inexpensive carotenoid biomarkers to evaluate F/V intake. In spite of its invasiveness and costly process, blood carotenoid concentrations have remained the gold standard to assess fruit and vegetable intake in humans (Krinsky et al., 2000). Recently however, studies have suggested the use of skin carotenoid assessment as a reliable, non-invasive, expedient, and inexpensive biomarker for F/V intake. In studies assessing skin carotenoids using Resonance Raman spectroscopy (RRS) versus blood carotenoids using high-performance liquid chromatography (HPLC) analysis of plasma, it was found that RRS is equally effective at

predicting F/V intake as the HPLC method (Mayne et al., 2010; Jahns et al., 2014). Reflection spectroscopy (RS), referred to as the VEGGIE METER™ (VM) (Figure 3), is the newest non-invasive method for assessment carotenoids in human skin. Unlike RRS, which uses complex argon laser detection and requires painstaking calibration, RS uses light emitting diode (LED) optical detection and requires little calibration (Ermakov, Ermakova, Rosenberg, & Gellermann, 2013). Darwin and colleagues measured human skin carotenoids using both RS and RRS and determined a strong correlation between carotenoid concentrations determined by either method (Darvin et al., 2012)

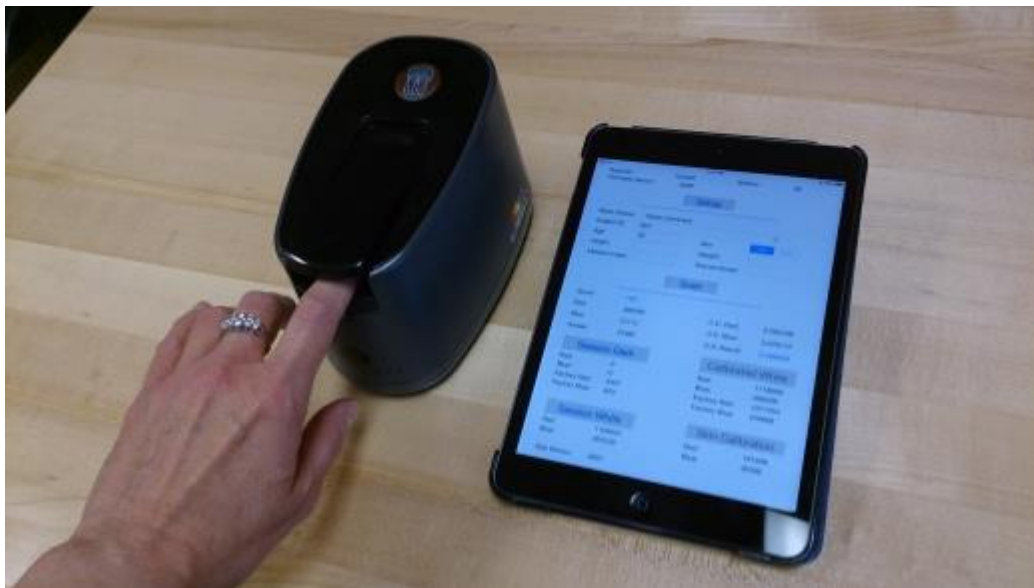


Figure 3. VEGGIE METER™ with tablet software companion (Source: Institute for Healthy Living).

CHAPTER 2. OBJECTIVES AND SPECIFIC AIMS

The overall goal of this study is to determine the impact of exposure to a school garden and its curriculum on F/V intake among student using carotenoids as a biomarker.

SPECIFIC-AIM 1

To determine if participation in a high school garden curriculum impacts F/V intake.

HYPOTHESES

H1A

Students who participate in a school garden curriculum (intervention group) will increase F/V intake from baseline to follow-up as measured by RS.

H1B

Students who do not participate in a school garden curriculum (control group) will not increase F/V intake from baseline to follow-up as measured by RS.

H1C

The change in F/V intake from baseline to follow-up among the intervention group will be greater than the change in F/V between baseline to follow-up among the control group.

SPECIFIC-AIM 2

To determine if participation in a school garden curriculum changes self-efficacy to consume F/V.

HYPOTHESES

H2A

Students who participate in a school garden curriculum (intervention group) will increase self-efficacy for F/V intake from baseline to follow-up.

H2B

Students who do not participate in a school garden curriculum (control group) will not increase self-efficacy for F/V intake from baseline to follow-up.

H2C

The change in self-efficacy for F/V intake between baseline to follow-up among the intervention group will be greater than the change in self-efficacy for F/V intake between baseline to follow-up among the control group.

CHAPTER 3. METHODS AND MATERIALS

3.1 STUDY DESIGN

The parent study is a quasi-experimental design (treatment assignment was based on class enrollment, not random) with a primary objective to evaluate the impact of a high school garden and its curriculum on F/V intake using changes in carotenoids as a biomarker. Additional objectives of the primary study included psycho-social constructs, focus groups, media analysis, and force-field analysis. The focus of this thesis is to use secondary analysis to compare changes in carotenoids as a biomarker of changes in total F/V intake and changes in self-efficacy to consume F/V. Data were collected from participants at baseline (early fall) and at the end of the 9-month intervention (follow-up). Participants included in this study are Bowie High School students, primarily of Hispanic ethnicity, residing in El Paso, Texas. Institutional review board approval for the parent study was given by both the University of Texas at El Paso (UTEP) and the El Paso Independent School District (EPISD).

3.2 STUDY SITE

The city of El Paso, Texas is located on the U.S-Mexico border and within the greater metropolitan area of the Paso del Norte Region. With a population of 2.4 million, this bi-national region is one of the largest international border-cross areas of the world (OECD, 2010). According to the 2015 U.S Census, there are an estimated 681,124 residents in the city of El Paso, Texas (U.S. Census, 2015). Of the total population, 80.7% classify themselves as Hispanic or Latino descent, 52% are female, and 29.1% are persons under the age of 18 years old (U.S. Census, 2010). This study was conducted at Bowie High School, which is located in the Chamizal neighborhood in the South-Central part of the city of El Paso. Located within 100 yards of the U.S-Mexico border, the school serves Downtown El Paso and the western half of

South-Central El Paso. In 2015, the student body population of Bowie High School was 1,205 students, of which 99% were Hispanic and 48% were female (Public School Review, 2017). Student body population in 2015, broken down by grade, are as follows: 9th = 326; 10th = 364; 11th = 268; 12th = 247 (Public School Review, 2017).

3.3 STUDY PARTICIPANTS

The study consisted of 8 classes: 3 control group classes and 5 intervention group classes. Of the 192 students in these 8 classes, 157 assented/consented to participate. Of the 157, 138 completed the survey at baseline, and 149 completed VEGGIE METER™ (VM) at baseline. Table 2 shows the percentage of students by exposure at baseline and follow-up. At follow-up, 102 completed the survey, and 85 completed VM. Study participants were between the ages of 14 and 19 and were all enrolled as Bowie High School students during this study.

Table 2: Number of students (percent) by intervention exposure at baseline and follow-up

	Baseline VM	Baseline Survey	Follow-up VM	Follow-up Survey
Control	57 (38%)	54 (39%)	40 (47%)	49 (48%)
Exposure (LD)	33 (22%)	27 (20%)	13 (15%)	11 (11%)
Exposure (HD)	59 (40%)	57 (41%)	32 (38%)	42 (41%)

LD indicates low dose (Env. Tech class)

HD indicates high dose (Plant & Soil class)

Three intervention group classes were offered via Advanced Plant and Soil Science and two intervention group classes were offered via Advanced Environmental Technology. Three control classes, via algebra 1, had no formal exposure to the garden, nor garden curriculum, and were instructed by the same teacher offering the Plant and Soil Science intervention group.

Table 3 details the teacher, exposure, subject, and class period of participants in this study. All study group classes were 2-semester courses.

Table 3: Study group description by exposure and subject

Exposure	Subject	Class
Intervention	Plant & Soil	Period 1
Intervention	Plant & Soil	Period 2
Control	Algebra	Period 3
Control	Algebra	Period 4M
Intervention	Env. Tech	Period 4L
Intervention	Env. Tech	Period 5
Control	Algebra	Period 7
Intervention	Plant & Soil	Period 8

Among baseline survey data, 22.0% are 9th grade, 27.3% are 10th grade, 15.9% are 11th grade, and 34.8% are 12th grade students, 54.8% of participants are male, and the mean age of students ranging from 14 to 19 years old was 16.1 years. Table 4 represents student demographics by exposure group. Bowie High School is a traditional 9th through 12th grade campus.

Table 4: Student's demographics by exposure group

	Control	n	Intervention LD	n	Intervention HD	n
Age*	14.95 (14.75-15.14)	56	16.25 (15.38-17.12)	20	17.17 (16.98-17.40)	58
Sex (M)**	31 (55.4)	56	9 (42.9)	21	34 (58.6)	58
Grade**		55		20		57
9 th	22 (40.0)		7 (35.0)		0	
10 th	33 (60.0)		3 (15.0)		0	
11 th	0		1 (5.0)		20 (35.1)	
12 th	0		9 (45.0)		37 (64.9)	
Hispanic**	55 (98.2)	56	20 (100)	20	57 (98.3)	58
Race**		54		20		57
Am. I or AN	3 (5.6)		0		1 (1.8)	
Asian	2 (3.7)		0		0	
B or A. Am.	1 (1.9)		0		0	
NH or PI	0		0		0	
White	20 (37.0)		12 (60.0)		34 (59.6)	
No answer	28 (51.8)		8 (40.0)		22 (38.6)	

* indicates mean (CI)

** indicates n (% of exposure group)

LD & HD = low dose & high dose intervention exposure

Am. I or AN = American Indian or Alaskan native

B or A. Am. = Black or African American

NH or PI = Native Hawaiian or other Pacific islander

No answer = Prefer not to answer

3.4 DATA COLLECTION

F/V data was collected at two time points during the 2015-16 Bowie school year: Oct 2015 and June 2016. Participants for the current analysis, n=149, were tested with VM at the same hour (class period) for all time points. Students' data were collected by a team of qualified personnel from the Paso del Norte Institute for Healthy Living. The team followed VM validation techniques by asking a series of 3 questions related to staining of the testing finger (1. Have you eaten Takis, Cheetos, or Doritos in the past 24-hours? 2. Do you smoke? 3. Does anyone you live with smoke?) and 2 questions related to smoking and exposure to smoke.

Further, specialized cleaning techniques and finger selection (based on hand dominance) were required prior to testing.

Self-efficacy (SE) questions were created using protocols from the Integrated Behavioral Model (IBM) and were asked via a student survey at baseline and follow-up (Baranowski et al., 2000). Answers to question were based on a 6-point Likert scale from “strongly disagree” to “strongly agree” for questions 1 and 2 and “very difficult” to “very easy” for question 3.

Questions include: 1) In the next month, I have complete personal control over eating more F/V if I really wanted to do so; 2) Eating more F/V is mostly up to me in the next month if I wanted to do so; 3) Eating more F/V over the next month if I wanted to do so would be (Bowie Jardín Student Survey (Appendix 1), 2015).

All participant names were replaced with ID numbers. Confidential, de-identified data was maintained and stored through the secure PiLR web service used by the Institute for Healthy Living. All participant information, including surveys, signed consent forms, and VM data, was synched with the PiLR web service for storage, management, and analysis.

3.5 CURRICULUM

Instruction was divided into classroom and garden time for both exposure groups (Plant and Soil Science and Environmental Technology). The Advanced Plant and Soil Science, (Text: Plant & Soil Science: Fundamentals & Applications. Parker 1st Edition. [Skills, 2010]), is Texas Education Agency (TEA) approved. This class incorporated hands-on garden exposure to help emphasize instruction from the text. Garden exposure was typically 3-5 times per week, depending on climate. Garden activities, such as basic composting (Vermont Dept. of Education, 2011), planting F/V according to a seasonal circle (Nourishlife.org, 2017), and local food systems (Cultivando Tradición, 2010) were derived from curricula-driven materials. A garden

coordinator maintained the garden and provided students with additional hands-on instruction when visiting the garden. The garden coordinator was instrumental in providing freshly picked F/Vs for class tastings for the students during class time. Examples of tastings offered were: arugula salad with dried herbs, a variety of different F/V smoothies, and candies made from Amaranth. Tastings were prepped and created as a collaborative experience among students and instructor. Neither curricula included any nutrition education nor did they integrate behavior change theory to target changes in behavior in the students. Though tastings offered the greatest health context to F/V intake for this intervention, they were not associated with behavioral change theory. The Advanced Environmental Technology class has less garden exposure, limited to approx. 2-4 times per month, depending on climate, and less garden curriculum exposure.

3.6 INFORMED CONSENT PROCESS

Study staff explained in detail the study objectives, potential risks and benefits, and requirements to prospective participants. Those who indicated a willingness to participate and submitted signed student assent and parent or guardian consent forms were included in the study. Only after receipt of such forms from participants did data collection begin.

3.7 REFLECTANCE SPECTROSCOPY PROTOCOL

Skin carotenoids were measured using reflectance spectroscopy (VM). Measurements were conducted indoors and away from direct sunlight. Participants were matched to the same VM and also use the same testing finger for all testing time points. VEGGIE METERS™ were calibrated to manufacturers specifications prior to each testing session and will be re-calibrated if the instrument goes into sleep mode (turns off). VEGGIE METERS™ will be cleaned with the specified material and solution prior to each test.

3.8 DATA ANALYSIS

All quantitative variables were cleaned and analyzed using SPSS v22. Descriptive statistics were conducted to include sample size (n), mean, frequencies, and percentages. Continuous variables in this study include skin carotenoids and self-efficacy. Variables in this study include sex, age, and intervention (exposure variable). All continuous variables were assessed for normality using symmetry, skewness, and kurtosis. Dependent variables were skin carotenoids and self-efficacy. Independent variables include intervention, sex, age, and the baseline variables for skin carotenoids and self-efficacy for analysis models regressing to the mean.

Mean difference between baseline and follow-up carotenoids were analyzed with a paired t-test using unequal variances. Two models were analyzed by multiple linear regression to determine if exposure to a school garden and related curriculum increases F/V intake (as measured by changes in skin carotenoid levels) while controlling for baseline carotenoid levels, sex, intervention, and age.

Self-efficacy was analyzed using the imputed average of the 3 survey questions which created a single Self-Efficacy Integrated Behavioral Model (IBM) variable. This variable has already been tested for reliability (Cronbach's $\alpha > 0.7$). Mean difference between baseline and follow-up self-efficacy were analyzed with a paired t-test using unequal variance. Two models were analyzed by multiple linear regression to determine if exposure to a school garden increases self-efficacy while controlling for baseline self-efficacy, sex, intervention, and age.

3.9 POST HOC QUALITATIVE COLLECTION

Due to lack of impact of quantitative outcomes, qualitative methods were employed to investigate the robustness of the intervention and determine other factors that influenced primary

outcomes. The focus of these methods was to document the source and details of the curriculum used in this intervention. Post hoc in-personal and phone interviews were conducted with responsible parties to gain insight into the origins and credibility of the curriculum and the confounders that shaped the results of the parent study.

CHAPTER 4. RESULTS

There was no significant change in skin carotenoid levels during the study in either group (% change, control vs. garden: 4.0% vs. -2.6%, $p = \text{NS}$). There was also no change in self-efficacy for F/V intake (% change, control vs. garden: -1.4% vs. 4.8%, $p = \text{NS}$). Figure 4 shows the difference between exposure groups between baseline and follow-up for skin carotenoids and self-efficacy. Figure 4 shows the mean change between baseline and follow-up for skin carotenoids and self-efficacy.

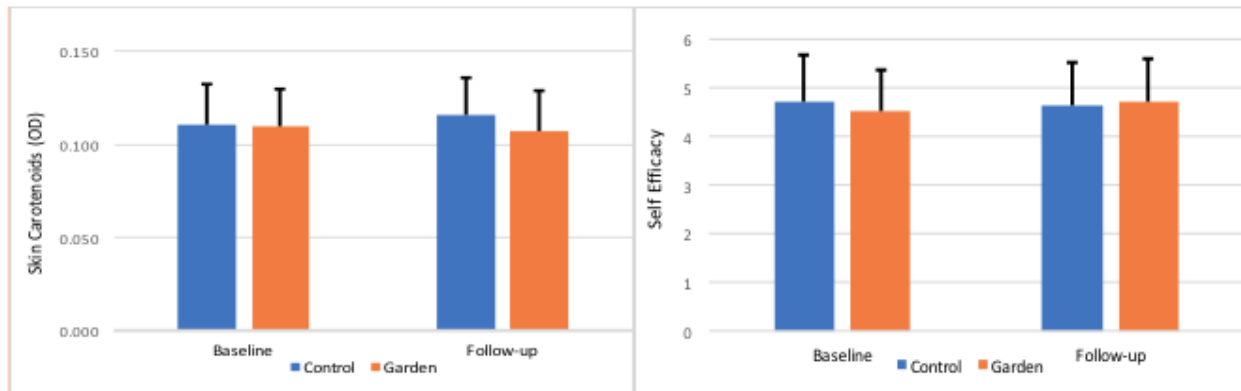


Figure 4: mean and SD at baseline and follow-up for skin carotenoids and self-efficacy among exposure groups

Two multiple linear regression analyses were conducted to predict change in skin carotenoids. Model 1 included four predictors (intervention, sex, baseline carotenoids, and age). Model 2 did not include baseline carotenoid and included three predictors (intervention, sex, and age). Table 5 shows the model summary for both regression analyses. Model 1 was significant, $R^2 = 0.145$, adjusted $R^2 = 0.100$, $F(4, 76) = 3.231$, $p = 0.017$. However, Model 2 was not significant, $R^2 = 0.039$, adjusted $R^2 = 0.001$, $F(3, 77) = 1.037$, $p > .05$. Therefore, Model 1 (including baseline carotenoids) is a better predictor for participants' change in skin carotenoids. Additionally, effect size was calculated for both models using Cohen's f^2 . Model 1 has a medium effect size (0.17) and Model 2 has small effect size (0.041).

Table 5: Regression summary of two predictor models of skin carotenoids

Model Summary^a						
	R	R Square	Adjusted R Square	F	p-value	Cohen's f^2
Model 1 ^b	0.318	0.145	0.100	3.231	0.017	0.17
Model 2 ^c	0.197	0.039	0.001	1.037	0.381	0.041

a. Dependent Variable: Difference from baseline follow-up

b. Predictors: Intervention, Sex, Baseline Skin Carotenoids Result, Age

c. Predictors: Intervention, Sex, Age

Next, the analyses for change in skin carotenoid predictor variables within each model reveal that, in Model 1, only baseline carotenoids were significant at predicting change in skin carotenoids from baseline to follow-up, $p = 0.003$. Table 6 illustrates individual predictor variables for both models.

Table 6: Multiple linear regression predictor variables for change in skin carotenoids

Individual Variables (Model 1)							
	Mean	SD	B	Std. Error	Beta	t	p-value
Age	15.69	1.291	-0.003	0.002	-0.219	-1.332	0.187
Sex	N/A	N/A	-0.003	0.004	-0.089	-0.830	0.409
Baseline O.D.	0.11	0.019	-0.311	0.101	-0.331	-3.077	0.003
Intervention	N/A	N/A	0.001	0.003	0.075	0.452	0.653
Individual Variables (Model 2)							
	Mean	SD	B	Std. Error	Beta	t	p-value
Age	15.69	1.291	-0.003	0.002	-0.221	-1.276	0.206
Sex	N/A	N/A	-0.005	0.004	-0.127	-1.132	0.261
Intervention	N/A	N/A	0.002	0.003	0.114	0.653	0.516

According to the analyses for change in skin carotenoids, the following hypotheses are rejected:

HIA – Students who participate in a school garden curriculum (intervention group) will increase F/V from baseline to follow-up as measured by RS

HIB – Students who participate in a school garden curriculum (control group) will not increase F/V from baseline to follow-up as measured by RS

HIC – The change in F/V intake from baseline to follow-up among the intervention group will be greater than the change in F/V intake between baseline to follow-up among the control group.

Two multiple linear regression analyses were conducted to predict change in self-efficacy to eat F/V. Model 1 included four predictors (intervention, sex, baseline self-efficacy, and age). Model 2 did not include baseline self-efficacy and included three predictors (intervention, sex,

and age). Table 7 shows the model summary for both change in self-efficacy regression analyses. Model 1 was significant, $R^2 = 0.369$, adjusted $R^2 = 0.342$, $F(4, 94) = 13.751$, $p < 0.001$. However, Model 2 was not significant, $R^2 = 0.039$, adjusted $R^2 = 0.009$, $F(3, 95) = 1.297$, $p = 0.280$. Therefore, Model 1 is the better predictor for participants' change in self-efficacy. Additionally, effect size was calculated for both models using Cohen's f^2 . Model 1 has a large effect size (0.59) and Model 2 has small effect size (0.041).

Table 7: Regression summary of two predictor models for self-efficacy

Model Summary^a						
	R	R Square	Adjusted R Square	F	p-value	Cohen's f^2
Model 1 ^b	0.608	0.369	0.342	13.751	0.000	0.585
Model 2 ^c	0.198	0.039	0.009	1.297	0.280	0.041

a. Dependent Variable: Difference from baseline to follow-up

b. Predictors: Intervention, Sex, Baseline SE Result, Age

c. Predictors: Intervention, Sex, Age

Next, the analyses for change in self-efficacy predictor variables within each model reveal that, in Model 1, only baseline self-efficacy was significant at predicting change in self-efficacy from baseline to follow-up, $p < 0.001$. Table 8 illustrates individual predictor variables for both models.

Table 8: Multiple linear regression predictor variables for change in self-efficacy

Individual Variables (Model 1)							
	Mean	SD	B	Std. Error	Beta	t	p-value
Age	15.89	1.369	-0.078	0.086	-0.114	-0.904	0.368
Sex	N/A	N/A	-0.154	0.155	-0.082	-0.997	0.321
Baseline SE	4.561	0.978	-0.555	0.079	-0.580	-7.010	0.000
Intervention	N/A	N/A	0.176	0.123	0.180	1.432	0.156
Individual Variables (Model 2)							
	Mean	SD	B	Std. Error	Beta	t	p-value
Age	15.89	1.369	-0.038	0.105	-0.056	-0.361	0.719
Sex	N/A	N/A	-0.291	0.189	-0.155	-1.544	0.126
Intervention	N/A	N/A	0.149	0.151	0.152	0.985	0.327

According to the analyses for change in self-efficacy for F/V intake, the following hypotheses are rejected:

H2A – Students who participate in a school garden curriculum (intervention group) will increase F/V self-efficacy from baseline to follow-up.

H2B – Students who participate in a school garden curriculum (control group) will not increase F/V from baseline to follow-up as measured by RS

H2C – The change in self-efficacy for F/V intake from baseline to follow-up among the intervention group will be greater than the change in self-efficacy for F/V intake between baseline to follow-up among the control group.

Post hoc in-person and phone interviews with key personnel indicated three primary intervention barriers: 1) the intended curriculum was not implemented, 2) the curriculum that was used did not address nutrition or F/V intake, and 3) no behavior change theory was integrated into the curriculum to align with the intended outcome of increased F/V intake and self-efficacy.

CHAPTER 5. DISCUSSION

Using a reliable biomarker of F/V intake, this study found no impact on F/V intake in students in classrooms participating in a high school garden and garden-related curriculum. These results align with studies using self-report methods to evaluate the ability of school garden interventions to increase F/V intake (Robinson-O'Brien, Story, & Heim, 2009; Lineberger & Zajicek, 2000; Lautenschlager & Smith, 2007; Christian et al., 2014; Morgan et al., 2010). Notably, most school garden interventions assess F/V intake predictors (rather than actual intake), such as preference, knowledge of, willingness to taste, and attitudes toward F/V (Lineberger & Zajicek, 2000; Morris & Zidenberg-Cherr, 2002; Lautenschlager et al., 2007). Of the few school garden studies measuring F/V intake three found a significant increase in intake of F/Vs (Palmer et al., 2009; McAleese et al., 2007; Wang et al., 2010). However, as opposed to this study, which used a valid biomarker to measure F/V intake, these previous studies used self-report to measure F/V intake.

As with F/V intake, this study found no impact of a high school garden and garden-related curriculum on self-efficacy for F/V intake. Self-efficacy is among the psychosocial factors most consistently associated with higher F/V consumption (Contento, Randell, & Basch, 2002). Studies targeting self-efficacy outcome measures for school garden interventions are limited; two studies are highlighted here. In one study, students exposed to a moderate dose, two or more (six total) components of the school garden intervention, produced significant changes in self-efficacy to eat more F/V (Evans et al., 2012). Conversely, self-efficacy for F/V consumption in another study was not significant between baseline and end-program (O'Brien & Shoemaker, 2006).

Post hoc qualitative evaluation revealed the lack of intended curriculum implementation, as well as a replacement curriculum that did not include nutrition content or use behavior change theory. The application of theory in dietary behavior change is mainstream; a systematic review

of behavior change theories used in public health interventions concluded that interventions based on theory were more effective at causing behavior change than those not using theory (Glanz & Bishop, 2010). However, many school garden study publications do not indicate that behavior change theory has been explicitly used. Often in public health programming, behavior change theory is not correctly applied (Brug, Oenema, & Ferreira, 2005). In addition, in the case of F/V intake, inadequate methods for assessing changes in intake (e.g. self-report of intake) make it impossible to confirm if changes in psychosocial outcomes are associated with actual changes in behavior.

A major strength of the present study was the use of a valid biomarker to objectively assess skin carotenoid status given that reliance on self-report of dietary intake is inherently biased. Additionally, the biomarker was comparatively less-expensive and non-invasive compared to analysis of blood carotenoids. Also, this study targeted a high school demographic, which is uncharacteristic of school garden interventions. Future research targeting a high school demographic is needed.

Limitations of this study included lack of implementation of intended curriculum, as noted above. In addition, the quasi-experimental design of this study resulted in some limitations. Participants were not randomized and the control group was located at the same school and therefore still exposed to the garden. Also, there were differences in grade level between control and intervention classes, where the control group consisted of 9th and 10th grade students. Lastly, qualitative evaluation revealed a considerable difference in garden exposure between the plant and soil science and environmental science intervention classes – a difference that was non-quantifiable in data analysis.

As with many school garden interventions, our study found no impact on F/V intake or self-efficacy for F/V intake. This study strengthens the existing evidence because an objective biomarker of intake was used. Further investigation into reasons for lack of intended outcomes indicated implementation and alignment of curriculum with health outcomes and behavior change were primary barriers.

CHAPTER 6. MPH CORE COMPETENCIES

Among the core competencies that shape the curriculum and student learning activities for the Masters of Public Health (MPH) Program at the University of Texas at El Paso (UTEP), this thesis project used 5 competencies to help shape its research methodologies and research practices.

6.1 BIOSTATISTICS

The application of biostatistics employs statistical and methodological reasoning in the areas of public health, clinical and population-based research, healthcare, and biomedical industries. The application of statistical analysis for this school garden data was more efficient and effective after exposure to this MPH program. From data collection, data entry, cleaning, analysis, interpretation, to reporting, a strong biostatistical understanding was employed to present this study in the interest of scientific expectations.

6.2 EPIDEMIOLOGY

Epidemiology is the study of disease and injury patterns in human populations while using the application of this study to control health problems. This school garden study harnessed many components from the epidemiological process and helped increase the understanding and relevance of the scientific process. Components adopted include first-hand exposure to: 1) the principals and limitations of public health screenings and qualitative data collections, 2) constructing, rationalizing, and evaluating the strengths and limitations of public health studies, 3) drawing appropriate inferences from public health data in spite of rejected hypotheses, 4) understanding ethical considerations at all points of the study process and learning

to report such considerations appropriately, and 5) realizing the importance of a well-planned and crafted study methodology to serve as the blueprint for the study process.

6.3 SOCIAL AND BEHAVIORAL SCIENCES

According to the UTEP MPH handbook, public health integrates social and behavioral sciences by addressing the behavioral, social, and cultural factors related to individual and population health and health disparities over the life course. This behavior change intervention required much understanding of different constructs and outcomes of behavior change science. Literature review, and this study's practical associations, gave me insight to better interpret other studies centered on social and behavioral science; and possibly create my own behavior change interventions. However, it also helped me realize the fluidity of science that results from questioning previously accepted ideals and theories; that such fluidity helps great thinkers build upon the ideas of previous great thinkers. This notion of scientific evolution was most obvious in my research of behavior change theory and how we may be better at dispensing theory than at practical application of the theory – we're good at offering *what* we need to change but not so effective at showing *how* we need it to be changed.

6.4 HISPANIC AND BORDER HEALTH

The Paso del Norte region is esteemed for its studies on Hispanic and Border Health. However inadvertent, living in this area offers one the experience of the Hispanic community. Working in public health and being exposed to the cultural and social diversities of the community, in El Paso and Ciudad Juarez, gives one the ideal landscape to put practical application to those theoretical border health ideals that are reinforced in the MPH program. This thesis gave additional perspective to Hispanic and border communities since the population was overwhelmingly Hispanic. The events, considerations, and strategies that helped construct this

study design were centered around Hispanic culture, such as food tastings for the garden, participant surveys, and culturally sensitive verbiage used during focus groups and other qualitative measures.

6.5 ENVIRONMENTAL HEALTH SCIENCES

These sciences represent the study of environmental factors such as biological, chemical, and physical that affect the health of the community. This study addressed specific approaches to assessing, preventing and controlling environmental hazards that pose risks to human health and safety by reducing the use of chemical pesticides in the garden and instead using natural predators, or beneficial bugs, such as ladybugs to fight garden pests. Additionally, the construction of the garden used water conservation construction efforts and recycled materials.

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APPENDIX 1

15.02.Bowie 2015 Student Survey

Q1.1 Subject ID (The number on your wristband, including the dashes)

Q1.2 Your subject ID must be verified by one of the data collectors before you continue on the next page. Please raise your hand so we can come check that it has been entered right. If it is not verified before you continue, you will need to start the survey over.

Q39 Time Point

- ☐ Time 1 (Fall) (1)
- ☐ Time 2 (Spring) (2)

Q2.1 Thanks for helping us today! We would like to ask a few questions about the Bowie Garden and what you think about fruits and vegetables.

Q2.2 How often have you participated in the garden at your school?

- ☐ Never (1)
- ☐ 1-2 Times (2)
- ☐ Once a Month (3)
- ☐ Several Times per School Year (4)
- ☐ About once a month (5)
- ☐ Multiple times per month (6)

Q2.3 Over the next 10 days, how many times do you expect to eat fruits and vegetables?

Q2.4 Please choose the appropriate box to complete each sentence:

Q2.5 I am ____ to eat more fruits & vegetables over the next 30 days

- ☐ Very unmotivated (1)
- ☐ Unmotivated (2)
- ☐ Somewhat unmotivated (3)
- ☐ Somewhat motivated (4)
- ☐ Motivated (5)
- ☐ Very motivated (6)

Q2.6 I am ____ to eat more fruits & vegetables over the next 30 days

- ☐ Very undetermined (1)
- ☐ Undetermined (2)
- ☐ Somewhat undetermined (3)
- ☐ Somewhat determined (4)
- ☐ Determined (5)
- ☐ Very determined (6)

Q2.7 Please choose the appropriate box to complete each sentence:

Q2.8 Eating more fruits & vegetables in the next month would be ____ for me

- ☐ Very unpleasant (1)
- ☐ Unpleasant (2)
- ☐ Somewhat unpleasant (3)
- ☐ Somewhat pleasant (4)
- ☐ Pleasant (5)
- ☐ Very pleasant (6)

Q2.9 Eating more fruits & vegetables in the next month would be ____ for me

- ☐ Very unenjoyable (1)
- ☐ Unenjoyable (2)
- ☐ Somewhat unenjoyable (3)
- ☐ Somewhat enjoyable (4)
- ☐ Enjoyable (5)
- ☐ Very enjoyable (6)

Q2.10 Eating more fruits & vegetables in the next month would be ____ for me

- ☐ Very boring (1)
- ☐ Boring (2)
- ☐ Somewhat boring (3)
- ☐ Somewhat exciting (4)
- ☐ Exciting (5)
- ☐ Very exciting (6)

Q2.11 Eating more fruits & vegetables in the next month would be ____ for me

- ☐ Very useless (1)
- ☐ Useless (2)
- ☐ Somewhat useless (3)
- ☐ Somewhat useful (4)
- ☐ Useful (5)
- ☐ Very Useful (6)

Q2.12 Eating more fruits & vegetables in the next month would be ____ for me

- ☐ Very foolish (1)
- ☐ Foolish (2)
- ☐ Somewhat foolish (3)
- ☐ Somewhat wise (4)
- ☐ Wise (5)
- ☐ Very wise (6)

Q2.13 Eating more fruits & vegetables in the next month would be ____ for me

- ☐ Very harmful (1)
- ☐ Harmful (2)
- ☐ Somewhat harmful (3)
- ☐ Somewhat beneficial (4)
- ☐ Beneficial (5)
- ☐ Very beneficial (6)

Q2.14r Please choose the appropriate box to complete each sentence:

	Strongly Disagree (12)	Disagree (13)	Somewhat Disagree (14)	Somewhat Agree (15)	Agree (16)	Strongly Agree (17)
I am motivated to eat more fruits & vegetables over the next 30 days (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most people who are important to me would want me to eat more fruits & vegetables (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most people whose opinions I value would approve of me to eat more fruits & vegetables (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most friends who are important to me will eat more fruits & vegetables (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most family members who are	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

important to me will support me eating more fruits & vegetables (8)						
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Q2.15r Please choose the appropriate box to complete each sentence:

	Strongly Disagree (10)	Disagree (11)	Somewhat Disagree (12)	Somewhat Agree (13)	Agree (14)	Strongly Agree (15)
In the next month, I have complete control over eating more fruits & vegetables if I really wanted to do so (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eating more fruits & vegetables is mostly up to me in the next month if I wanted to do so (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q2.16 Eating more fruits & vegetables over the next month if I wanted to do so would be

- ☐ Very Difficult (1)
- ☐ Difficult (2)
- ☐ Somewhat Difficult (3)
- ☐ Somewhat Easy (4)
- ☐ Easy (5)
- ☐ Very Easy (6)

Q2.17 How certain are you that you could overcome the following barriers? I can manage to carry out my intentions to eat more fruits & vegetables in the next month...

	Very uncertain (1)	Uncertain (2)	Somewhat uncertain (3)	Somewhat certain (4)	Certain (5)	Very certain (6)
... even when I have worries and problems (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... even if I feel depressed (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... even when I feel tense (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... even when I am tired (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... even when I am busy (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q3.1 How sure are you that you can do the following? I am _____ that I can ...

	Very uncertain (1)	Uncertain (2)	Somewhat uncertain (3)	Somewhat Certain (4)	Certain (5)	Very certain (6)
...write my favorite fruit or vegetable on the family's shopping list? (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...ask someone in my family to buy my favorite fruit or vegetable? (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...go shopping with my family for my favorite fruit or vegetable? (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...pick out my favorite fruit or vegetable at the store and put it in the shopping basket? (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...ask someone in my family to make my favorite vegetable dish for dinner? (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

...ask someone in my family to have fruits and fruit juices out where I can reach them? (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...ask someone in my family to have vegetables cut up out where I can reach them? (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...grow fruits or vegetables at your home? (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q4.1 The questions in this section are about what you think will happen if you eat fruits and vegetables. Tell us how much you agree or disagree with the following statements.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
I will have more energy for playing (sports, skateboarding, etc.) if I eat fruits and vegetables. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will get sick more often if I don't eat fruits and vegetables. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eating fruits and vegetables will help me grow. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I eat fruits and vegetables, I will have stronger eyes. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I eat fruits or vegetables at breakfast, I will be able to think better in class. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eating fruits and vegetables may help keep me from getting cavities. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q5.1 The next questions ask about what you eat.

Q5.2 I like to try new foods

- ☐ Never (1)
- ☐ Almost never (2)
- ☐ Sometimes (3)
- ☐ Almost always (4)
- ☐ Always (5)

Q5.3 During the past 7 days, how many times did you drink 100% fruit juices such as orange juice, apple juice, or grape juice? (Do not count punch, Kool-Aid, sports drinks, or other fruit-flavored drinks.)

- ☐ I did not drink 100% fruit juice during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.4 During the past 7 days, how many times did you eat fruit?

- ☐ I did not eat fruit during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.5 During the past 7 days, how many times did you eat green salad?

- ☐ I did not eat green salad during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.6 During the past 7 days, how many times did you eat potatoes? (Do not count French fries, fried potatoes, or potato chips.)

- ☐ I did not eat potatoes during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.7 During the past 7 days, how many times did you eat carrots?

- ☐ I did not eat carrots during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.8 During the past 7 days, how many times did you eat other vegetables? (Do not count green salad, potatoes, or carrots.)

- ☐ I did not eat other vegetables during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.9 During the past 7 days, how many times did you drink a can, bottle, or glass of soda or pop, such as Coke, Pepsi, or Sprite? (Do not count diet soda or diet pop.)

- ☐ I did not drink soda or pop during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q5.10 During the past 7 days, how many times did you eat breakfast?

- ☐ I did not eat breakfast during the past 7 days (1)
- ☐ 1 to 3 times during the past 7 days (2)
- ☐ 4 to 6 times during the past 7 days (3)
- ☐ 1 time per day (4)
- ☐ 2 times per day (5)
- ☐ 3 times per day (6)
- ☐ 4 or more times per day (7)

Q6.1 Are you a ...?

- ☐ Boy / Male (1)
- ☐ Girl / Female (2)

Q6.2 How old are you?

Q6.3 What grade are you in?

Q6.4 Hispanic or Latino means that your family was originally from Mexico, Cuba, Puerto Rico, a Central or South American country, or from Spain, even if they came to the US many years ago. Are you Hispanic or Latino?

- ☐ Yes (1)
- ☐ No (2)

Q6.5 How would you classify your race? (Select one or more responses)

- ☐ American Indian or Alaska Native (1)
- ☐ Asian (2)
- ☐ Black or African American (3)
- ☐ Native Hawaiian or Other Pacific Islander (4)
- ☐ White (5)
- ☐ Prefer not to answer (6)

APPENDIX 2

[773606-4] 2014 HEAL Projects Evaluation: Bowie Jardín of La Semilla


You have Read access to this project.

Research Institution	University of Texas at El Paso, El Paso, TX
Title	2014 HEAL Projects Evaluation: Bowie Jardín of La Semilla
Principal Investigator	Whigham, Leah, PhD FTOS
Keywords	HEAL Evaluation, school garden

The documents for this project can be accessed from the [Designer](#).

Project Status as of: 06/13/2017

Reviewing Board	Board Ref #	Initial Approval Date	Project Status	Expiration Date
University of Texas at El Paso IRB, El Paso, TX	College of Health Sciences-PDN	07/07/2015	Closed - Expired Expired	09/20/2016

Package 773606-4 is:  Locked

Package 4 of 4 | Jump ▼ |

Submitted To	Submission Date	Submission Type	Board Ref #	Board Action	Effective Date	
University of Texas at El Paso IRB, El Paso, TX	02/28/2017	Closure/Final Report	College of Health Sciences-PDN	Closed	03/01/2017	Review Details

Shared with the following users:

User	Organization	Access Type
Aguilera, Juan	University of Texas at El Paso, El Paso, TX	Read
Gallegos, Rebecca	University of Texas at El Paso, El Paso, TX	Read
Hopkins, Patrick	University of Texas at El Paso, El Paso, TX	Read
Mangadu, Thenral	University of Texas at El Paso, El Paso, TX	Write
Redelfs, Alisha	University of Texas at El Paso, El Paso, TX	Full
Whigham, Leah	University of Texas at El Paso, El Paso, TX	Full

APPENDIX 3

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM) COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Patrick Hopkins (ID: 4801489)
- **Email:** pvhopkins@miners.utep.edu
- **Institution Affiliation:** University of Texas at El Paso (ID: 2114)
- **Institution Unit:** Health Sciences
- **Curriculum Group:** Physical Science Responsible Conduct of Research
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - RCR
- **Description:** This course is for investigators, staff and students with an interest or focus in Physical Science research. This course contains text, embedded case studies AND quizzes.
- **Report ID:** 15877746
- **Completion Date:** 04/26/2015
- **Expiration Date:** 04/25/2018
- **Minimum Passing:** 85
- **Reported Score*:** 98

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Responsible Conduct of Research (RCR) Course Introduction (ID:1522)	04/25/15	No Quiz
Research Misconduct (RCR-Basic) (ID:16604)	04/25/15	5/5 (100%)
Data Management (RCR-Basic) (ID:16600)	04/25/15	5/5 (100%)
Authorship (RCR-Basic) (ID:16597)	04/25/15	5/5 (100%)
Peer Review (RCR-Basic) (ID:16603)	04/25/15	5/5 (100%)
Mentoring (RCR-Basic) (ID:16602)	04/25/15	4/5 (80%)
Using Animal Subjects in Research (RCR-Basic) (ID:13301)	04/25/15	5/5 (100%)
Conflicts of Interest (RCR-Basic) (ID:16599)	04/25/15	5/5 (100%)
Collaborative Research (RCR-Basic) (ID:16598)	04/26/15	5/5 (100%)
Research Involving Human Subjects (RCR-Basic) (ID:13566)	04/26/15	5/5 (100%)
Responsible Conduct of Research (RCR) Course Conclusion (ID:1043)	04/26/15	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Patrick Hopkins (ID: 4801469)
- **Email:** pvhopkins@miners.utep.edu
- **Institution Affiliation:** University of Texas at El Paso (ID: 2114)
- **Institution Unit:** Health Sciences

- **Curriculum Group:** Social & Behavioral Researchers (Faculty & Students)
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Report ID:** 16407571
- **Completion Date:** 07/08/2015
- **Expiration Date:** 07/07/2018
- **Minimum Passing:** 90
- **Reported Score^a:** 94

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID:1127)	07/05/15	3/3 (100%)
Students in Research (ID:1321)	07/05/15	8/10 (80%)
History and Ethical Principles - SBE (ID:490)	07/05/15	4/5 (80%)
Defining Research with Human Subjects - SBE (ID:491)	07/06/15	5/5 (100%)
The Federal Regulations - SBE (ID:502)	07/06/15	5/5 (100%)
Assessing Risk - SBE (ID:503)	07/06/15	5/5 (100%)
Informed Consent - SBE (ID:504)	07/06/15	5/5 (100%)
Privacy and Confidentiality - SBE (ID:505)	07/07/15	5/5 (100%)
Research with Prisoners - SBE (ID:506)	07/07/15	5/5 (100%)
Research with Children - SBE (ID:507)	07/07/15	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID:508)	07/07/15	5/5 (100%)
Internet-Based Research - SBE (ID:510)	07/07/15	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID:483)	07/07/15	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects (ID:488)	07/08/15	4/5 (80%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID:14928)	07/08/15	5/5 (100%)
International Studies (ID:971)	07/08/15	2/3 (67%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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VITA

Patrick Hopkins has a professional and education background in nutrition and fitness and has practices in the private sector as a strength and conditioning coach, a physique athlete coach, and a nutrition specialist for nearly two decades. He is a nutritionist with a BS in Nutritional Science from California Polytechnic State University. Now pursuing a Master's degree in Public Health (MPH) at the University of Texas at El Paso (UTEP), his research has focused on healthy eating and active living among Hispanic populations. Currently, Patrick is working as a graduate research assistant (GRA) for the Paso del Norte Institute for Health Living (IHL), under the instruction and mentorship of Executive Director, Dr. Leah Whigham. The IHL is an organization that provides leadership and innovative approaches to support regional community efforts that promote proper nutrition, healthy eating behaviors, and physical activity, while fostering efforts to reduce obesity bias. Prior study collaborations for Patrick have been as a GRA in the area of bystander intervention of sexual and physical violence, for Dr. Thenral Mangadu. Additionally, he worked as an undergraduate epidemiology tutor Health Promotion students under the guidance of Gabriel Ibarra-Mejia, M.D., PhD.

Upon completion of his MPH, Patrick will be starting the UTEP Health Sciences Interdisciplinary PhD Program under the direction and mentorship of Dr. Leah Whigham. His dissertation focus will be to study breath stable carbon isotopes in a population undergoing weight management in an effort to understand the relationship of C^{13}/C^{12} in breath to energy balance.

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This thesis/dissertation was typed by Patrick Hopkins