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# The Relationship Between Self-Efficacy and Fruit and Vegetable Intake in Overweight and Obese Adolescents

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# THE RELATIONSHIP BETWEEN SELF-EFFICACY AND FRUIT AND VEGETABLE INTAKE IN OVERWEIGHT AND OBESE ADOLESCENTS

by

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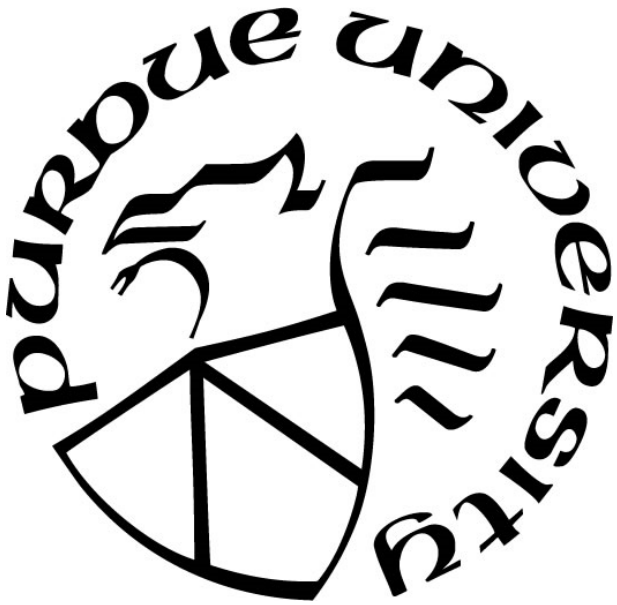


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*To my loving family who has encouraged me throughout this rigorous program. Without your love and support, I would not be where I am today. To my loving fiancé, who has shown constant patience, kindness, and encouragement.*

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| Abbreviations | Term |
|---|---|
| BMI | Body Mass Index |
| CEPC | Cup-equivalents per 1,000 calories |
| EMA | Ecological Momentary Assessment |
| EMI | Ecological Momentary Intervention |
| FFQ | Food Frequency Questionnaire |
| F&V | Fruits and Vegetables |
| HC | Health Coaching |
| MI | Motivational Interviewing |
| REDCap | Research Electronic Data Capture |
| SCT | Social Cognitive Theory |
| SE | Self-Efficacy |
| SES | Socioeconomic Status |
| TADA | Technology Assisted Dietary Assessment |

# ABSTRACT

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Adolescents have the poorest diet quality of any age group, characterized by a low consumption of fruits and vegetables. In order to target behavior change, it is necessary to determine factors that predict fruit and vegetable consumption among adolescents. Numerous studies have assessed the relationship between self-efficacy and fruit and vegetable consumption among adolescents, but these studies have produced mixed results. Our study is unique in that it allowed participants to use technology to create a mobile food record, which is a more objective measurement of diet. In addition, we targeted prediabetic adolescents who are overweight and obese for a health coaching intervention, a method that has shown to improve self-efficacy. This pilot study analyzed baseline and longitudinal data from a behavioral intervention in adolescents who are overweight and obese, in order to determine the association between self-efficacy and fruit and vegetable consumption. Fruit and vegetable consumption was determined from analysis of pictures taken using the Technology Assisted Dietary Assessment (TADA). Self-efficacy was determined using the Diet and Exercise Behavioral Strategies Questionnaire. Statistics included Spearman correlations and a paired samples t-test. Data are reported as mean ± standard error of the mean. Participants for baseline analysis (N=30) were 63% female, 70% white and 15.4 ± 0.4 years old. BMI Z-score and waist circumference for the total population were 2.3 ± 0.1 and 107.8 ± 2.7 cm, respectively and were measured at the screening clinic visit. Fruit intake for our

population did not meet the recommended 1.5 cups per day established in the Dietary Guidelines for Americans. However, vegetable intake for our population did meet the recommended 2 cups per day established in the Dietary Guidelines for Americans. Self-efficacy towards fruit and vegetable consumption was not significantly different between boys and girls (P=0.35). Self-efficacy at baseline and six month follow up was 7.5 ± 1.3 and 6.5 ± 0.8, respectively and did not significantly change during the six month intervention (P=0.42). Fruit intake at baseline and six month follow up was 0.9 ± 0.3 and 1.4 ± 0.5, respectively and did not change during the intervention (P=0.09). Vegetable intake at baseline and six month follow up was 1.8 ± 0.3 and 1.9 ± 0.5, respectively and did not change during the six month intervention (P=0.72). Measures of obesity did not change during the six-month intervention. Our study was underpowered; therefore, we were not able to determine if there is a correlation between self-efficacy and fruit and vegetable consumption for our sample size at baseline or six-month follow-up.

# CHAPTER 1. REVIEW OF LITERAURE

## 1.1 Childhood Overweight and Obesity Definition and Prevalence

Obesity during childhood and adolescence has become an emerging epidemic in the past 30 years [1]. From 2003-2004, 17% of children and adolescents were overweight [2]. For adolescents between 12-19 years, obesity increased from 10.5% to 21% over years 1988-1994 to 2013-2014 [3]. In order to take into account variation due to sex and age, body mass index (BMI) in children and adolescents is evaluated using sex and age specific reference values [4]. For children and adolescents, overweight is defined as a BMI at or above the 85th percentile, and obesity is defined as a BMI at or above the $95^{th}$ percentile [4, 5]. BMI z-score represents the number of standard deviation units a child is away from the population average and is another measure of adiposity that is based on age and sex [6]. Unfortunately, obesity that emerges during childhood or adolescence often persists into adulthood [7], and childhood obesity is correlated with disease states such as type 2 diabetes, hypertension and stroke [8]. Furthermore, excess body weight and poor diet quality are related to body dissatisfaction [9], low self-esteem [10-12], and poor quality of life [13, 14].

### 1.1.1 Factors That Influence Obesity in Adolescents

Several factors influence the current obesity epidemic. For instance, today's adolescents consume snacks that are high in sugar instead of eating balanced meals composed of fruits and vegetables. In addition, snacking, especially for adolescents, is associated with consumption of energy-dense foods that are often high in saturated fat and refined grains [15-17], as well as a

higher caloric intake. Socioeconomic status (SES) might also contribute to obesity. SES is assessed by measuring a combination of factors including family income, education, and profession. In a national sample of 40,000 children ages 10-17 in the United States, youth from low socioeconomic households were 3.4-4.3 times more likely to be obese than youth from higher SES backgrounds [18]. In addition, obesity among children from low SES increased by 23-33% from 2003-2004 [18]. Low income households have lower dietary quality and tend to consume more processed meats, baked goods and sweets, and less fruits, vegetables, and whole grains [19]. Lastly, high consumption of fast food may play a major role in the development of obesity through its effects on diet composition. Consumption of fast foods by youth has increased 300% over the last 20 years [20]. A study showed that when youth consume fast food, their energy and fat intake for that day are likely to be higher, and their fruit and vegetable intake (F&V) is likely to be lower than normal [21]. Further, low consumption of F&V is associated with higher body weight [22].

### 1.1.2 Efficacy of Current Obesity Prevention and Intervention Efforts

There is a wide range of interventions for both prevention and treatment of obesity. These interventions differ by length, approach, and outcome measures. Comprehensive interventions that include healthy diet counseling, physical activity counseling, and behavior management techniques for obese adolescents have been effective only in short-term weight loss, defined as one year or less [23]. On average, at 6-12month follow-up, intervention groups were 0.3-3.3kg/$m^2$ lighter than control groups due to weight loss and weight-gain prevention efforts for intervention groups. A systematic review that analyzed 90 randomized controlled trials for prevention of obesity in children and adolescents found a small, yet significant effect in intervention groups compared with control groups for change in BMI and BMI z-score for

adolescents ages 13-18 [24]. However, many studies involved in this analysis received low quality ratings due to inadequate randomization procedures and indirectness, as the studies included mixed weight (normal and overweight) populations so weight-gain prevention efforts could not adequately be measured in a specific population. A recent systematic review and meta-analysis analyzed 44 randomized controlled trials of diet, physical activity, and behavioral interventions for the treatment of obesity in overweight and obese adolescents ages 12 to 17 years old. The study found low quality evidence that interventions with multiple components (diet, physical activity, and behavioral) cause a reduction in BMI. The same review found moderate quality evidence that these interventions reduce weight in overweight and obese adolescents compared to control groups who received no treatment. These findings are limited however, due to inconsistent results, indirectness of outcomes or risk of bias [25].

### 1.2 Benefits of Fruit and Vegetable Consumption

A diet that is rich in F&V helps prevent diseases such as cardiovascular disease, obesity and type 2 diabetes [26-28]. Evidence suggests that the reasons for the benefits of F&V consumption for adolescents is that they are low in energy which could promote healthy weight status [29, 30]. Also, F&V contain nutrients such as vitamin C, fiber, and potassium and have phytochemical properties that have antioxidant and anti-inflammatory functions. Due to their high water and fiber content, F&V can promote greater satiety so a person feels full for a longer period of time. F&V also have a low energy density so someone can consume a larger portion size for the same amount of energy as a smaller portion containing relatively high fat and high sugar [31].

### 1.2.1 Adolescents' Current Consumption of Fruits and Vegetables

The 2010 Dietary Guidelines for Americans recommends that individuals aged 1-18 eat 1-2 cups of fruit and 1-3 cups of vegetables per day, based on age, sex, and activity level [26]. For adolescents ages 9-18 years, the recommendation is 1.5-2 cups of fruit and 2-3 cups of vegetables [26]. Adolescents have the poorest diet quality of any age group with high intake of foods that are high in saturated fats and added sugar and low consumption of fruits, vegetables, and fiber [32, 33]. According to a report by the Centers for Disease Control and Prevention in 2010, adolescents consumed 0.62 cup-equivalents per 1,000 calories (CEPC) of fruits and 0.53 CEPC of vegetables [34]. Cup-equivalent per 1,000 calories refers to quantities of foods within each food group that have comparable nutritional content. These data demonstrate that adolescents are consuming below the recommended 0.9 CEPC of fruits and 1.1 CEPC of vegetables [34]. Consumption of F&V differs based on age, gender, and socioeconomic status. Girls are more likely to consume F&V than boys and this finding is consistent across age groups [35-37]. According to the 2015 Dietary Guidelines Report, boys ages 9-13 years and girls ages 14-18 years have the lowest consumption of vegetables in the United States with less than 1% of these populations meeting the recommendations for fruit and vegetable consumption [32]. Poor diet quality of adolescents, including low consumption of F&V, may be responsible for current obesity trends and the increasing prevalence of metabolic diseases among adolescents [38, 39]. This is worrisome because research shows that food preferences and eating habits developed during adolescence often continue into adulthood [40, 41]. Therefore, it is crucial for adolescents to adopt healthy lifestyle habits, such as consuming fruits and vegetables. However, adolescents face numerous barriers to fruit and vegetable consumption.

### 1.2.2 Common Barriers to Fruit and Vegetable Consumption

A systematic review analyzing 31 qualitative studies found several barriers to F&V consumption among children and adolescents [42]. Time cost, or convenience, was determined a major barrier to consumption of F&V [44-54]. Even if children liked particular F&V, they were not willing to sacrifice time to prepare and consume F&V [43-46]. Instead, children preferred snacks that required no preparation such as fast food and salty snacks [47-49]. F&V were seen as inconvenient due to the amount of preparation involved (washing, peeling, cooking) [43-45, 50, 51]. Moreover, youth often underestimated the satiety effects of F&V [43, 46, 47, 51, 52]. For instance, in one study, children thought that snacks such as chips and chocolate were more filling than F&V [46].

Another barrier is taste guarantee. Taste guarantee refers to children's reasoning that they do not want to waste money on buying F&V since they cannot always be certain that they will have a pleasant taste (due to variation in ripeness, etc). Youth thought the taste guarantee of F&V differed from chocolate since the taste of chocolate never changes [46, 52, 53]. Adolescents' perception of when it is appropriate to eat F&V is another barrier to consumption. Four studies suggested that adolescents perceive dinner as the only appropriate time to consume vegetables [44, 54-56]. Therefore, if they did not consume vegetables at dinner time, they usually did not consume them at all [55]. In contrast, adolescents felt that fruit could be eaten any time during the day [55, 56]. Sensory and physical traits are another barrier to fruit and vegetable consumption. Sensory characteristics of vegetables are frequently associated with negative implications specifically related to the texture [54, 56, 57] and taste [43, 46, 47, 50, 54, 56, 58-61] which is described as bland. Numerous studies found that taste is a barrier to consuming F&V, especially for vegetables [47, 53, 54, 56, 57, 59, 60, 62-64]. However, children tend to

prefer the taste of fruits compared to vegetables due to the sweeter taste [44, 45, 47, 54, 55, 58, 60, 63]. In addition, peer influences have a major impact on F&V consumption in adolescents. Youth perceived peer influences as not being supportive towards consuming F&V due to the peer pressure to eat unhealthy foods [43, 44, 50, 54, 55, 60, 65].

Exposure to F&V at home was deemed a significant factor that influences F&V consumption [44, 45, 47, 49, 51, 53-55, 60, 62, 63, 66]. Variety was included as an aspect of availability of F&V in the home and lack of variety in available F&V was determined as a barrier of consumption [53, 67]. Socioeconomic status also affects the variety of F&V available. Lower socioeconomic households tend to have a smaller variety of F&V than higher socioeconomic households [54]. Lastly, accessibility and visibility were identified as key determinants of F&V consumption. Accessibility refers to whether F&V are in a form and location that is convenient to youth. One study indicated that F&V were available in the home but were not visible or accessible to youth [68]. Adolescents thought that adults were responsible for preparing F&V and displayed them in an easily identified location [45, 48, 51].

Barriers to F&V intake in children and adolescents concern convenience, taste guarantee and exposure due to socioeconomic status, however, it is often difficult to address these barriers in interventions. Therefore, it is crucial to target barriers that are easier to modify, such as self-efficacy (SE).

### 1.3 The Importance of Targeting the Adolescent Population

Adolescence is defined as the time period between ages 10-21 [69]. Development during adolescence has been researched thoroughly as this is a time of rapid physical changes due to puberty. In order to facilitate these physical changes, a healthy diet is essential [70]. Adolescence is also a time of cognitive development as adolescents acquire the ability to think logically and

abstractly [69]. This is an optimal period for intervention as adolescents are beginning to comprehend future consequences of their current actions. Therefore, adolescents may be able to understand the adverse outcomes they can face in adulthood as consequences of their eating patterns during adolescence. On the other hand, adolescents may adopt an optimistic bias orientation where they believe they are immune to negative consequences [69]. These characteristics make it difficult, yet necessary to target this population.

Adolescence is also a time that is characterized by enhanced cognitive ability for self-reflection [69]. Adolescents begin to develop their own perception of their capabilities. Thus, it is crucial that adolescents develop a healthy sense of SE, or belief in their ability to perform a given behavior in the midst of challenges, as this could have positive effects on the formation of their identity. Adolescents also begin to become aware of their ideal self, or the person they aspire to be, in relation to their actual self. SE can influence the development of one's ideal self because someone who has higher SE will set higher goals for themselves and be more confident in their ability to reach those goals [71]. Adolescence is also a time where habits are being formed and these habits can transfer into adulthood [69]. Once adolescents enter adulthood, it is harder to intervene as habits are more resistant to change [69]. Thus, it is critical that adolescents develop SE and healthy eating habits as these could have a major impact in adulthood.

Adolescence is also a time of increased independence which includes more time spent with friends and less time spent with family. This is important because adolescents began to have more control over their food choices and fewer meals are consumed at home [69]. As adolescents spend more time with their peers, their choices become influenced by their peers and social norms [69]. As adolescence is a time of both increased outside influence and independence, it is key that adolescents develop SE in order for them to confidently practice healthy eating habits

when faced with unhealthy alternatives. Therefore, the adolescent population is an important target of SE and F&V interventions.

### 1.4 The Social Cognitive Theory

The Social Cognitive theory (SCT) postulated by Albert Bandura, started as Social Learning theory in the 1960s, which later developed into SCT in 1986 [72]. SCT states that human behavior is shaped by a person's environment and people are able to change their environment and consequently change their behavior [72]. The SCT is the most commonly used theory in the development of dietary interventions in youth [73, 74]. Bandura introduced the concept of SE in the SCT and defined SE as a person's belief in their ability to perform a certain behavior in the midst of challenges [72]. SE is crucial because if people do not believe that their actions will enable them to accomplish their desired goal, they will have little motivation to make a change or to continue their new habits when conflict arises [71]. SE is also important because it influences the results people expect from their actions. Thus, people with stronger SE will set higher goals for themselves and will be more committed to those goals [71]. SE scales usually have a Likert scale format and assess a person's confidence in their ability to accomplish a given task at that particular moment [75]. A person's level of SE affects how they approach conflict; a person with a lower level of SE is more likely to stop their efforts when conflict arises. In contrast, people with a higher level of SE have the perspective that conflict can be overcome with consistency of effort [71]. Increased SE is also related to the improvement in skills related to maintenance of behavior change such as planning and self-monitoring [76]. SE is believed to influence a wide range of factors including choices, motivations, and emotions. The impact of SE has been assessed in numerous populations, such as children and adults, including

those experiencing a dietary intervention to those suffering from addiction [72]. SE is modifiable in that it is affected by observations, experiences, and influences [72].

Self-efficacy assesses one's confidence at the present moment to perform a given behavior. Previous research has been conducted on behavior modification interventions for momentary decision making. Specifically, ecological momentary assessment (EMA) and ecological momentary intervention (EMI) have been used together to better understand factors that influence individuals struggling with alcohol and drug addiction [77]. Ecological momentary assessment involves participants randomly being prompted to report how they feel at a given time (craving a cigarette or drink) and what environmental or internal cues contributed to their mood. Ecological momentary interventions emphasize delivering an intervention in real-life settings during an individual's daily routine [78]. Ecological momentary interventions allows clinicians to deliver an intervention to patients as they go about their normal routine in order to build skills between treatment sessions and are often delivered through a mobile phone app. Ecological momentary interventions can include organized interventions where participants receive a text message when they usually smoke that discusses the benefits of not smoking or alternatively, a less rigorous intervention where the clinician sends texts at random about tips to cope with stress aside from smoking. Ecological momentary interventions allow clinicians to teach patients how to take control during momentary decision making by sending them tips and reminders to facilitate the decision-making process. An example of a successful EMI includes a study conducted in smokers. The investigators of the study found that individuals in the intervention group who received EMI support were more likely to quit smoking than those in the control group [77]. Therefore, interventions that focus on momentary decision making and self-efficacy towards making healthy choices are important for behavior modification.

Dietary SE has been defined as one's ability to make healthy dietary choices in spite of challenges. There is a wide range of research evaluating SE and the ability to adopt a healthy dietary behavior that includes diets high in F&V. Multiple studies have found that high SE was correlated with high fruit and vegetable intake [79-84]. An example of a finding of a positive correlation is a study that was conducted by Granner, et al. The researchers sought to determine the factors that related to fruit and vegetable intake in 736 middle school students ages 11-15 years [80]. Participants completed a food frequency questionnaire (FFQ) to determine fruit and vegetable intake and a questionnaire with a Likert scale format to assess their SE towards fruit and vegetable consumption. Researchers found that SE influenced fruit and vegetable consumption among adolescents. Participants who were 14-15 years old reported lower SE than participants who were 11 years old. Older participants also reported lower preferences for fruit and vegetables compared to 11-year-old participants. These results are consistent with prior data suggesting that older adolescents tend to have a lower consumption of F&V [41, 85, 86]. Adolescents' low consumption of F&V provides the rationale to target factors such as SE, to improve F&V consumption and reduce adolescents' risk of disease.

Although there are studies that have found a positive association between SE and F&V consumption, not all investigators have observed these positive associations [87]. An example of a null finding is a study by Neumark-Sztainer, et al, identifying personal, behavioral, and socio-environmental factors of fruit and vegetable intake among 3,957 adolescents from public middle and high schools in Minnesota [87]. To determine fruit and vegetable intake, participants were asked to complete the Youth and Adolescent Food Frequency Questionnaire. Participants also completed the Project EAT survey, a 221-item survey evaluating personal, behavioral and socio-environmental factors that the researchers thought may influence dietary intake. Structural

equation modeling was used to determine the factors that affect fruit and vegetable consumption. The researchers found that SE was not significantly correlated with fruit and vegetable intake. The studies were similar in that they all included cross-sectional analysis of SE and F&V, assessed SE using a Likert scale format, and used FFQ to determine F&V intake.

A systematic review analyzed 70 studies evaluating psychosocial determinants of fruit and vegetable consumption in children and adolescents ages 3-18 years old [88]. From this review, the correlates of fruit and vegetable consumption best supported by the literature include norms, dietary interventions, liking and preferences, and perceived modeling. Further, the results showed no consistent associations between SE and F&V consumption.

### 1.4.1 Behavioral Capability

The SCT also includes the construct of behavioral capability. Behavioral capability refers to the knowledge and skill required to perform a desired behavior. Therefore, if we want adolescents to increase their consumption of F&V, we need to provide them with the knowledge and skill to do so. However, interventions that have sought to improve nutrition knowledge towards F&V and improve F&V intake in adolescents have produced mixed results [89-93].

### 1.4.2 Efficacy of Interventions for Fruit and Vegetable Intake in Children and Adolescents

In a systematic review summarizing the literature on interventions for F&V intake in children and adolescents, nine studies found a significant positive effect on F&V consumption of dietary interventions compared to controls in those ages 5-12 years old [94]. In the same systematic review, only one of four interventions for those ages 13-18 years was successful in increasing F&V consumption. Moreover, the intervention increased F&V consumption in girls but not in boys [94]. Another systematic review analyzed 36 studies measuring F&V intake in

adults and children. Several studies tested the association between change in F&V intake and SE and the results suggested that SE promoted greater F&V intake [95, 96]. The mixed results of these studies support the need for more research to be conducted on the relationship between SE and F&V intake in adolescents.

### 1.4.3 Technology Assisted Dietary Assessment

Adolescents view conventional methods of dietary recall, such as 24-hour recall or FFQ, as burdensome. There are not enough validation studies in adolescents that justify using one method of dietary assessment over another. However, researchers have sought to incorporate technology in dietary assessment methods to better suit the adolescent population. One such method is the Technology Assisted Dietary Assessment (TADA) application, which was created by a Purdue engineering team. The TADA allows participants to take before and after pictures of each meal on an iPhone [97]. Adolescents attending a residential summer camp on Purdue University's campus were given an iPhone with the TADA app installed and asked to take pictures of their meals for two days using the TADA. After these two days, participants were asked to complete a usability questionnaire and the results showed that 80% of participants found the TADA software easy to use [98]. Adolescents found the TADA app less burdensome as they were able to actively take pictures of their meals in order to create a food record [96]. Studies have shown that adolescents often find it difficult to report dietary intake, especially portion sizes [99]. The TADA allows participants to take pictures of their food, eliminating the need for adolescents to estimate portion sizes. In addition, the TADA app is useful for adolescents because it sends reminders for participants to take pictures of their meals. However, a drawback of using the TADA is that participants might change their dietary habits as a result of being asked to take pictures of their food. In order to address this issue, when participants are

consented for our study, they are asked to continue with their regular eating habits. However, despite this limitation, the TADA app is still a viable method of dietary assessment.

### 1.4.4 Health Coaching Intervention

Health coaching (HC) is a combination of education and behavior modification that is used widely to promote behavior change for disease prevention [100]. HC is a patient-centered approach in which dietitians provide education and support in order to increase patient motivation and self-efficacy [104]. HC has shown to be effective in improving health behaviors in patients with prediabetes [100, 101], diabetes [102], cancer [103], and obesity [104]. HC has also improved adherence in individuals seeking to adopt a healthy diet [103]. HC differs from a standard consultation with a dietitian in that patients are able to have one-on-one sessions with the dietitian each week, instead of simply seeing the dietitian once every few months at a doctor's appointment. HC sessions can occur in person, over the phone, or through email. A limitation of studies involving HC is that frequency, length, duration, and delivery often differ [105]. One unique aspect of HC includes the practice of motivational interviewing (MI) which has been used to promote healthy behavior change in youth [106]. MI emphasizes the client-centered approach of HC and allows the client to decide their degree of readiness for behavior change while the coach simply provides support [107]. Therefore, due to the focus on improving self-efficacy and the incorporation of motivational interviewing, we believe health coaching will be an effective strategy in our intervention.

## 1.5 Research Questions

The high prevalence of obesity in adolescents increases their risk for disease and predisposes them to obesity in adulthood. Several factors play a role in the development of

obesity including low consumption of F&V. Adolescence is a time of increased independence and more meals are consumed away from home. Habits established in adolescence can carry into adulthood, so it is key to promote healthy eating habits in adolescents. According to the data from the NHANES survey, adolescents are consuming below the recommended values for F&V which increases their risk of disease. Bandura's SCT states that behavior is shaped by cognitive, environmental and behavioral factors such as SE. SE is a crucial component in behavior change as it influences a person's belief in setting and achieving goals. By delivering a dietary intervention through health coaching, we believe our intervention will successfully improve self-efficacy towards consumption of fruits and vegetables. Allowing participants to track dietary intake through the use of the TADA app is an innovative method for dietary assessment in youth and may lead to more cooperation among adolescent participants. Thus, the purpose of this project is to determine the relationship between SE and intake of F&V among overweight and obese adolescents. We hypothesized that high SE would be correlated with a high consumption of F&V. We also sought to determine if the SE and F&V was modified by gender. Lastly, we sought to determine the role of health coaching on improving self-efficacy towards fruit and vegetable intake.

# CHAPTER 2. THE RELATIONSHIP BETWEEN SELF-EFFICACY AND FRUIT AND VEGETABLE CONSUMPTION AMONG OVERWEIGHT AND OBESE ADOLESCENTS

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## 2.1 Abstract

**Background:** In adolescents, low consumption of fruits and vegetables (F&V) may be associated with obesity. We suspect low self-efficacy (SE) prevents adolescents from consuming fruits and vegetables.

**Objective:** In a pilot study, using baseline and longitudinal data from a behavioral intervention in adolescents who are overweight and obese, to determine the relationship between SE and F&V. We also sought to compare self-efficacy and fruit and vegetable intake among boys and girls.

**Hypothesis:** High self-efficacy for fruit and vegetable consumption is associated with high fruit and vegetable intake at baseline. Girls will have higher self-efficacy and fruit and vegetable intake than boys at baseline and six-month follow up. The health coaching intervention will improve self-efficacy and thereby improve fruit and vegetable intake.

**Research Design and Methods**: Participants included a free-living population of overweight and obese (>85$^{th}$ percentile) adolescents between the ages of 10-21 years old. Diet was assessed using the Technology Assisted Dietary Assessment system, whereby participants used the mobile food record to capture before and after images of their eating occasions over 4 days. Dietary intake was analyzed using the Nutrient Data System for Research software (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). Self-efficacy towards intake of F&V was assessed on a scale of 1 (low) to 10 (high) through the Diet and Exercise Behavioral Strategies questionnaire. Cross-sectional data included participants who were analyzed at the screening clinic visit. Longitudinal data included those who were assessed at the screening visit, qualified and completed the six-month intervention. The association between SE and fruit and vegetable consumption was determined by using Spearman correlations. Data are expressed as means ± standard error. T-tests were used to determine between and within group comparisons.

**Results**: Participants included in baseline analysis (N=30) were 63% female, 70% white, 20% African-American, 10% biracial, and 10% of this group were Latino. The average age of participants was 14.7 ± 0.4 years old. Average dietary intake of fruits during the four-day baseline period (servings/day) for boys and girls was 1.3 ± 0.3 and 1.0 ± 0.2, respectively (P=0.43). Average dietary vegetable intake (servings/day) at baseline for girls and boys was 2.2 ± 0.2 and 2.5 ± 0.5, respectively (P=0.41). Reported SE at baseline for girls and boys was 6.1 ± 0.7 and 7.2 ± 0.9, respectively (P=0.35). No correlation between SE and fruit intake (P=0.19) and SE and vegetable intake (P=0.54) was observed at baseline. Of the participants included in six-month analysis (N=6), 67% were male, 83% were White, 17% were African American; and none were Latino. The participants were 16.5 ± 0.8 years. Dietary fruit intake (servings/day) at baseline and six-month follow up for the total population was 0.9 ± 0.3 and 1.4 ± 0.5,

respectively (P=0.09). Dietary vegetable intake at baseline and six-month follow up for the total population was 1.8 ± 0.3 and 1.9 ± 0.5, respectively (P=0.72). Reported SE at baseline and six-month follow-up for the total population was 7.5 ± 1.3 and 6.5 ± 0.8, respectively (P=0.42). Measures of obesity did not change during the six-month intervention. There was no correlation found between SE and fruit intake (P=0.19) and SE and vegetable intake (P=0.47) at six-month follow up.

**Conclusions:** We were underpowered and therefore not able to determine if self-efficacy was associated with fruit and vegetable consumption in this pilot study of adolescents. Limitations of this study include the cross-sectional study design and small sample size.

## 2.2 Introduction

Adolescents have the poorest diet quality of any age group with a diet that is characterized by a low intake of fruits and vegetables (F&V) [32, 33]. Adolescence is a time of physical change with the onset of puberty, and a healthy diet can facilitate growth and development [70]. A diet that is high in F&V can also prevent the onset of diseases. Dietary habits that form during adolescence often persist into adulthood [40, 41], therefore this is a critical period for dietary intervention. Self-efficacy (SE), or a person's belief in their ability to perform a given behavior, has been recognized as a possible determinant of behavior change [71]. However, studies that have assessed the relationship between SE and its effects on F&V consumption have yielded mixed results [79-84, 108-110]. Previous studies that assessed the relationship between SE and F&V consumption often used food frequency questionnaires (FFQs) to assess F&V intake [82, 111]. The use of FFQs limits the variety of F&V that can be reported; thus alternative dietary methods could lead to more accurate measures [112]. The Technology Assisted Dietary Assessment (TADA) app allows participants to take before and

after pictures of their meals for four days. The TADA app is an innovative method because it allows participants to actively take pictures of their food to track their dietary intake, rather than trying to recall previous eating occasions on a standard questionnaire. Also, taking pictures using the TADA app is more objective than other methods of dietary assessment such as dietary recalls. Our intervention targeted prediabetic adolescents for an intervention that uses health coaching to facilitate the adoption of healthy dietary behaviors. Health coaching has shown to improve self-efficacy in adolescents with prediabetes [100, 101]. The overall aim of this pilot study was to determine the relationship between SE and F&V intake in a free-living population of adolescents. In addition, we sought to determine if the relationship among F&V and SE is modified by gender as previous studies have shown a possibility of this relationship [113]. Our hypothesis was that SE is correlated with F&V consumption at baseline and that girls would have higher SE and F&V compared with boys. Our secondary aim was to determine longitudinal associations between SE and F&V consumption and the effect of health coaching on self-efficacy towards fruit and vegetable intake. Our hypothesis was that SE is correlated with F&V consumption after the intervention and that health coaching improves self-efficacy towards fruit and vegetable consumption.

## 2.3 Participants

The study included baseline and longitudinal data from an intervention that uses health coaching to help overweight and obese adolescents with prediabetes adopt healthy dietary behaviors [114]. The first consultation with the health coach for all participants took place at the screening clinic visit. Participants from the West Lafayette, IN, Lafayette, IN and Indianapolis, IN areas were recruited through physician referrals. We also used a search of electronic medical records in the Indiana University Health system, using criteria of age and physician reported

body mass index, or weight to height ratio, to identify and recruit individuals. Inclusion criteria included those between ages 10-21 years with a BMI $\geq 85^{th}$ percentile for age and sex or $\geq 95^{th}$ percentile for age and sex according to the Centers for Disease Control and Prevention [115]. Exclusion criteria include self-reported use of medications for glucose metabolism, pregnancy, and syndromic obesity. This study is approved by the Purdue University and Indiana University Institutional Review Boards (IRB Study #: 1403986016).

## 2.4. Demographics Measures

All participant characteristics including age, sex, and race/ethnicity were self-reported at the screening clinic visit at the Clinical Research Center in the Indiana University Health University Hospital in Indianapolis, IN. Participants younger than 18 years old were required to have their parent or legal guardians present at the clinic visit due to their status as a minor. Written assent and consent was obtained from all participants before any study activities occurred.

### 2.4.1 Anthropometric Assessment

Anthropometric measures were taken during clinic visits at the Indianapolis University Clinical Research Center in Indianapolis, IN. Height was measured to the nearest 0.1 cm using a stadiometer (Seca Model, Hamburg, Germany) and weight was measured using an electronic scale (Scale Tronix Model, White Plains, NY). BMI percentiles and Z scores were calculated using age- and sex-specific values from the Centers for Disease Control and Prevention growth charts [115].

### 2.4.2 Fruit and Vegetable Assessment

Fruit and vegetable servings were assessed using the Technology Assisted Dietary Assessment (TADA) system, whereby participants used the mobile food record to capture before and after images of their eating occasions over four days. The TADA app was developed at Purdue University and its acceptance among adolescents was validated at a residential summer camp on Purdue University's campus [99, 116]. Participants took pictures of their food, these pictures were sent to a secure database whereby a food record was created for each participant's four-day intake. Food in the images were identified and portion sizes were classified by a registered dietitian. Fruit and vegetable intakes were analyzed using the Nutrient Data System for Research (NDSR) software (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). We used NDSR to create an output of average energy intake per day, macronutrient and micronutrient composition, and food groups for each of the four days of recorded dietary intake. NDSR categorized fruits into the following categories: citrus juice, fruit juice excluding citrus juice, citrus fruit, fruit excluding citrus fruit, avocado and similar, fried fruits, and fruit-based savory snacks. NDSR categorized vegetables into the following categories: dark-green vegetables, deep-yellow vegetables, tomato, white potatoes, fried potatoes, other starchy vegetables, legumes (cooked dried beans), other vegetables, fried vegetables, vegetable juice, and vegetable-based savory snacks. If participants took pictures of mixed dishes, at the screening clinic visit they were asked to clarify each food that was in the dish. If participants did not take pictures of all meals, a 24-hour recall was conducted by the dietitian at the screening clinic visit. Fruit and vegetable intake for participants was compared with recommended F&V intake for adolescents in the Dietary Guidelines for Americans [32].

### 2.4.3 Self-Efficacy Assessment

Self-efficacy towards intake of F&V was assessed on a Likert scale of 1 (low) to 10 (high) through the Diet and Exercise Behavioral Strategies questionnaire. This questionnaire was adapted from the Self-efficacy for Diabetes Self-Management scale [117]. The questionnaire asked participants, "On a scale of 1 (not at all) to 10 (completely sure), please rate how sure are you that you can eat at least 5 servings of fruits and vegetables per day?" The Self-efficacy for Diabetes Self-Management scale was developed to evaluate adolescents' SE towards managing type 1 diabetes [118]. The Self-efficacy for Diabetes Self-Management scale allowed adolescents to rank on a scale from 1(low) to 10 (high) their self-efficacy for managing their type 1 diabetes.

### 2.4.4 Underreporting

In order to determine if participants were underreporting, their reported energy intake was compared with their energy requirements using predictive equations. We used the standard deviation for the calculated energy expenditure for this calculation. Energy requirements were calculated using equations for overweight children and adolescents in a weight maintenance condition [119].

### 2.4.5 Health Coaching Intervention

All participants received a consultation with the dietitian at the screening clinic visit. The consultation visit lasted 20-45 minutes with the child and legal guardian present. Participants who were randomized to the standard of care group had one consultation with the dietitian at the screening visit and did not interact with the dietitian again until the six month follow up clinic visit. The dietitian's notes from consultations at the screening visit were stored in REDCap (Research Electronic Data Capture, Vanderbilt University, Nashville, TN), an

internet-based database platform. REDCap is an instrument used for the collection and management of data for research studies. Participants randomized to the health coaching group set up either weekly or biweekly phone calls with the dietitian. Calls included the participants and at least one legal guardian, however, if needed, the dietitian talked with participants and their legal guardian separately. In order to determine adherence to the health coaching intervention, the dietitian kept health coaching notes in REDCap for each session they had with the participant. The health coaching notes included if they were able to reach the participant, and the frequency and duration of the calls. The notes also included all topics discussed in each call such as current eating habits, participants' goals and their progress towards their goals.

### 2.4.6 Power calculation

Statistical power was calculated using the GPower 3.1 software (Franz Faul, Universitat Kiel, Kiel, Germany). The correlation coefficient (R=0.3) from a previous study that found a significant correlation between SE and F&V intake was used to calculate power for our study [108]. To have statistical power of 80%, 84 participants would need to provide complete dietary and SE data at baseline.

### 2.4.7 Data Analysis

Data from this study were collected and stored using REDCap. Statistical analyses were performed using IBM SPSS Statistics 24 (IBM Corp. Armonk, NY: IBM Corp.). Normality of distribution was assessed using the Shapiro-Wilk test. Spearman correlations were performed throughout since self-efficacy data were not normally distributed. Spearman correlations were performed in order to determine correlations between F&V and SE at baseline and six-month follow-up. Paired samples t-tests were performed on six-month data (n=6) in order to determine

changes in SE and F&V intake from baseline to six-month follow up. A P value of less than 0.05 was deemed as statistically significant. A chi-square analysis was performed to determine differences between participants who dropped out and participants who completed the screening clinic visit. All data are reported as means ± standard error of the means unless otherwise indicated. In order to determine if participants were underreporting, their reported energy intake was compared with their energy requirements which were calculated using equations for overweight children and adolescents in a weight maintenance condition [119].

### 2.4.8 Participant Exclusion for Cross-sectional and Longitudinal Data Analysis

For the cross-sectional data analysis, twenty participants were excluded. Eight participants were excluded because they dropped out of the study before the baseline clinic visit. Four participants were excluded due to malfunctions with the TADA app and inability to capture dietary information. One participant's dietary information was excluded because it was suspected that the participant was struggling with an eating disorder. One participant was excluded because they did not take any pictures of their food. Six participants were excluded because of incomplete food records. We defined incomplete food records as participants taking two pictures or less each day of their meals, especially if the pictures represented very small meals. Therefore, for statistical analyses for cross-sectional data, only data from 30 participants were used (**Figure 2.1**).

At the screening clinic visit, 12 participants were determined prediabetic and were enrolled in the six-month intervention; six participants were randomized to the health coaching group and seven participants were randomized to the standard of care group. From the health coaching group, two participants were lost to follow up, one participant did not provide six-month self-efficacy data, and one participant withdrew from the study. From the standard of care

group, one participant was lost to follow up and two participants' clinic visits fell after the data collection time period for the longitudinal analysis. Thus, for longitudinal analyses, data from two participants in the health coaching group and four from the standard of care group were included. Due to the small sample size, data from participants were not separated based on intervention group and data from six participants were included **(Figure 2.1)**.

## 2.5 Results

### 2.5.1 Participant Characteristics

For cross-sectional analysis, data from 30 participants were used. Our goal was to have complete diet and self-efficacy data for 84 participants in order to have statistical power of 80%. Therefore, since we only included 30 participants in this analysis, we had statistical power of 49% and were underpowered. For the 30 participants included in statistical analyses, the participants were 15.4 ± 0.4 years old at baseline. Of these participants, 63% were female, 70% were white, 20% were African-American, and 10% were biracial, and 10% of this group were Latino. The average BMI Z-score was 2.3 ± 0.1 and the average waist circumference was 107.8 ± 2.7 cm. Participant dietary intake and SE at baseline are shown in **Table 2.2**. Girls and boys reported eating 1834 ± 87 and 1918 ± 160 kcal per day, respectively (P=0.62). Dietary fruit intake (servings/day) at baseline for girls and boys was 1.3 ± 0.3 and 1.0 ± 0.2, respectively (P=0.43). Dietary vegetable intake (servings/day) at baseline for girls and boys was 2.2 ± 0.2 and 2.5 ± 0.5, respectively (P=0.41). Reported SE at baseline for girls and boys was 6.1 ± 0.7 and 7.2 ± 0.9, respectively (P=0.35). Therefore, SE and F&V among girls and boys were not significantly different.

### 2.5.2 Changes in Fruit and Vegetable Consumption and Self-Efficacy During the Intervention

We determined changes in F&V consumption and SE during the intervention (**Table 2.3**). Following the exclusion process (**Figure 2.1**), six participants were included in the longitudinal analysis; two were in the health coaching group and four were in the dietary consult control group. Due to the small sample size we did not determine whether the changes in SE or F&V consumption were different between groups. For this total population, 83% were White, 17% were African American; and none were Latino. The participants were 16.5 ± 0.76 years and 67% of the population was male. In this small sample, we did not observe any changes from baseline in dietary intake of F&V or in SE after the intervention. Dietary fruit intake (servings/day) at baseline and six-month follow up for the total population was 0.9 ± 0.3 and 1.4 ± 0.5, respectively (P=0.09). Dietary vegetable intake at baseline and six-month follow up for the total population was 1.8 ± 0.3 and 1.9 ± 0.5, respectively (P=0.72). Reported SE at baseline and six-month follow-up for the total population was 7.5 ± 1.3 and 6.5 ± 0.8, respectively (P=0.42). In addition, measures of obesity did not change during the six-month intervention (**Table 2.4**).

### 2.5.3 Associations Between Self-Efficacy and Intake of Fruits and Vegetables

To assess the association between baseline SE and F&V consumption, a Spearman correlation was performed on the cross-sectional data that included 30 participants (**Table 2.3**). There was no significant correlation found between baseline SE and fruit consumption, R= 0.248, P= 0.186. There was no significant correlation found between baseline SE and vegetable consumption, R=0.116, P=0.542.

To assess the relationship between SE and F&V consumption after the intervention, a Spearman correlation was performed using six-month follow up values (**Table 2.5**). There was no significant correlation found between six-month values for SE and fruit consumption,

R=0.617, P= 0.192. Also, there was no significant correlation found between six-month follow up SE and vegetable consumption R= -0.370, P= 0.470. In order to determine the correlation between the change in screening and six-month follow up SE and F&V consumption, a Spearman correlation was performed (**Table 2.5**). Change values used for this spearman correlation included the cross-sectional data subtracted from the six-month data. There was a significant correlation found between change in fruit intake and change in SE, R=0.841, P=0.036. There was no significant correlation found between change in vegetable intake and change in SE, R= -0.087, P=0.870.

### 2.5.4 Underreporting

Reported intake for girls and boys was 1834 ± 87 and 1918 ± 160 kcal/day, respectively (**Table 2.6**). Of the 30 participants included in the cross-sectional analysis, we found that 18 were underreporting. We calculated that these eighteen participants were underreporting by 14%.

### 2.5.5 Chi Square Analysis

A chi-square test was performed and the gender between participants who remained and those who dropped out of the study were not different (P=0.46) (**Table 2.1**). However, race was significant in terms of participants who dropped out as majority of the participants who dropped out were African American (P=0.03).

## 2.6 Discussion

The purpose of this study was to determine relationships between SE and F&V consumption among adolescents that were participating in a behavioral lifestyle intervention. Our participants did not meet the recommendations for fruit intake but did meet the recommendations for vegetable intake. Also, SE and fruit and vegetable intake did not change

during the six-month period. We were underpowered and were therefore not able to determine if SE was correlated with fruit and vegetable intake at baseline or six-month follow up. Recruitment was difficult for this study which explains our small sample size. At baseline, fruit and vegetable intake for girls and boys were similar. Further, reported energy intake among boys and girls at baseline were also similar. There was no significant difference found between SE for girls and boys at baseline.

Our participants were very obese yet boys reported consuming fewer calories than their sedentary energy expenditure. According to our analysis on underreporting, girls and boys in our sample size were underreporting which may impact the accuracy of the fruit and vegetable intake data. Although there are not many studies that have identified foods that are commonly underreported in children and adolescents, adults typically underreport sweetened foods and drinks [120, 121]. A study analyzing NHANES data found that overweight and obese boys and girls reported consuming fewer calories than their healthy weight counterparts [122]. These findings are in contrast with the expectation that overweight and obese adolescents consume more energy than their healthy-weight peers. This may be due to a predisposition of individuals who are obese to underreport their dietary intake [123-125].

We did not find changes in SE and vegetable intake between baseline and six-months. One reason for not finding any differences could be our low number of participants for which we collected longitudinal data. With a larger sample size, we may be able to find differences in these values. Although we did not meet our sample size goals, mailing postcards was an effective method for recruitment as 12 of the 30 participants included in the cross-sectional analysis were recruited using this method. Most participants who responded to the postcards showed a desire to change their lifestyle behavior. Thus, our sample size might reflect individuals who are ready to

change. Also, our chi-square analysis revealed that majority of the participants that dropped out of the study were African-American. Therefore, in the future we need to increase our efforts to improve attrition in this population.

Results from previous studies found that adolescents who had higher SE towards F&V had higher levels of perceived benefits of consuming F&V such as avoiding weight gain and being healthy [109, 126, 127]. We did not assess our participants' perceived benefits of fruit and vegetable consumption so this could play a role in participants' level of SE. We measured SE on a 10-point scale and found that SE for our sample size was on average 6 out of 10 for girls and 7 out of 10 for boys. Self-efficacy is usually measured on a five-point scale and previous studies have shown that adolescents usually rank their self-efficacy for F&V as a 3 on a 5-point scale [79, 81]. Therefore, girls in our sample size had average self-efficacy while boys had slightly higher than average self-efficacy.

Another limitation of our study included only having one question to assess SE. Self-efficacy is usually measured by administering a questionnaire that has a Likert scale format with multiple questions assessing SE [82, 128]. By only having one question to assess SE, we could not accurately determine if our participants had higher SE towards fruit or vegetables because our SE questionnaire assessed their SE towards consuming F&V combined. Also, our SE questionnaire had a Likert scale format which used an ordinal scale, thus limiting the choices of the responses. For future studies, having multiple questions for SE and assessing SE as a continuous variable might provide a more accurate view of adolescents' SE. However, most studies use a Likert scale format so a new self-efficacy questionnaire with a continuous scale would need to be developed. Previous studies had several questions that assessed SE towards F&V [81, 110, 129]. By developing numerous questions that assess SE towards F&V separately,

we might have a more in-depth perspective on factors that influenced our participant's SE. A strength of our self-efficacy measurement was that self-efficacy was assessed at the baseline and six-month clinic visits. Self-efficacy assesses one's confidence in making a decision in the moment to perform a given behavior. Thus, it was optimal that we measured self-efficacy for fruit and vegetable intake at screening and at the six-month follow up in order to determine how self-efficacy would relate to fruit and vegetable consumption for those specific time points. Therefore, I would expect self-efficacy at baseline to affect baseline F&V consumption and self-efficacy at six-months to affect F&V consumption at six-month follow up.

Another limitation of our study is that our primary aim was based on a correlation between self-efficacy and fruit and vegetable consumption at baseline. However, high self-efficacy could be a result of previous nutrition education. Therefore, we would not be able to discern if increased fruit and vegetable intake was a result of high self-efficacy or previous nutrition knowledge. We could have assessed previous nutrition education by asking participants if and how often they had attended a nutrition consultation, class, or event in the past six months. This way, we could have compared self-efficacy and fruit and vegetable consumption with participants who had received nutrition education recently to those who had not.

One strength of our study was the use of the TADA app for collection of fruit and vegetable intake. The TADA app is an easy and less burdensome method of dietary assessment as participants can take pictures of their food and send it to our database. The TADA app also sends reminders to participants to take pictures of their food throughout the day which may help with participants forgetting to take pictures of their meals. Therefore, participants' use of the TADA app in our study is an optimal method of dietary assessment. However, there were some malfunctions with the TADA app that resulted in an inability to receive several participants'

pictures. The reason for the malfunction included incompatibility of the TADA app with the iPod software, therefore we began using iPhones to solve this issue.

Boys and girls had similar levels of SE in our sample size. This is surprising as previous research shows that girls are usually more confident in their ability to eat 5 servings of F&V [130]. Adolescents tend to have higher SE towards fruits than vegetables [131] but we were not able to assess this because we measured SE towards F&V together. Higher SE towards fruit intake may be related to adolescents' preference for fruit which has been demonstrated previously [132]. Research has shown that adolescents' preference for fruit play a major role in their consumption of F&V [110, 126]. Our finding that girls and boys consumed similar amounts of F&V is surprising as this is in contrary with other studies that found that girls consumed more F&V than boys [35, 133-138]. Girls tend to have more positive views towards the benefits of consuming F&V and therefore have higher SE and higher fruits and vegetable consumption [83]. In comparison to the general adolescent population, our sample size consumed more F&V. However, our sample size still did not meet the recommendations for servings of fruit. The evidence in this study is not strong enough to assess the relationship between self-efficacy and fruit and vegetable consumption since we did not have sufficient power. This pilot study can serve as the foundation for future studies that can further investigate the correlation of self-efficacy and fruit and vegetable intake among adolescents.

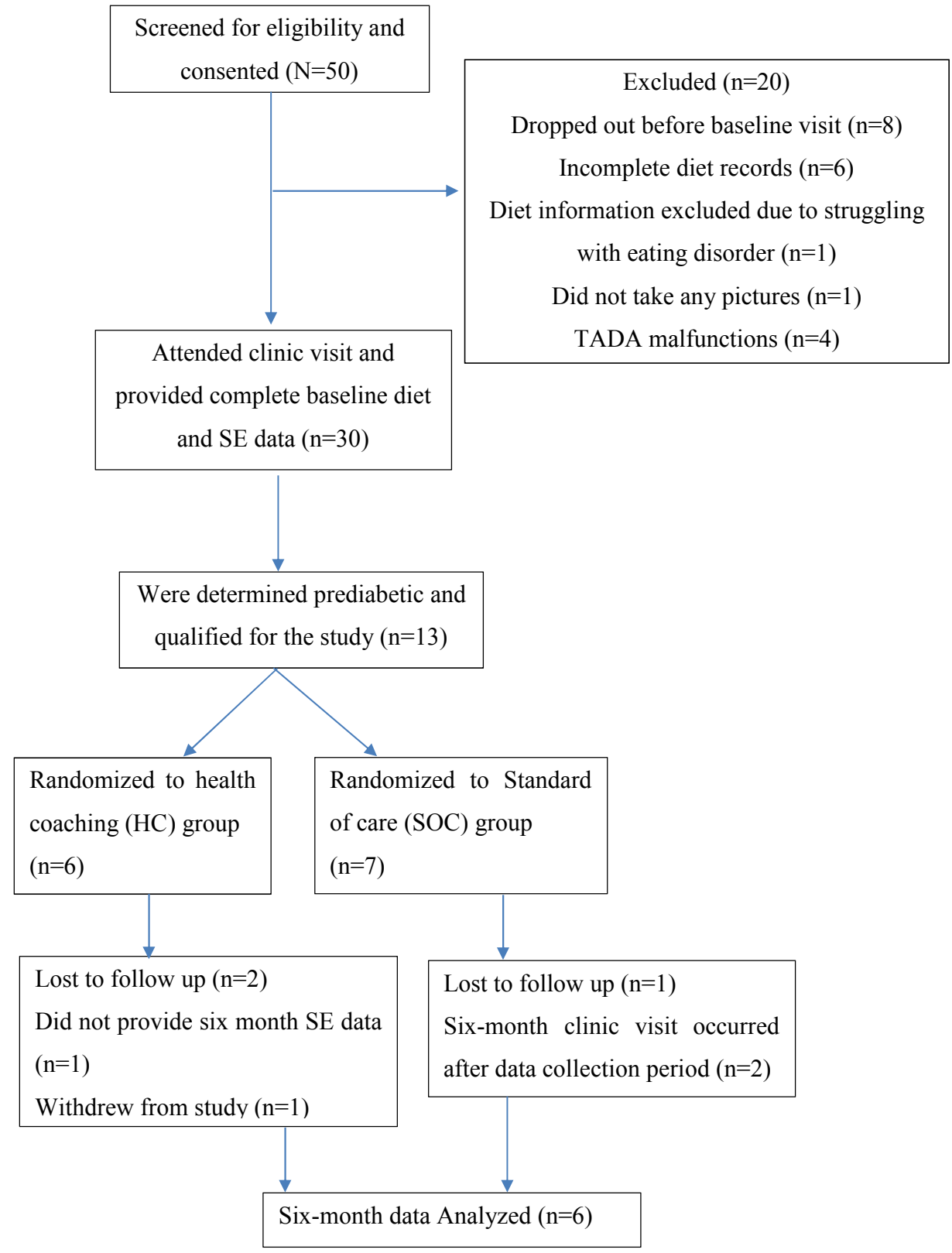


Figure 2.1 Participant Flow Diagram

Table 2.1 Participant Demographics for those Included Compared with those Excluded from Cross-Sectional Analysis

| Category | Included | Excluded | P value |
|---|---|---|---|
| **Sample Size (% female)** | 30 (63%) | 20 (52.6%) | 0.46 |
| **Race (% White: nonwhite )** | 70 : 30 | 31 : 69 | 0.03 |
| **Age** | 15.4 ± 0.4 | 13.6 ± 0.5 | 0.01 |

Differences for gender and race were determined from a chi-square analysis. Differences in age were determined using a t-test.

Table 2.2 Participant Dietary Intake and Self-efficacy at Baseline (n=30)

| Outcome | Girls | Boys | P value |
|---|---|---|---|
| **Energy Intake (kcal/day)** | 1834 ± 87 | 1918 ± 160 | 0.62 |
| **Fruit intake (cups, servings/day)** | 1.3 ± 0.3 | 1.0 ± 0.2 | 0.43 |
| **Vegetable Intake (cups, servings/day)** | 2.2 ± 0.2 | 2.5 ± 0.5 | 0.41 |
| **Self-efficacy** | 6.1 ± 0.7 | 7.2 ± 0.9 | 0.35 |

Fruit and vegetable intake is reported as an average intake of the four days of dietary assessment. *P<0.05 was deemed as significant. Independent samples t-test was performed.

Table 2.3 Participant Demographics for Longitudinal Analysis (n=6)

| Category | Value |
|---|---|
| **Sex of the participants, girls, N (%)** | 2 (33%) |
| **Age** | 16.5 ± 0.76 |
| **Race/Ethnicity (% White: Black: Other)** | 83:17:0 |

Table 2.4 Fruit and Vegetable Intake, Self-efficacy, and Measures of Obesity at Baseline and Six-month Timepoint (n=6)

| | Baseline | 6 month | Δ | P-value |
|---|---|---|---|---|
| **Fruit intake** | 0.9 ± 0.3 | 1.4 ± 0.5 | 0.5 ± 0.2 | 0.09 |
| **Vegetable intake** | 1.8 ± 0.3 | 1.9 ± 0.5 | 0.1 ± 0.3 | 0.72 |
| **Self-efficacy** | 7.5 ± 1.3 | 6.5 ± 0.8 | -1.0 ± 1.1 | 0.42 |
| **BMI Z-score** | 2.3 ± 0.3 | 2.4 ± 0.3 | 0.1 ± 0.1 | 0.29 |
| **Waist Circumference (cm)** | 109.3 ± 8.2 | 113.5 ± 7.8 | 4.2 ± 2.1 | 0.11 |

Results from paired samples t-test (n=6) at the baseline time point and after the six-month health coaching intervention. Data are presented as mean ± standard error. *P<0.05 was deemed as significant.

Table 2.5 Spearman Correlation Results

| **N=30** | **Baseline SE** |
|---|---|
| **Baseline Fruit Intake** | R=0.248 |
| | P=0.186 |
| **Baseline Vegetable Intake** | R=0.116 |
| | P=0.542 |
| **N=6** | **Six-month SE** |
| **Six-month Fruit Intake** | R=0.617 |
| | P=0.192 |
| **Six-month Vegetable intake** | R= -0.370 |
| | P=0.470 |
| **N=6** | **Change in SE** |
| **Change in Fruit intake** | R= 0.841 |
| | P= 0.036* |
| **Change in Vegetable Intake** | R= -0.087 |
| | P=0.870 |

Results from the spearman correlation for cross-sectional (n=30) and longitudinal (n=6) data. *P<0.05 was deemed as significant. Data are presented as mean ± standard error of the mean.

Table 2.6 Reported Intake and Calculated Energy Needs

| Sex | Average Reported Intake (mean ± SE) | Average sedentary energy expenditure estimated | % sedentary energy expenditure consumption |
|---|---|---|---|
| **Female** | 1834 ± 87 | 2420.6 ± 88.9 | 80% |
| **Male** | 1918 ± 160 | 2901.9 ± 177.7 | 72% |

# CHAPTER 3. CONCLUSIONS AND FUTURE DIRECTIONS

## 3.1 Conclusions

In conclusion, we were not able to determine whether self-efficacy was correlated with fruit and vegetable intake because we were underpowered. Previous studies that have sufficient power have found a correlation between these variables. Therefore, we need to achieve an adequate sample size to research this topic further. More in-depth studies that measure self-efficacy and fruit and vegetable intake before and after an intervention need to be conducted in adolescents. Also, these studies need to include researchers adequately explaining self-efficacy to participants to ensure they understand the concept of self-efficacy and how it includes confidence towards performing a behavior at the specific time of assessment.

## 3.2 Future Directions

In the future, we would like to include a larger sample size of participants in order to better detect differences between intervention and control groups. Our power calculation found that we needed 84 participants. Therefore, future directions for this study could include obtaining self-efficacy and fruit and vegetable data on at least 84 participants. Recruitment for our study is ongoing, therefore, increasing our sample size to 84 participants is achievable. For participants that are recruited in the intervention phase of our study, it might be beneficial to assess family involvement in the intervention and its effects on adolescents' self-efficacy. There are studies that have found that an increase in family involvement, especially parent modeling for healthy eating, improves adolescents' attitudes towards healthy eating [139-141]. In the future, we would like to analyze the effect of our health coaching intervention. Therefore, obtaining more longitudinal data by finding alternative methods to keep participants engaged throughout the entire study

would be beneficial. We would also like to recruit a more diverse population as majority of our participants were Non-Hispanic Caucasian. Self-efficacy and its impact on fruit and vegetable consumption may differ by race. Therefore, it is important to recruit a diverse sample of participants from different ethnic backgrounds.

The topic of our study is significant for public health as adolescents are currently at a higher risk for adult diseases and a healthy diet plays a role in the prevention of such diseases. Targeting ways to help adolescents adopt healthy eating behaviors, such as increasing consumption of fruit and vegetables, is of the utmost importance in our obesogenic society. Therefore, continuing to conduct studies that establish and target determinants of behavior change in adolescents is imperative.

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# VITA

Kendra Wilder was born in Birmingham, Alabama. She obtained her Bachelor of Science degree in Dietetics from Tuskegee University in July 2016. In August 2016, Kendra began her graduate career in the Interdepartmental Nutrition Program at Purdue University under the guidance of Dr. Nana Gletsu-Miller. Kendra worked on several research projects involving providing nutrition education to at-risk adolescents. Kendra's main research project explored the relationship between self-efficacy and fruit and vegetable consumption in adolescents. She will begin her dietetic internship at Emory University Hospital in the fall of 2018.