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Childhood Obesity Prevention in Income-Disadvantaged Populations: An Evaluation of Two Novel Approaches

Kayla Lee Vosburgh

B.S., University of Connecticut, 2014

A Thesis

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APPROVAL PAGE

Masters of Science Thesis

Childhood Obesity Prevention in Income-Disadvantaged Populations: An Evaluation of Two Novel Approaches

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CHAPTER ONE

INTRODUCTION

1.1 Childhood Obesity: Prevalence, causes, and consequences

Childhood obesity has become a public health issue worldwide. In the United States, 17% of children and adolescents are obese, and 5.8% are extremely obese. [1] For children, sex-specific BMI-for-age growth charts are used to classify weight category. The Centers for Disease Control and Prevention (CDC) define overweight as at or above the 85th but less than the 95th BMI percentile, and obesity as at or above the 95th BMI percentile. [2] A new classification if extreme obesity is defined as being at or above 120% of the 95th percentile. [1] Older children, ages 6 to 11 years old and adolescents ages 12 to 19 years old, are more likely to be obese than younger children (2 to 5 years old), with obesity rates at 17.5% and 20.5%, respectively. [1] Between 1988-1994 and 2013-2014, there has been a marked increase in obesity among adolescents (12 to 19 years old). [1]

There are multiple racial/ethnic and socioeconomic disparities related to obesity prevalence in children. Both Latino/Hispanic (21.9%) and non-Hispanic black (19.5%) children and adolescents are more likely than non-Hispanic white children and adolescents (14.7%) to be obese. [1] Additionally, children from economically disadvantaged households are even more likely to fall in the obese categories.[3-5] Children living below the federal household poverty line and in low-income neighborhoods are more likely to be obese than their counterparts. [4] Thirty-eight percent and 34.1% of African American and Latino children under 18, respectively, are living below the poverty line. [6,7] Twenty-five percent of both African American and Latino families experience food insecurity, compared to only 11% of White families. [4,6,8] Lack of access to grocery stores, particularly those with healthy, affordable options such as fresh produce,

contributes to risk of obesity and food insecurity. According to the 2013 Youth Risk Behavior Survey (YRBS), African American and Latino children are less likely to consume vegetables than White children.[9] In addition, African American, Latino, and overall income-disadvantaged children and adolescents are more exposed to marketing and advertisements for unhealthy items, such as fast food and sugar-sweetened beverages[6,8,10] In addition, African American and Latino children are 70% and 30%, respectively, less likely to participate in physical activity than White children due to limited access to safe play areas.[6,8] It is important to note these inequalities because they translate to health disparities. For example, African Americans and Latinos are more likely to be diagnosed with Type II diabetes,[6,8] as well as other conditions, such as heart disease[6] or stroke.[6,8]

Many factors contribute to risk of childhood obesity, including, but not limited to, diet, physical activity, sedentary behaviors, genetics, environmental factors, socio-cultural factors, family factors, and psychological factors.[11] Diet is on of the main contributor to weight status. A large portion of children's and adolescent's diet is energy contributing nutrient-poor foods and drinks, such as fast food, highly processed snack foods with added fats and sugars and sugar-sweetened beverages.[12-14] In addition, portion sizes of these nutrient-poor foods and drinks continue to increase, promoting excess caloric intake.[11,12] The Expert Committee on the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity recommends limiting sugar-sweetened beverages, energy-dense foods, portion sizes, and consumption of fast food, as well as increasing the consumption of fruits, vegetables, and other fiber-rich foods.[15] Furthermore, many children and adolescents are not getting the recommended amount of physical activity, with less than one-third of high school students participating in 60 minutes per day.[16] The YRBS found that, in 2015, 41.7% of high school students played

video/computer games and 24.7% watched television for 3 or more hours per day. Limiting screen time and encouraging daily physical activity are key recommendations for obesity prevention. [14,15]

In addition to diet and activity level, environmental factors play a role in childhood obesity. Environmental factors include advertisements of less healthy foods, unsafe areas to be physical active and limited access to healthy and affordable foods. [11,14] Family eating habits, particularly those of the parent's, have a substantial impact on the types and amounts of foods consumed by children, [11]as well as their behaviors and attitudes towards food. [17] According to expert recommendations, eating meals as a family is associated with higher-quality diet and lower rates of obesity, and should therefore be encouraged. [15] Furthermore, family activity habits influence children's participation in physical activity; [11] therefore, promoting activities that involve the entire family have the potential to increase rates of physical activity among children.[18]

There are many consequences of childhood obesity, both during childhood and in future adulthood. Obese children are at risk of developing type II diabetes, hypertension, hyperlipidemia, fatty liver, joint and musculoskeletal problems, gallstones, gastro-esophageal reflux disorder, breathing problems, and sleep-disorders. [11,14,19] Obesity also has been linked to social, emotional, and psychological stress such as discrimination, depression, low self-esteem, and behavioral issues. [11,14] Moreover, obesity and its comorbidities are likely to carryover into adulthood, during which time metabolic syndrome, cardiovascular disease, and diabetes can become more severe. [14] The medical costs associated with obesity are substantial. It has been estimated that 21% of all medical expenses ($190 billion in 2005 dollars) are related to obesity. [20] Research estimates lifetime medical costs for an obese child relative to a normal-weight child to

be $19,000.[21] Therefore, approximately $14 billion in direct medical costs is related to childhood obesity each year.[21] In comparison, only $165 million was spent on the USDA Fresh Fruit and Vegetable Program in the 2013/2014 school year,[22] a program proven to increase fruit and vegetable consumption among children.[23]

1.2 Involvement of Supplemental Nutrition Assistance Program- Education (SNAP-Ed)

The Supplemental Nutrition Assistance Program (SNAP) offers food assistance to low-income families via monthly allotments towards purchasing food. SNAP includes a nutrition education arm (SNAP-Ed), partnering with nutrition educators to empower SNAP clients in making healthy lifestyle choices. The goal of SNAP-Ed is to "improve the likelihood that persons eligible for SNAP will make healthy food choices within a limited budget and choose physically active lifestyles consistent with the current 2015-2020 Dietary Guidelines for Americans and the USDA food guidance."[24] SNAP-Ed aims are as follows:

1) "Implementing strategies or interventions, among other health promotion efforts, to help the SNAP-Ed target audience establish healthy eating habits and a physically active lifestyle."[24]
2) "Primary prevention of diseases to help the SNAP-Ed target audience that has risk factors for nutrition-related chronic disease, such as obesity, prevent or postpone the onset of disease by establishing healthier eating habits and being more physically active."[24]

As SNAP-Ed is an established Nutrition Education and Obesity Prevention Grant Program, it strives to provide evidence-based, nutrition education to low-income families, with a

focus on obesity prevention.[25] The two projects presented in this report, both of which were completed with the help of the University of Connecticut Department of Allied Health Sciences SNAP-Ed Team, align with SNAP-Ed goals and aims. SNAP-Ed has created six guiding principles[24] to be used in these health promotion and obesity prevention efforts, many of which we have incorporated here. First, SNAP-Ed serves low-income individuals,[24] a population we have reached through an urban pediatric emergency department and a Title I school. The second guiding principle states that SNAP-Ed programs should consist of a combination of educational strategies to facilitate nutrition-related behavior changes.[24] Throughout these two projects we have provided indirect, as well as direct nutrition education to all participants. We have also incorporated the use of an original mobile health (mHealth) program. The third guiding principle states that SNAP-Ed has the largest impact when directed towards low-income women and children.[24] Both of these projects focus on improving obesity screening and education tools for income-disadvantaged families, children and parents/guardians, while also providing them with nutrition education. Next, the fourth guiding principle suggests the use of evidence-based, behaviorally focused interventions,[24] which we are currently working towards incorporating into both projects. Finally, the fifth guiding principle states that SNAP-Ed is maximized when efforts are coordinated between various stakeholders in the community.[24]Both projects described in this report could not have been completed without our collaborations with Connecticut Children's Medical Center in Hartford, CT and Kelly Middle School in Norwich, CT. Healthcare facilities and schools are both key stakeholders in these health promotion and obesity prevention studies, as the results directly affect their community and the individuals that they service. Overall, the involvement of SNAP-Ed in these projects further enhances our efforts of obesity prevention in low-income children.

1.3 Two Complimentary Approaches to Childhood Obesity Prevention

Within this report, two approaches to early detection and prevention of childhood obesity are examined. First, many low-income families are seeking health care in pediatric emergency departments (PED). [26] As pediatricians are being urged to screen for obesity and associated behaviors, as well as to also provide education on healthy weight management, [27,28] more accurate and efficient screening tools are needed in pediatric care settings. Since survey-responses toward what is liked/disliked in foods and beverages has been shown to correspond well with those toward frequency of consumption of foods and beverages, as well as correspond with biomarkers of dietary intake and measures of nutritional status, [29-34] a Pediatric-Adapted Liking Survey was used as a screening tool in an urban PED to create a Healthy Behavior Index. Here we will test the validity and reliability of a Healthy Behavior Index calculated from PALS responses in the child and parent to screen for health behaviors that may increase the child's risk of obesity.

Second, there is an increasingly high rate of technology usage, particularly smartphones, by children and adolescents, [35] providing a new platform for obesity prevention. Multiple reviews[36-38] indicate that mHealth approaches to preventing and treating obesity are feasible and acceptable; however, current programs do not include behavior change theories or expert recommendations. [36,38-41] Therefore, we strove to create an app to help preteen and adolescents increase their nutrition and fitness literacy, improve their efficacy for healthy eating and active living, and cultivate a healthy body image and self-esteem. The first step, discussed here, was to create an original app and pilot test the prototype among a sample of low-income adolescents to assess its usability and gain feedback on the simple health and nutrition messages provided.

1.4 Purpose of Research

The purpose of this research is to investigate two novel approaches to childhood obesity prevention in income-disadvantaged populations: 1) Healthy Behavior Index generated from a Pediatric-Adapted Liking Survey; 2) An original smartphone app prototype to promote healthy weight in children. Findings from these studies will help to enhance obesity prevention tools to reach SNAP-Ed clients and income-challenged children and families.

1.5 Specific Aims:

1. To determine the validity and reliability of a liking-based Healthy Behavior Index as a tool to screen for children's lifestyle behaviors in a health care setting.
2. To pilot test an original smartphone app prototype to promote healthy weight in children, including its usability and evaluation of simple health and nutrition messages, as the first step to creating an app to facilitate future childhood obesity prevention efforts.

1.6 Significance

The prevalence of childhood obesity continues to increase throughout the United States. Obesity increases the risk of serious medical consequences in the child that are likely to persist into adulthood, and result in significant financial and quality of life burdens.[14] Low-income populations are even more so affected by this epidemic.[3-5] There is a need for improved and novel tools for screening and intervening to help prevent childhood obesity. This research seeks to evaluate two innovative approaches; first, a simple liking-based index to help healthcare professionals screen for behaviors that increase the risk of obesity. If such a tool is feasible, valid and reliable for use in pediatric care settings, healthcare professionals may be able to implement

it into their practice, helping them to provide families with tailored nutrition education that they may otherwise not have received. Second, as mHealth programs are becoming increasingly popular, it is imperative that they are consistent with health and nutrition recommendations as well as well-established behavioral-change theories. Pilot testing an original smartphone application for usability is the first step to creating an interactive, enjoyable, and evidence and theory-based mHealth program for children and adolescents. Ultimately, this work will add to, and hopefully improve mHealth tools as well as provide alternative tools that can be utilized within SNAP-Ed obesity prevention programs for children and adolescents.

1.7 References

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CHAPTER TWO

Pediatric-Adapted Liking Survey (PALS): A Brief and Valid Lifestyle Behavior Screener for Obesity Prevention in Pediatric Care

2.1 ABSTRACT

Background—Rapid yet useful methods are needed to screen for lifestyle behaviors in clinical settings to form tailored and reinforcing obesity prevention messages for patients and their families. We aimed to test construct validity and reliability of a lifestyle behavior index, generated from the Pediatric-Adapted Liking Survey (PALS). Method—Enrolled were 925 ethnically/racially diverse children (average age=11, range 5-17 y; 55% publicly insured) in an urban pediatric emergency department. Child/parent dyads completed a 33-item PALS, which was coded into groups (sweet drinks, sweets, vegetables, fruits, proteins, technology), weighted and averaged into a lifestyle behavior index. From measured height and weight or waist circumference, approximately 33% had excessive adiposity. Results—The survey took less than 4 minutes to complete and was simple to process. Parent and child lifestyle indices were highly variable, normally distributed, showed construct validity and adequate internal reliability. The index reflected 2 dimensions—less healthy (sweet drinks, sweets, sedentary behaviors) and healthy (vegetables, fruits, proteins). The lifestyle index detected significant group differences (criterion validity), with healthier scores in parents vs. children, females vs. males, privately vs. publically insured and reported residence as higher income vs. lower income. A healthier child or parent lifestyle index failed to explain adiposity across the sample. However, these indices were associated with lower adiposity among healthy weight children, with the parent index explaining more variability in child adiposity than the child index. Conclusion—PALS can be used to generate a valid/reliable index to screen for obesity-related behaviors in pediatric care settings.

Practitioners can form tailored obesity prevention messages from liking/disliking responses to individual survey items.

2.2 INTRODUCTION

Childhood obesity has reached epidemic proportions throughout the globe. In the U.S., more than one third of children and adolescents were classified as overweight or obese in 2012, [1] with economically disadvantaged children more likely to meet this classification. [2] In 2014, the prevalence of childhood obesity reached 17% ($\geq$95th BMI-for-age/sex percentile), with 5.8% in a new classification of extreme obesity (BMI $\geq$120% of the 95th BMI-for-age/sex percentile). [3] Childhood obesity can cause social and health issues such as discrimination, low self-esteem, and associates with greater risk of developing cardiovascular disease, stroke, and type 2 Diabetes in both childhood and adulthood. [1]

Obesity prevention efforts and early detection methods are essential in combating this epidemic. The U.S. Preventive Services Task Force (USPSTF) recommends that children ages 6 to 18 years old be screened for obesity[4] to provide subsequent behavioral interventions, involving nutrition and physical activity counseling, as well as behavioral management techniques (self-monitoring, cognitive-behavioral techniques, etc.). Pediatricians are urged[5] to follow-up obesity screening with patient-centered techniques about healthy weight management, including increasing physical activity as well as limiting screen time and sugar-sweetened beverages. The provision of patient-centered techniques would require screening for the child's adiposity as well as the family's nutrition and physical activity habits and readiness to change.[5]

Ideally, children and families receive timely and comprehensive medical care, including preventative screenings[6] and treatments for acute and chronic conditions such as obesity, through

primary care physicians.[5] However, many families receive pediatric medical care in the emergency department (ED) setting for non-emergent reasons.[7] Of the 25.5 million ED visits made by children in 2010, 96% were released without hospitalization, with twice as many visits made by children of low-income families compared to those of the highest income level.[8] Previous research shows that pediatric emergency departments (PED) are a feasible and acceptable setting to screen for childhood obesity, and could include an evaluation of eating habits that are linked to higher rates of obesity.[9,10] Families using PED as a source of non-urgent care are more likely to be interested in obesity screening being provided in this setting.[10] Moreover, PED may also be an effective setting to introduce obesity education. One study, completed in an urban PED with a high minority population, suggests that children and parents found the PED to be an appropriate setting for obesity intervention and introduction to making healthy lifestyle changes.[11] Overall, PED can serve as a valuable location in the health care system to help screen for obesity, promote healthy behaviors, and connect families with additional specialized care, particularly for those who lack access to primary care facilities.

Furthermore, accurate and efficient screening tools to assess behaviors that increase the risk of obesity are needed in primary care settings. Food frequency screeners and 24-hour recalls are traditionally used to collect diet information and for calculating indices of dietary quality. However, misreporting is common.[12] Additionally, collecting data on the dietary behaviors of children and adolescents can be difficult because these traditional methods are time-intensive, costly, and may require an adult proxy.[13] Therefore, there is a need for rapid, valid, and reliable dietary assessment tools for screening in children's primary care. Since individuals tend to consume foods that are liked and avoid those that are disliked, a liking survey has been shown to provide an accurate assessment of diet[14,15] and may also be able to capture other behaviors such

as physical activity.[16] Previous studies utilizing the liking survey have shown that liking-based food groups and/or liking-based dietary quality indices correspond with food frequency-based food groups and/or frequency-based dietary quality indices, biomarkers of dietary intake, and/or measures of nutritional status[14,15,17-20]

The present study involves assessing the utility of a liking survey, the Pediatric-adapted Liking Survey (PALS), to screen for diet and activity behaviors in children and parents/caregivers who have used the PED for non-urgent care. The specific aim was to assess the internal reliability and construct validity of a Healthy Behavior Index (HBI), constructed from the PALS. As shown in Table 1, measures of internal reliability and construct validity were assessed following the guidelines of Guenther et al,[21] that were used to evaluate the Healthy Eating Index 2010.[22,23] Concurrent criterion validity also was assessed through the ability of the HBI to detect differences in reported lifestyle between child and parent, by the child's age and gender, proxies of the family's economic status, as well as by the child's adiposity. Need to mention regression analysis?

Table 1. Tests to assess the internal reliability and validity of the Healthy Behavior Index (HBI)[21]

Question	Test statistic
Reliability	
How internally consistent is the total score?	Cronbach's Alpha
What are the relationships among the index components?	Pearson's *r* correlations between each component
Which components have the most influence on the total score?	Pearson's *r* correlations between each component and the total index
Construct and Concurrent Criterion Validity	
Does the index score foods and behaviors based on those recommended by the 2015 Dietary Guidelines?	Descriptive statistics
Does the index allow for sufficient variation in scores among individual?	Measures of central tendency, histogram, normality testing (Kolmogorov-Smirnov)
What is the underlying structure of the index (i.e., > 1 dimension)?	Principal component analysis and plot; derived factors to explain >50% of variance
Does the index distinguish between groups with known differences in diet quality (i.e., concurrent criterion validity)?	Descriptive statistics, ANOVA with post-hoc analysis, ANCOVA, multiple regression analysis between demographic characteristics, liking for physical activity and child's level of adiposity

2.3 METHODS

This observational study had the recruitment goal of enrolling a convenience sample of 1,000 children-parent dyads who sought medical care at CT Children's Medical Center's (CCMC) Pediatric Emergency Department (PED) in Hartford, CT. The sample size was to assure sufficient diversity in the child and/or parent/caregiver in demographic variables, lifestyle behaviors, and adiposity to address the study aims. The data were collected from March 2013 to April 2016 on patients aged 5 to 17 years old (until 18th birthday). The final study sample was 925 child/parent dyads that were diverse in child age, race/ethnicity, and measures of family economic status (Table 2). Children were excluded from participating if they had history of severe behavioral/mental health condition or diagnosed eating disorder, were non-English speaking, or too ill to participate (determined by attending physician). Both the University of Connecticut and CCMC Institutional Review Boards approved this study. To participate, parents/guardians signed informed consent, and children aged 7 and older signed assent. Medical staff members participating directly in the child's care obtained verbal permission for trained research assistants (RAs) to approach and explain this study. Additional eligibility criteria were then confirmed using the electronic medical record.

Table 2. Characteristics of CCMC PED patients

	N=925	%
Age **[Avg. 10.9 y]**		
5 - <9 y	356	38
9 - <13 y	257	28
13 – 17 y	312	34
Sex		
Male	463	50.1
Female	462	49.9
Race/Ethnicity		
Caucasian	357	38.6
Black	133	14.4
Hispanic	344	37.2
Other	91	9.8

Insurance		
Private	382	41.3
Public	507	54.8
Self Pay	16	1.7
Other	20	2.2
Income Level*, [a]		
< $21,432	26	2.8
$21,433 - $41,186	288	31.1
$41,187 - $68,212	245	26.5
$68,213 - $112,262	313	33.8
≥ $112,263	29	3.1
Food Insecurity*, [b]		
Greatest risk	574	62.1
Higher than average risk	102	11
Lower than average risk	134	14.5
Lowest risk	99	10.7

*Percentages ≠ 100 due to missing data (<3%)
[a]Based on zip code analysis using U.S. Census Bureau data from the 2010-2014 American Community Survey 5-Year Estimates[24]
[b]Based on data from the Zwick Center for Food and Resource Policy and the Cooperative Extension System at the University of Connecticut[25]

2.3.1 Procedure

Data collection took place in the patient's PED exam room. Trained RAs enrolled patients and facilitated data collection. Following a flow sheet, RAs confirmed the inclusion and exclusion criteria and collected the parent/guardian name and address, as well as the child's age, sex, race/ethnicity, type of insurance, and history of chronic medical condition (e.g., asthma, diabetes). Additional measures are described below. The data collection averaged about five minutes.

2.3.2 Proxies of Family Income and Food Resources

The community of family residence by zip code reported by the parent/caregiver was used as a proxy of family income and level of food insecurity. Median household income by zip code reported by the U.S. Census Bureau, 2010-2014 American Community Survey 5-Year

Estimates, was used to determine the family income level.[24] Additionally, a ranking of Connecticut's town's food security completed by the Zwick Center for Food and Resource Policy based on the town's economic and social characteristics, access to food retailers, and utilization of public food assistance, was used to code for participants' risk of food insecurity.[25]

2.3.3 Pediatric-Adapted Liking Survey (PALS)

Both child and parent/guardian were asked to complete the PALS, a food and activity liking/disliking survey, based on their own likes and dislikes (average completion time was <4 minutes). This simple, three-page survey consisted of 33 food items and activities, represented with both pictures and words. There were 3 to 4 items included in each of the 8 major food/nutrient groups (fiber, salty, vegetables, fruits, sweet drinks, milk, protein, sweets), physical activities, and technology. Participants reported their level of liking/disliking, marking a perpendicular line anywhere along the scale with seven faces labeled as *love it*, *really like it, like it, it's ok, dislike it, really dislike it, and hate it*. Distance was measured from the center of the scale (0; *he/she thinks it's okay*) to the participant's marking, with a maximum of +100 (*he/she loves it*) and a minimum of -100 (*he/she hates it*). Children and parents/caregivers also could mark "never tried/done." Previous work, testing the liking survey in the PED and retesting at home, yielded similar results in both settings, supporting its test-retest reliability and that a child's responses in a PED are a reasonable indicator of responses at home.[26]

<u>The Healthy Behavior Index (HBI) Score</u> was conceptually constructed based on the 2015 Dietary Guidelines,[27] with a single score of dietary quality similar to the USDA's Healthy Eating Index (HEI)[22,23] and following our previously validated liking-based dietary quality indices.[20,28,29] The HBI differs from these liking-based dietary quality indices in that it also

included liking/disliking of using technology. Similar to our previous studies,[20,28] foods and activities from the liking survey were grouped into conceptual groups: vegetables, fruits, protein, sweets, sugary drinks, fiber, salty, dairy, physical activity and technology. Next, positive and negative weights consistent with the Dietary Guidelines were assigned to each group: vegetables (+3), fruits (+2), protein (+2), sweets (-3), sugary drinks (-3), fiber (+2), salty (-2), dairy (+2), physical activity (+2) and technology (-3). The final HBI was scored from six of the groups that formed an internally reliable, normally distributed index: vegetables, fruits, protein, sweets, sugary drinks, and technology. The HBI equaled the average of these weighted groups; higher scores indicated healthier behaviors.

2.3.4 Measured and Self-Reported Adiposity

Multiple anthropometric measures were collected by trained RAs, including height (cm; portable Stadiometer, Seca) and weight (kg; from electronic health record) for calculating body mass index (BMI) and waist circumference (WC; cm; flexible measuring tape), and used to calculate age-and-sex specific BMI and WC percentiles. Specifically, the online CDC BMI percentile calculator,[30] with the child's exact age (based on birth and measurement dates), was used to assign underweight $<5^{th}$, healthy weight 5th – $<85^{th}$, overweight 85th – $<95^{th}$, or obese $\geq 95^{th}$ percentile.[31] WC percentiles were calculated using percentile standards based on The Third National Health and Nutrition Examination Survey data,[32] and categorized into underweight $<10^{th}$, healthy weight 10th – $<80^{th}$, overweight 80th – $<90^{th}$, or obese $\geq 90^{th}$ percentile. Central adiposity has been associated with cardiovascular risk factors, type 2 diabetes, and many other comorbidities in adults and children;[32,33] WC as a valid measure of adiposity[34] may improve the ability to predict risk of future obesity-related illnesses.[34-36] Parents/caregivers and children self-

reported the child's body size using sex-specific, 7-point Collins Drawings,[37] where underweight was <2, healthy weight 2 to <5, overweight 5 to 6, and obese ≥6.

2.3.5 Data Analysis

All data were analyzed using SPSS statistical software (version 22.0) and RStudio (version 0.99.482). Significance levels were set at $p<0.05$ for all analysis. Descriptive statistics were used to compare measured adiposity against national statistics and contrast measured versus self-rated body size. All variables were evaluated for distribution, normality and central tendency. Following Table 1, the assessment of reliability and validity of the HBI is described below.

Reliability of the parent/child HBI was determined by 1) Cronbach's alpha ($\alpha > 0.7$) to test its internal consistency; 2) Pearson's correlation analysis to determine the association among the HBI components and which components influence the index most.

Construct and/or concurrent criterion validity of parent/child HBI was determined by: 1) measures of central tendency and Kolmogorov-Smirnov analysis to test normality and variability; 2) principal component analysis (PCA) to determine the underlying structure of the index; and 3) Analysis of variance (ANOVA) with post-hoc Tukey tests to determine if the index is able to distinguish between groups with known differences, including gender, race/ethnicity, insurance type, income level, risk of food insecurity, and adiposity.

In addition, direct relationships between the parent's and child's HBI and adiposity were examined with multivariate analysis. Specifically, standard multiple linear regression analysis was used to determine if a relationship existed between the child and/or parent HBI and BMI

percentile while controlling for demographic variables, such as gender, age, proxies of family income, and child's liking of physical activity.

2.4 RESULTS

2.4.1 Child Adiposity

Overall, 37.4% of children were classified as overweight or obese by BMI percentile (Table 3), compared to 28.5% by WC percentile. BMI and WC percentiles were highly correlated (Spearman's rho=0.727, p=0.000). The frequency of overweight or obese by BMI percentile from our sample was comparable to the national average of 36.6% of children aged 5 to <18 years old[38] (Table 4); however, the study sample showed a higher percentage of overweight and obese males. Children ages 9 to 13 years old had higher rates of overweight (21% by BMI and 13.2% by WC percentile) and obesity (25.3% by BMI and 21.4% by WC percentile) than any other age group. Overweight and obesity rates were fairly similar between boys and girls. Extreme obesity (BMI ≥120% of the 95th BMI-for-age/sex percentile[3]) in children ages 6–11 and 12–19 years old was 7% and 9.5%, respectively, and exceeded the national averages of 4.3% and 9.1%, respectively.[3] Based on self-report, 29.4% and 27% of children (n=896) and parents (n=897), respectively, perceived themselves or their child to be smaller than their measured BMI percentile.

Table 3. Body Mass Index (BMI) percentiles by age and gender of children who were patients at a pediatric emergency department (PED)

	5-<18 years		**5 - <9 years**		**9 - <13 years**		**13 - <18 years**	
	Count	**%***	**Count**	**%***	**Count**	**%***	**Count**	**%***
5th – <85th percentile								
Male	275	29.7	102	28.7	74	28.8	99	31.7
Female	277	29.9	110	30.9	59	23.0	108	34.6
Total	552	59.6	212	59.6	133	51.8	207	66.3

85th – <95th percentile								
Male	68	7.4	22	6.2	31	12.1	15	4.8
Female	82	8.9	27	7.6	23	8.9	32	10.3
Total	150	16.2	49	13.8	54	21.0	47	15.1
≥95th percentile								
Male	105	11.4	48	13.5	35	13.6	22	7.1
Female	91	9.8	28	7.9	30	11.7	33	10.6
Total	196	21.2	76	21.4	65	25.3	55	17.7

*Percentages ≠ 100 due to missing data (Percent of total sample size, N=925; <2% missing)
Underweight (<5th percentile) not shown due to small sample size (n=19, avg. age= 9.7 years, mean BMI percentile= 1.52 and SD= 1.33)

Table 4. Body Mass Index (BMI) percentiles of children (5 to <18 years) who were patients at a pediatric emergency department (PED) compared to 2013-2014 U.S. averages

	U.S.* (%)	**PED (%)**
≥85th percentile	**36.6[a]**	**37.4^**
Male	36.1[b]	37.4†
Female	37.5[b]	37.4†
≥95th percentile	**19.6[a]**	**21.2^**
Male	19.1[b]	22.7†
Female	20.3[b]	19.7†

*U.S. prevalence based on 2013-2014 NHANES data[38]
^ Percent of total sample size, N=925
† Percent of sample size of respective gender (male n=463; female n=462)
[a] Percent of total sample size, N= 2550
[b] Percent of sample size of respective gender (male n=1314; female n=1236)

2.4.2 Relative Comparison of Parent and Child Food and Activity Preferences:

Figures 1 and 2 illustrate differences between child and parent rating of foods and activities. Across the sample, parents rated highest liking of fruits and physical activity, whereas children reported higher liking for sweets and use of technology (e.g. watching TV, playing video games, and listening to music). Children reported lower liking for fiber-rich foods and vegetables compared with parents who had a relatively high overall liking for these foods. Variance within food/activity groups was highest for children's liking of healthier groups (vegetables, fruit, proteins), and parent liking of the less healthy groups (sweets drinks, and sweets) (Table 5). For both children and parents, the least liked items had the highest variability

in ratings. Effect sizes show the magnitude of difference between child and parent dyads and were largest for vegetables, sweet drinks, technology, and sweets.

An additional categorical variable was created in order to test the relative liking for sweets and technology in children, the two highest ranked groups. Average liking of technology was subtracted from the average liking of sweets and then coded into three groups of children: greater liking of technology than sweets; equal preference of technology and sweets; greater liking of sweets than technology. From ANCOVA controlling for age and gender, children who had a higher affinity for use of technology than sweets had significantly higher WC [$F(2, 868)=3.265$, $p<0.05$] and BMI [$F(2, 873)=4.022$, $p<0.05$] percentiles than children who preferred sweets to technology.

Figure 1. Reported liking of groups by % of sample of children (n=925), from most to least liked.

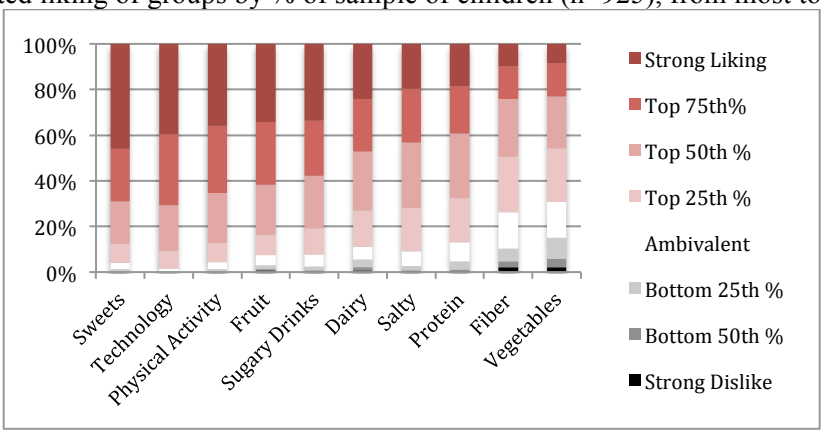


Figure 2. Reported liking of groups by % of sample of parents (n=925), from most to least liked.

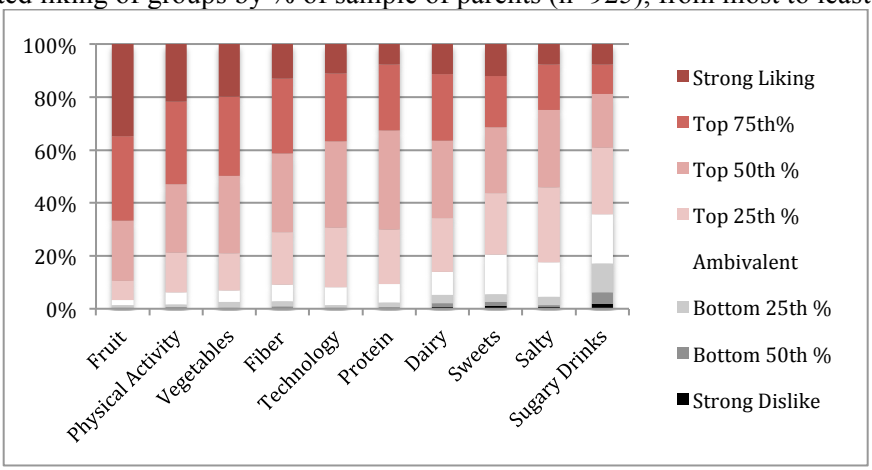


Table 5. Variance and estimated effect sizes of parent and child survey-reported preferences of food/activity dyads (n=925)

	Child			Parent			Effect Size
	Mean	**SD**	**Variance**	**Mean**	**SD**	**Variance**	**Cohen's *d***
Vegetables	19.49	40.45	1636.56	48.40	30.63	938.32	0.81*
Fruits	56.89	33.14	1098.01	60.53	27.38	749.74	0.12
Protein	40.94	35.25	1242.68	37.87	27.90	778.63	0.10
Sweet Drinks	54.98	33.30	1108.73	14.05	39.57	1565.45	1.12*
Technology	64.29	26.49	701.56	39.91	27.71	767.95	0.90*
Sweets	64.40	31.21	974.24	30.98	36.30	1317.68	0.99*
Fiber	23.58	38.43	1476.74	41.58	30.60	936.42	0.52
Salty	44.08	32.07	1028.39	28.32	30.55	933.43	0.50
Physical Activity	59.51	29.80	888.13	49.31	30.67	940.40	0.34
Dairy	45.56	36.69	1346.34	35.45	34.61	1198.04	0.28

*Large effect size

2.4.3 Internal Reliability of Parent and Child HBI:

After testing a number of combinations of food and activity groups, the following combination yielded the most reliable index: vegetables, fruits, protein, sweets, sugary drinks, and technology. Both the parent and child HBI approached internal reliability, as tested by Cronbach's alpha (parent HBI $\alpha = 0.646$; child HBI $\alpha = 0.613$). Children who reported liking healthier foods and behaviors received a higher score on the weighted index, when compared to those who preferred less healthy foods and behaviors, as seen by comparing the lowest and top quartiles of the indices across the sample (Table 6). The same pattern was seen for parents.

Children and parents who reported high liking of sweets also reported significantly higher liking of sedentary behaviors and sugary drinks, as well as lower liking (disliking) for vegetables (all Spearman's rho's, $p<0.01$). The child and parent HBI scores are highly influenced by liking of vegetables, sugary drinks, and sweets (Pearson's r, $p<0.01$) (Table 7).

Table 6. Child Healthy Behavior Index (HBI) component scores are consistent with less healthy (lowest quartile) and healthiest (highest quartile) dietary behaviors

	Lowest Quartile*	**Highest Quartile***
Sugary Beverages	75.915	28.411

Sweets	84.667	38.029
Use of Technology	78.295	45.413
Vegetables	-19.583	45.238
Fruit	43.483	64.155
Protein	31.465	41.351
Mean HBI Score	-104.262	1.657

* Mean score in designated quartile

Table 7. Component correlations within overall Healthy Behavior Index (HBI)

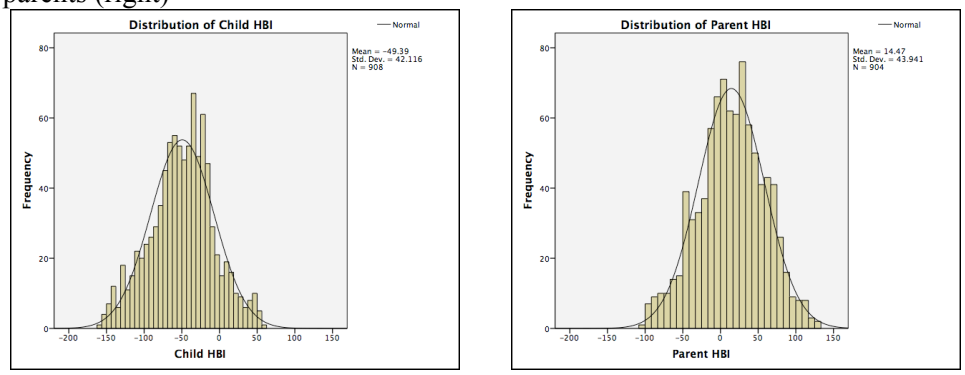
		Vegetables	**Fruit**	**Protein**	**Technology**	**Sweet Drinks**	**Sweets**
Child HBI	Pearson's *r*	.625**	.285**	.118**	-.465**	-.549**	-.595**
Parent HBI	Pearson's *r*	.528**	.263**	-.169**	-.557**	-.713**	-.734**

** Correlation is significant at the 0.01 level (2-tailed)

2.4.4 Construct Validity of the HBI

The child HBI was normally distributed (Kolmogorov-Smirnov=0.028, p=0.081), averaging -49.39 ±42.1 SD (Figure 3), as was the parent HBI (Kolmogorov-Smirnov =0.02, p=0.200). The parent's HBIs were distributed toward higher scores than were the children's HBIs, with a higher average score of 14.47±43.9 SD (Figure 3). Both child and parent scores were highly variable. Although weak, child HBI showed a significant positive correlation to parent HBI (r=0.219, p<0.01). Individual components of the HBI scores followed the same pattern: weak but significant positive correlation between parent and child liking of vegetables, fruits, protein, technology, sweet drinks, and sweets (r=0.082 – 0.239, p<0.05).

Figure 3. Histograms showing normal distributions of HBI scores in children (5-17 years old.; left) and parents (right)



The principal component analysis of the child HBI revealed two underlying dimensions (Figure 4), which can be labeled as healthy and less healthy (Table 8) and which accounted for 57.2% of total variance across the indices. However, the protein group did not load completely on either dimension. The principal component analysis for the parent HBI yielded similar results. Two dimensions were identified (Figure 5; Table 9), accounting for 62.7% of total variance. Unlike the child indices, the protein group more strongly loaded with the less healthy items.

Figure 4. Scree plot (left) and rotated component loading plot (right) from principal component analysis of child Healthy Behavior Index (HBI) showing the amount of variance accounted for by each dimension

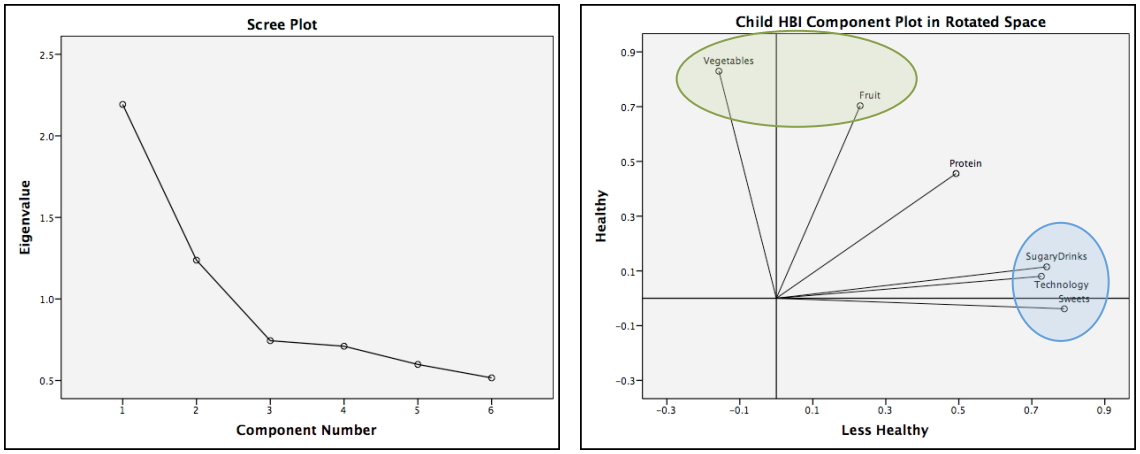


Table 8. Child Healthy Behavior Index (HBI) dimensions

	Less Healthy*	Healthy*
Vegetables	-0.157	0.830
Fruits	0.230	0.703
Protein	0.492	0.456
Technology	0.726	0.080
Sugary Drinks	0.741	0.115
Sweets	0.789	-0.039

*Rotated component matrix values

Figure 5. Scree plot (left) and rotated component loading plot (right) from principal component analysis of parent Healthy Behavior Index (HBI) showing the amount of variance accounted for by each dimension

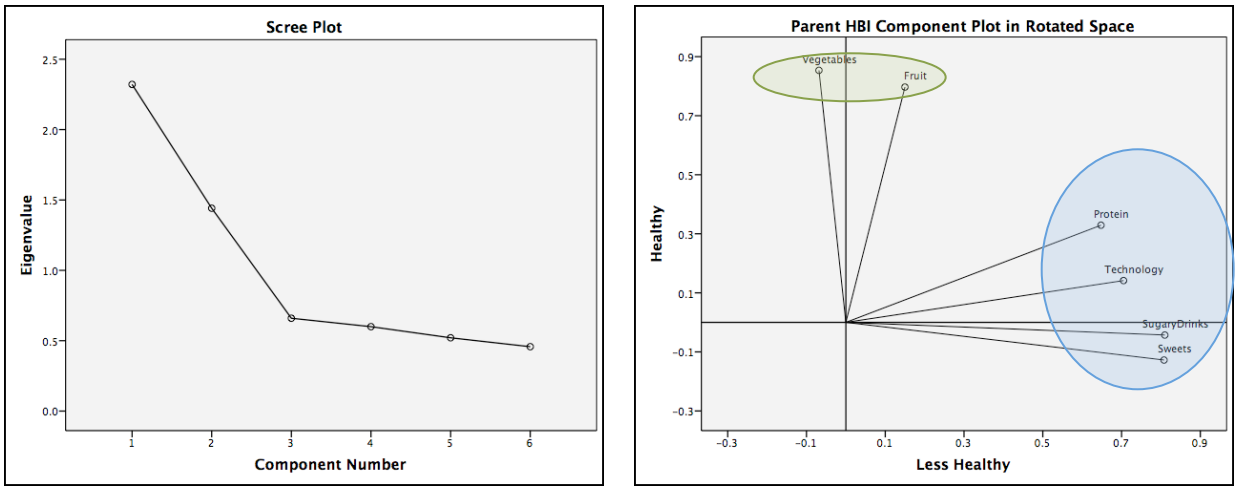


Table 9. Parent Healthy Behavior Index (HBI) dimensions

	Less Healthy*	Healthy*
Vegetables	-0.068	0.854
Fruits	0.150	0.797
Protein	0.648	0.329
Technology	0.705	0.142
Sugary Drinks	0.810	-0.043
Sweets	0.808	-0.128

*Rotated component matrix values

2.4.5 Concurrent Criterion Validity of the HBI

As shown in Table 10, the comparison of mean differences in child HBI scores via ANOVA with post-hoc tests as appropriate revealed significant effects of gender (males<females), health insurance type (public<private), race/ethnicity (Hispanic/Latino and Black/African American<White), income levels (determined through zip code analysis;[24] low income<high income), and risk of food insecurity (determined through zip code analysis;[25] high risk<low risk). Similar findings were seen for child or parent reported HBI. Higher age was correlated with healthier behaviors (r=0.239, p=0.000) with similar associations in females

(r=0.263, p=0.00) and males (r=0.202, p=0.000). In an income by race/ethnicity ANCOVA controlling for age and gender, only income category was a significant contributor to child HBI score (p<0.001) with no significant interaction with race/ethnicity (p=0.09). In a gender by race ANCOVA controlling for age, there were significant main effects (p=0.008 and 0.014, respectively) on child HBI, but no significant interaction effects. In summary, children who were older, white, female, and from families with private insurance, and from communities with higher-income and lower risk for food insecurity had the highest or healthiest HBI scores.

No significant differences in child HBI scores were found between BMI and WC percentile categories. Parent HBI scores followed similar trends. However, among children who were of normal weight (BMI percentile between the 10th and 85th percentiles), a higher child or parent HBI tended to associate with lower BMI percentile.

Table 10. Analysis of variance for mean child and parent Healthy Behavior Index (HBI) scores by child's demographics, community food environment, and adiposity

	Child				**Parent**			
Characteristic*	**Mean HBI**	**N**	**SD**	***p*-value**	**Mean HBI**	**N**	**SD**	***p*-value**
Gender								
Male	-53.77	449	40.07	0.002**	12.97	449	44.76	0.280
Female	-45.26	439	42.96		16.17	439	43.90	
Race/Ethnicity								
White	-41.13	341	42.31	0.000**	22.95	341	43.07	0.000**
Af. Amer./Black	-55.17	129	39.31	0.006†	10.12	129	43.29	0.023†
Hispanic/Latino	-55.47	330	40.74	0.000†	8.65	330	44.16	0.000†
Insurance Type								
Private	-44.04	364	40.37	0.001**	23.67	364	41.27	0.000**
Public	-53.68	490	41.94		7.26	490	45.02	
Income Level								
$21,433-41,186	-58.92	277	40.88	0.000**	4.80	277	45.17	0.000*
$41,187-68,212	-47.43	234	41.46	0.015[a]	14.70	234	41.28	0.075
$68,213-112,262	-41.77	301	40.99	0.000[a]	24.38	301	42.32	0.000[a]
Food Insecurity								
Greatest risk	-54.21	552	40.93	0.000**	7.78	552	43.50	0.000**
> than avg. risk	-46.09	99	42.09	0.272	19.66	99	46.42	0.058
< than avg. risk	-40.68	125	38.95	0.005[b]	27.90	125	39.89	0.000[b]
Lowest risk	-36.76	97	44.62	0.001[b]	27.29	97	42.26	0.000[b]

BMI Percentile								
Normal weight	-49.59	523	40.71	0.738^	14.82	523	44.31	0.759^
Overweight	-46.59	149	42.42	0.716^^	12.00	149	40.65	0.767^^
Obese	-48.99	189	42.67	0.984^^	15.14	189	44.48	0.996^^
WC Percentile								
Normal Weight	-48.88	580	41.83	0.942^	14.62	580	44.28	0.805^
Overweight	-48.99	112	36.32	1.000^^	16.64	112	41.82	0.898^^
Obese	-50.20	144	44.20	0.937^^	12.97	144	45.67	0.915^^
Overall	-49.39	908	42.12	---	14.47	904	43.94	---

*Characteristics of child, not parent
**Overall significant result, p<0.05
† Significant result, p<0.05, compared to white
a Significant result, p<0.05, compared to lower income level ($21,433-41,186)
b Significant result, p<0.05, compared to those at greatest risk for food insecurity
^Overall p-value
^^p-value compared to normal weight

A multiple linear regression model predicting child BMI percentile from child and parent HBI score, gender, insurance, and child liking for physical activity, was not significant for all participants. However, among children of healthy weight (between 10th and 85th BMI percentiles), significant predictors of higher child BMI percentile were seen among lower parent HBI scores (β=-0.11, $p<0.05$) and higher activity score (β=0.15, $p<0.005$).

2.5 DISCUSSION

The USDA's Healthy Eating Index (HEI) has been validated as a reliable measure of dietary quality.[21,39] The present observational study examined the internal reliability and validity of a Healthy Behavior Index (HBI) generated from a simple liking survey, the Pediatric-Adapted Liking Survey (PALS), tested on a convenience sample of over 900 child/parent dyads recruited from a single urban, pediatric emergency department. The HBI demonstrated both adequate internal reliability and construct validity. The HBI was able to detect differences in dietary quality and health behaviors between groups with previously identified differences in these lifestyle behaviors including gender (females>males), age (older>younger), parent>child,

insurance (private>public), and proxies of the family income based on community demographics and food security (higher income/food security>lower income/food security). A healthier child or parent lifestyle index failed to explain adiposity across the sample. However, these indices were associated with lower adiposity among healthy weight children, with the parent index just reaching significance.

The prevalence of overweight and obesity in this study population is comparable to that of the U.S., but with a greater percentage of children being classified as extremely obese. Parent and child food/activity preferences differed greatly, with the largest difference between liking for vegetables, sweet drinks, technology, and sweets. Children reported a greater affinity for foods higher in sugar, such as sweets, fruit, and sweet drinks, whereas parents ranked these foods much lower, with the exception of fruit. This finding is supported by previous literature suggesting that children prefer higher level of sweets than adults, possibly because of its link to physical growth and the need for additional calories during development.[40] As higher consumption of added sugar is associated with poor diet quality and excess adiposity,[41] children should be encouraged to replace high-sugar foods with healthier sweet options, such as fruit.

We found that the PALS and HBI were feasible assessment tools, as they can be replicated and completed in a short amount of time and without expensive dietary analysis. Other research suggests that simple indices may be useful in a clinical setting, as they have lower participant and researcher burden and can provide immediate feedback to families.[42] Based on the criteria developed by Guenther et al, the HBI has reasonable reliability, as shown by adequate internal consistency and intercorrelation between the index components. Previous work, where the liking survey was tested in the PED and then retested at home, yielded similar results in both settings, providing evidence to support test-retest reliability.[26] Although

Cronbach's alpha for the child and parent HBI fell just below the traditionally accepted value of α= 0.70, according to Guenther et al,[21] this is to be expected due to the complex nature of measuring dietary quality, and therefore internal consistency is not a required characteristic of the HEI.[21]

Both the child and parent HBI were normally distributed and highly variable. The overall parent and child HBI's, as well as the individual components, were all weakly, yet significantly, correlated. This indicates a positive relationship between parent and child liking of food groups, as well as overall diet quality and health behaviors. Previous studies on parent-child dyads also found significant relationships between dietary quality and intake,[43,44] likely due to parental influences and a shared food environment.[43,45] Additionally, this index has a multi-dimensional structure. The child HBI consists of two dimensions, which can be categorized as healthy (fruits and vegetables), and less healthy (sweets, sweet drinks, and technology). The sixth component of the HBI— protein foods— did not fully load with either of these groups, potentially because of the nature of its components. The protein group consisted of a hamburger, chicken nuggets, tuna fish, and eggs. Two of these food items are considered nutritionally "healthier" (tuna fish and eggs) and two are deemed "less healthy" (hamburger and chicken nuggets). Therefore, it is possible that the variety of items within the protein group caused this component to load with neither of the established factors. Overall, these factors successfully explained greater than 50% of variance in the index.

The HBI also showed concurrent criterion validity through its ability to detect variability within subpopulations of our study sample (gender, age, race/ethnicity, insurance type, income level, and risk of food insecurity). Our results are similar to previous work, with a few exceptions. A good comparison is a study by Hiza et al. using the 2005 Healthy Eating Index

(HEI) to measure dietary quality of Americans who participated in the 2003-2004 National Health and Nutrition Examination Survey.[46] These researchers found the following differences in total HEI score: women>men, younger children>older children, Hispanics>Blacks but not Whites, and higher income>lower income.[46] Our results, as well as others,[47,48] agree that girls have higher dietary quality and health behaviors scores than boys. Interestingly, our results differ from Hiza et al. in that we found older children had higher average HBI scores than younger children, which contradicts other studies that also suggest dietary quality decreases with age.[46,47,49,50] Previous research has found that older children are more likely to misreport health behaviors due to social pressures and expectation,[51] which may explain our findings. Our results partially agree with Hiza et al. regarding race/ethnicity, in that we also found White children to have higher dietary quality and health behaviors than Hispanics/Latinos,[46] however, we found no significant difference between Blacks/African Americans and Hispanics/Latinos. Additionally, when examining proxies of the family income based on community demographics, we found that families with lower income, receiving public medical insurance, and at high risk of food insecurity had lower HBI scores than their counterparts, which is consistent with Hiza et al[46] and many other studies examining income levels and food insecurity.[47,49,52,53] Finally, although not studied by Hiza et al, our results are comparable to previous work,[43,44] in that parent dietary quality and health behaviors were better than their children's.

In order to evaluate the utility of an index, it is important to determine its relationship with health outcomes.[42] Multiple regression analysis indicated a significant, but weak association between the parent HBI and adiposity in healthy weight children—parents with healthier behaviors (higher HBI scores) had children with lower BMI percentiles. Parental eating practices, including food preferences and food purchases, are known to influence child eating

practices.[45] Therefore, utilizing the PALS and HBI with both parents and children is necessary to obtain a more complete picture of the family's behaviors in order to aid in obesity screening and preventative efforts. This index may help determine dietary and lifestyle behaviors that are both beneficial to the child's health as well as those that are detrimental and may cause increased risk of overweight or obesity. In addition, the multiple regression analysis found a positive association between physical activity and BMI percentile, suggesting that children with higher adiposity have a higher liking for physical activity. Although this result was unexpected, previous research has found that obese children are more likely to report participating in healthy behaviors.[54] These children were also more likely to have been informed of their weight status by a physician,[54] which may indicate a higher awareness of future health risks, and therefore a desire to change health behaviors. However, misreporting is also possible. Weight status has been shown to influence dietary reports by children,[55] with heavier children being more likely to misreport health behaviors due to social pressures and expectations.[51] This could potentially explain why the parent HBI was a better indicator of the child's adiposity, and specifically in healthy weight children.

The PALS and subsequent HBI are unique in that they incorporate not only foods, but also behaviors, particularly sedentary behaviors and the use of technology. In the present study, children reported a high liking for use of technology. According to the American Academy of Pediatrics, children older then two years should limit screen time to one to two hours per day,[56,57] although on average "tweens" (8 to 12 y.o.) and teens (13 to 18 y.o.) spends six and nine hours per day, respectively, on various forms of entertainment media, not including time spent on homework or in school.[58] Excessive screen time has been linked to lower dietary quality[59] and negative health outcomes, including increased rates of obesity, hypercholesterolemia,

hypertension, and more.[56] When compared to liking for sweets, we found that children with a higher affinity for use of technology than consumption of sweets had significantly higher WC and BMI percentiles than those who preferred sweets to technology. Therefore, it is important to address not only dietary habits, but also daily activities of children in order to prevent obesity. Fortunately, physical activity was also ranked relatively high, for both parents and children, indicating that it is enjoyable for all ages. Promoting activities that involve the entire family have the potential to increase rates of physical activity among children.[60] Additionally, parental encouragement of physical activity has shown positive longitudinal effects on physical activity in adolescents.[61] Increased physical activity and decreased sedentary behaviors in children have been shown to provide health benefits, including lower levels of adiposity,[62] and should therefore be encouraged.

2.5.1 Strengths and Limitation

This study was conducted in a pediatric emergency department, which previous research has shown is an acceptable setting for obesity screening and education, particularly because high-risk populations, such as low-income, minority families, are seeking medical care.[9-11] Additionally, this study utilized a unique lifestyle assessment tool that is feasible for children aged 5 to 17, as it uses pictures and words to represent the survey items, as well as a simple hedonic scale. Furthermore, we assessed the reliability and construct validity of this Healthy Behavior Index using multiple statistical techniques and criteria outlined by Guenther et al.[21] We collected food preference data from both the child and parent, allowing us to examine two sets of the lifestyle behaviors that may influence the child's adiposity. Finally, various measures of adiposity were obtained from each participant. Although WC percentile and child- and parent-

reported perception of body size did not enhance the analysis, these measures were collected and tested along with the more traditional measure of BMI percentile. As with every study, there are limitations. The primary limitation to this study is the potential for individual rater error when grading the PALS and taking anthropometric measurements. In order to decrease potential errors, multiple trained RAs reviewed all grading and calculations for accuracy. There is also the possibility of misreporting, particularly among overweight/obese and older children.[51] Finally, only one measure of dietary quality was taken. Pervious studies have shown the importance of utilizing multiple measures, including biomarkers, in order to better determine overall dietary quality[20]

2.5.2 Future Research

There are many possibilities for future research utilizing simple preferences surveys. Additional research must be done on the ability of food and activity preferences surveys to explain adiposity in children. In addition, although zip codes were used to determine level of income and food security, actual location was not discussed in the current study. Individuals living in urban areas may also be living in a food desert, an area where healthy and affordable food is unavailable.[63] Therefore, food preferences and choice are likely dependent on what is readily available to that individual. Future studies should attempt to determine if geographic location mediates the effect of food preference on child's adiposity measures.

Future research efforts are currently underway to make the PALS accessible online using a smartphone or tablet, which will increase both feasibility, as well as the prevalence of nutrition education in the PED. The online survey will allow us to provide automatic feedback that is tailored to the individual based on personal food and activity preference responses and will

address areas in which the parent and child may be able to make small lifestyle behavior changes that will improve the child's weight status and overall health.

2.6 CONCLUSION

A simple liking survey can be used to generate a valid and reliable index to screen for obesity-related behaviors in pediatric emergency departments. Although additional research must be done on food preference surveys and their ability to explain adiposity, healthcare providers may be able to use the PALS and HBI to initiate conversations regarding behaviors that may increase the risk of obesity, and subsequently develop tailored behavioral prescriptions, including nutrition and activity recommendations, that best fit the child's needs.

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CHAPTER THREE

Exploring the use of mHealth Technology for Obesity Prevention in Children and Adolescents with Preliminary Usability Findings from a Novel Smartphone App

3.1 INTRODUCTION

With the increasingly high use of smartphones by individuals of all ages, mobile health (mHealth) technology may provide an innovative and effective platform for childhood obesity prevention and intervention programs. Therefore, faculty and students from the Department of Allied Health Science, including the SNAP-Ed team, and Departments of Communications and Engineering have worked together to create a mobile app to promote healthy living and an active lifestyle targeting income-disadvantaged adolescents. SNAP-Ed is the education component of the Supplemental Nutrition Assistance Program. As an Obesity Prevention Program, SNAP-Ed strives to provide evidence-based, nutrition education to low-income families, with a focus on obesity prevention. [1] In accordance with this program, our long-term goal is to integrate theory-based behavior change principles into a novel app, EAMAIL (Eat and Move As I Like), to help children increase their nutrition and fitness literacy, improve their efficacy for healthy eating and active living, and cultivate a healthy body image and self-esteem. This paper describes the first step of pilot testing the EAMAIL app prototype, with the primary aim of assessing its usability, usefulness, and user satisfaction, as well as to gain feedback on the simple health and nutrition messages provided.

3.2 BACKGROUND

3.2.1 Childhood Obesity

From 1988-1994 to 2013-2014, there has been a substantial increase in both obesity and extreme obesity among adolescents (12-19 years old) from 10.5 to 20.6% and 2.6 to 9.1%, respectively.[2] Childhood obesity increases the risk of other serious comorbidities[3] and has many financial consequences.[4] There are multiple racial/ethnic and socioeconomic disparities related to the risk of obesity in children. Both Latino/Hispanic (22.4%) and African American (20.2%) boys and girls are more likely than White children (14.1%) to be overweight or obese.[5,6] Sixty-nine percent of income-disadvantaged SNAP participants in 2014 were children and adolescents (5 to 17 years old)[1] and research shows that children from income-disadvantaged households are even more likely to categorized as overweight or obese.[7,8]

3.2.2 Use of Technology by Children and Adolescents

There has been an increase in the use of technology devices, particularly smartphones, with almost two-thirds of Americans owning smartphones in 2015.[9] Eighty-eight percent of teens own or have access to a mobile phone, 73% of which are smartphones.[10] Twenty-four percent of teens report being online "almost constantly" due to access through smartphones[10] and one in four teens "mostly" access the Internet via their cell phone.[11] Currently 91% of teens exchange text messages, with the typical teen (median) sending and receiving 30 texts per day.[10] Overall, mobile technology has significant use by this population. Smartphones and apps are widely available and have the ability to reach various demographic groups, including minorities and low-income populations.[11,12] Not only are children and adolescents using these forms of technology more readily, parents and caregivers are also interested in acquiring child nutrition information via technology.[13]

3.2.3 Use of mHealth Technology for Obesity Prevention

Due to the increase in technology usage by both children and adults, eHealth and mHealth platforms are now being utilized to facilitate dietary and fitness goals to reduce obesity.[14] Multiple reviews[12,15,16] show that mHealth approaches, via texting and smartphone apps, are feasible and acceptable tools for the prevention and treatment of pediatric obesity. As minorities and children from economically disadvantaged households are even more likely to become overweight or obese[7,17] mHealth approaches are potentially a great resource for reaching these typically underserved populations. [12,13] In a 2015 Pew Research Center report, 85% of African-American teens had access to a smartphone, compared to only 71% of White and 71% of Hispanic teens.[10] Additionally, 61% and 48% of teens from low-income households (<$30K) had access to a smartphone or tablet, respectively. [10]

3.2.4 Theories of Behavior Change and Their Use in Health/Nutrition Interventions

Behavioral change theories attempt to explain factors that influence an individual's ability and decision to change. These theories then provide a framework for designing and implementing various types of health intervention programs. [18]The use of theory-based strategies to promote health behavior changes is ideal, as many of these theories incorporate intrapersonal factors such as knowledge, attitudes, beliefs, motivation, skills, and self-efficacy. Health interventions based on these theories have proven to be successful. [19-34]

3.2.4a Transtheoretical Model

The Transtheoretical Model (TTM) examines readiness for behavior change by categorizing individuals into one of five stages of change, through which they will progress. The

stages are as follows: precontemplation, no intention to change; contemplation, recognition of a need to change; preparation, steps have been taken towards change in the near future; action, change has occurred; maintenance, change has been sustained for more than six months. [18,35] In order to progress through these stages, cognitive, affective, and evaluative processes are used by the participant (processes of change). Other important components of the TTM include: decisional balance, assessment of perceived pros and cons of the behavior; and, self-efficacy, degree of confidence an individual has regarding adoption of the behavior. [36] The TTM has proven to be a helpful framework for designing various types of health interventions, including weight loss and healthy eating, smoking cessation, and reducing behavioral risks that contribute to the development of chronic diseases. [19-23,33,34] Matching an individual's stage of change to the intervention in which they participate is key to their achievement of successful health behavior changes.

In an obesity and cardiovascular disease prevention study conducted by Frenn et al., [33] the TTM was used to provide tailored education on a low-fat diet and physical activity to low-income middle school students based on their stage of change. Students in the precontemplation or contemplation stages participated in four 45-minute classroom interventions aimed to increase knowledge and skills. Students in the preparation, action and maintenance stages participated in four small group sessions and prepared to be peer models for other. From the analysis, those in an earlier stage of change had lower self-efficacy and higher intake of fat. Overall, the intervention groups who were staged based on the TTM chose fewer high fat foods and increased their duration of physical activity. [33] In a similar study by Finckenor et al., [21] daily fat intake and stage of change was assessed in 110 undergraduate college students. The intervention group participated in 11 interactive lessons tailored to the pre-action stages. From pre to post test, those

in the experimental group averaged a significant reduction in fat intake and progressed in their stage of change. One-year follow-up results showed that stage progression persisted through that year. A limitation to this study is that students were sampled from nutrition classes; therefore, they may have had previous knowledge or interest in reducing dietary fat. Nonetheless, these results support the use of the TTM to match interventions with an individual's stage of change. [21]

In a quasi-experimental study with 507 economically-disadvantages African-American adolescents, Di Noia et al[20] applied the TTM framework to a computer-mediated intervention for increasing consumption of fruits and vegetables. The intervention group completed four 30-minute tailored interventions sessions regarding fruit and vegetable consumption. Those in the precontemplation stage received information to raise consciousness and promote acceptance of dietary change; contemplation/preparation were provided self-reevaluation and self-liberation strategies to increase self-efficacy; and action/maintenance were provided reinforcements. The authors concluded that tailoring interventions based on an individual's current stage of change resulted in an increased consumption of fruits and vegetables, 38% more than those in the control group, and promoted progress through the stages. [20] Overall, tailoring nutrition and health information to a child's stage of change can effectively facilitate health behavior changes. [20,21,33]

3.2.4b Theory of Planned Behavior

According to the Theory of Planned Behavior (TPB), an individual's intentions and actions are based on attitudes towards the behavior, subjective norms, and perceived behavioral control. [18,37] In other words, this includes: how the individual perceives the behavior, positively or negatively; the social pressure to engage in the behavior or not; and, their ability to perform the behavior. These factors contribute to the individual's readiness to take action as well as to

perform the behavior. [18,37]If health intervention programs can successfully address these three concepts, they will increase one's intention to change and contribute to change.

The TPB has widely been used to explain variability in health and nutrition behaviors and to create interventions. Blanchard et al[24], in a prospective study of 511 college students, examined constructs of the TPB (attitude, subjective norms, and perceived behavioral control) and fruit and vegetable consumption. Students completed a TPB questionnaire, and one week later, reported their fruit and vegetable consumption. Path analyses suggested that attitude and perceived behavioral control significantly predicted behavioral intentions, and therefore actions, toward consuming five servings of fruits and vegetables per day.[24] Researchers concluded from these findings that the TPB could provide a useful framework for a fruit/vegetable-based intervention program. In a similar study, Pawlak et al[25] used the TPB to describe beliefs from 157 ninth-graders about eating vegetables and further determined if those beliefs influenced intention to act. This descriptive study examined TPB constructs and behavioral intention to eat 2.5 cups of vegetables per day. From the analysis, all three components of the TPB, attitude, subjective norms, and perceived behavioral control, predicted intention to consume vegetables. [25] Although vegetable intake was not actually measured in this study, researchers concluded that intention to perform a behavior is highly correlated with the actual behavior.

According to Hackman et al., [26] few TPB-based nutrition/obesity interventions have been developed for adolescents, and those that have, have not been thoroughly reviewed for effectiveness. Therefore, a systematic review was conducted (n=11) on dietary behavior interventions for adolescents that utilized the TPB or Theory of Reasoned Action (TRA). [26] Nine studies resulted in dietary behavior changes, while ten reported change in at least one measured

construct. This review concluded that the use of the TPB showed a moderate effect on dietary interventions for adolescents and young adults.[26]

3.2.4c Self-Determination Theory

The Self-Determination Theory (SDT) focuses on motivation, personality, and optimal functioning. This theory posits that individuals have three basic psychological needs that must be supported. These include: competence—the need to effectively master an outcome; relatedness—the desire to connect with others; and autonomy—the need to control one's own future.[38-40] Both intrinsic and extrinsic motivation exists. Intrinsic motivation is doing something for oneself, which allows for the development of self-support and advocacy.[39] Multiple subtypes of extrinsic motivation exist, including external regulation (reward or punishment), introjection, identification, and integration.[40] Internalization occurs when extrinsic motivation becomes intrinsic, or autonomous.[27] This process leads to self-determined behaviors. The more intrinsic and extrinsic motivation that exists, the more self-sufficient the individual can be when performing the designated behavior.[38] Interventions based on the SDT show promising results in regards to changing various health behaviors, such as diet, smoking cessation, and chronic disease care.[27-30]

Few obesity interventions targeting children and adolescents have utilized the SDT alone, as it is usually paired with another theory, such as the Social Cognitive Theory (SCT). Wilson et al[31] conducted a student-centered intervention based on the SDT and SCT. This quasi-experimental study aimed to assess the intervention impact on physical activity in income-disadvantages adolescents. The intervention focused on increasing intrinsic motivation and developing behavioral skills for physical activity. More specific to the SDT, students developed

their own strategies for lifestyle and physical activity changes (to increase competence) and helped develop the actual intervention program (to enhance autonomy). Both of these elements worked to increase intrinsic motivation. From pre to post-intervention, students in the intervention versus control group spent more time engaging in moderate physical activity and had greater motivation. Future studies may benefit from utilizing this student-centered approach as it allows for autonomy and increased motivation to make a health behavior change.[31]

"Creature-101"[32] is a web-based game that promotes healthy eating and physical activity in young adolescents (11-13 years old) using an appealing, interactive platform. The SDT was used as a framework for the game: autonomy was enhanced through 'creature-care'; competence was increased by mastering challenges; and relatedness was achieved by caring for their creature in order to improve its health, as well as their own.[32] The SCT was also used to develop this game. Food and nutrition education was provided through mini-games, slideshows, and videos, which covered various topics such as sugar and fat content of beverages and snacks, and the importance of physical activity. Behavioral change techniques included goal setting, motivational messaging, outcome feedback/reinforcement, cues/triggers, and rewards. Majumdar et al.[32] conducted a pre-post intervention-control study (n=590) to test the effectiveness of "Creature-101." The intervention group reported decreased consumption of sugar-sweetened beverages and packaged snacks, but showed no change in fruit/vegetable or water intake, or amount of physical or sedentary activities. Overall, the SDT, when paired with another behavior change theory, may be an effective framework for nutrition-related interventions. Findings from Majumdar et al. also suggest that technology-based programs are a promising platform for childhood obesity interventions.[32]

3.2.5 Nutrition-Related Interventions for Children/Adolescents Using mHealth Technology

The popularity of mobile phones provides an opportunity to create more accessible health and nutrition programs. According to a national survey completed by Northwestern University, 21% of teens have downloaded health-related mobile apps, of which exercise and nutrition related apps are the most common.[41] Adolescents are interested in using smartphone technology for weight loss,[42] and mHealth programs seem to be advancing, as many have proven to be feasible, acceptable, and enjoyable tools for promoting healthy lifestyle and weight control in children and adolescents.[15,43-45]

In a review, Baranowski et al[46] discuss the importance of using interactive media to promote health and weight control in children. This review identifies five categories of electronic behavior change procedures: Web-based education/therapeutic programs, tailored message systems, data monitoring and feedback systems, active video games, and interactive multimedia involving games.[46] Each of these programs has potential benefits, including flexibility and convenience, as well as individualization of feedback messages and reminder prompts. However, there are also challenges, such as sustainability and creating interactive features that are engaging to adolescents. Overall, technology-based programs for children and adolescents should be developmentally appropriate and more research is required to determine which behavior change methods should be used to optimize health outcomes.[46]

Although mobile apps are becoming more popular, few studies have tested the effectiveness of standalone apps for the adoption of healthy behaviors in this population. Smith et al[47] created ATLAS (Active Teen Leaders Avoiding Screen-time), an obesity intervention using smartphone technology, and tested it among low-income adolescent boys. This app was created to help participants set personal health goals and monitor/track behaviors. Results of the

randomized controlled study show improvements in health related behaviors, such as screen time, physical activity, and consumption of sugar-sweetened beverages (SSB). However, this was primarily a school-based intervention, using the app to supplement education received elsewhere; therefore, conclusions about its effectiveness should be made with caution.[47] Nollen et al[48] tested an original, standalone app with a diverse group of 51 low-income, adolescent girls. The intervention targeted fruit/vegetable and SSB consumption, as well as screen time, via mobile technology providing cues to action, self-monitoring, feedback, and reinforcements. From pre to post-intervention, there were moderate effects for fruit/vegetable and SSB consumption in the mobile technology group.[48]

Turner et al[15] conducted a systematic review of mobile apps, games and text messaging programs for preventing and treating pediatric obesity. Mobile health tools were found to be enjoyable and feasible. The mobile apps were successful in promoting physical activity when coupled with social networking, self-monitoring and feedback features. Apps that provided nutrition education while using goal setting, reminders, feedback, diet tracking, and rewards, increased fruit and vegetable consumption and behavior change skills (i.e. self monitoring, goal setting). Multiple apps and games increased breakfast and fruit/vegetable consumption, physical activity, and decreased perceived barriers to engaging in physical activity. However, no significant improvements were found in adiposity measures with any mHealth program.[15] Overall, research in the field of mobile technology for adolescent health and nutrition needs to be strengthened, but these preliminary results are somewhat encouraging.

3.2.6 Use of Behavioral Change Theories in Child/Adolescent mHealth/Nutrition Programs

Although many teens are downloading health-related mobile apps, only 7% report changing a health behavior due to a phone application.[41] Brannon et al[16] reviewed 383

child/adolescent physical activity and dietary apps for the presence of behavior change techniques (BCTs). BCTs associated with changes in physical activity in adolescents included consequences for behavior, approval from others, self-monitoring, encouraging goal setting, and behavioral contracting; diet was predicted by modeling in adolescents and social support in children. Few apps incorporated the BCTs that were deemed effective; therefore, current apps are not likely to result in health behavior changes.[16] As the popularity of apps continues to increase, it is important that they include evidence-based BCTs. [16,49] In addition, a recently published review of 12 health apps (within 15 studies) for adolescents, focusing on nutrition, physical activity and obesity prevention, found that only five apps were developed using BCTs, specifically the TTM and the SDT. [50] Commonly used techniques included self-monitoring and performance feedback in the hopes of increasing awareness and motivation in the participants. [50]

Schoffman et al[12] analyzed 57 healthy eating, physical activity, and weight loss smartphone apps for children and teens. Researchers coded for inclusion of recommendations made by the 2007 Expert Committee for Pediatric Obesity Prevention (ECPOP). These recommendations included eight intervention strategies such as plotting BMI, using motivational interviewing, goal setting, involving family members, etc., as well as seven behavioral targets, such as reducing sugar-sweetened beverages, consuming ≥9 servings of fruits and vegetables, decreasing TV time, and ≥1 hour of physical activity each day. [12] Results show that 61.4% of apps did not use any ECPOP intervention strategies or behavioral targets. Goal setting was the most frequently used intervention strategy and highest rated apps only used six of the 15 strategies and targets recommended by the ECPOP. [12] These results are supported by Wearing et al,[51] who completed an in depth analysis of 62 apps for adherence to expert-recommended behaviors and strategies (as previously described) for pediatric obesity prevention. Overall,

adherence to guidelines was low, with recommended behavior targets being addressed much more frequently than intervention strategies. Additionally, only weak, non-specific promotion of these behaviors was found.[51] Overall, these findings suggest that, due to the lack of intervention strategies and behavioral targets, behavioral change by users is doubtful and interdisciplinary teams, including health professionals and app engineers, are needed in order to develop evidence-based mHealth programs for combating childhood obesity.[12,51]

3.2.7 Summary and Future Research

Based on the increasingly high prevalence of childhood obesity, more effective obesity prevention and intervention programs are needed, and technology-based programs may be an effective way to disseminate information and promote self-directed health care ideas to this population. Traditional health interventions using behavior change theories as a framework have been successful in producing positive behavior changes and therefore, provide a basis for which to create future programs. Although the TTM, TPB, and SDT were discussed here as effective behavior change theories, many more exist. For instance, the Social Cognitive Theory (SCT), which suggests that one's behavior is determined by the interaction of personal, behavioral, and environmental factors, with an emphasis on social influences,[52] has been used in conjuncture with the SDT to produce positive health behavior changes in children.[31,32] The use of other theories, such as the Self-Regulation Theory (Kanfer, 1970), which involves goal setting, self-monitoring, self-evaluation, self-reinforcement, and problem solving,[53] should be reviewed further. The constructs that make up these theories, such as stages of change, self-efficacy, attitude, perceived behavioral control, autonomy and competence, have successfully predicted and contributed to behavior change, specifically in child nutrition prevention and intervention

programs.[20,21,24-26,31-33] Therefore, these theories should be used as a foundation for developing technology-based health intervention programs.

Mobile health interventions have been developed for a variety of health behaviors, including weight loss, smoking cessation, chronic disease management, and medication adherence. However, the research shows mixed results on their effectiveness. Features that have shown success include text message support and reminders, self-monitoring, tailored feedback, and goal setting.[15,43,45,47,48,54-57] Although current mHealth programs have not yet shown an overwhelming impact on long-term health behavior changes, reviewing previous techniques may help provide an initial framework.

Currently, there is a gap between scientific literature and the mHealth programs available. Although a mobile technology approach to combating pediatric obesity is promising, multiple reviews have found a similar limitation: the majority of these apps are not created based on scientific theories of behavior change and do not include expert recommendations for reaching health goals.[12,16,50,58-60] Brannon et al suggests that the lack of regulation surrounding mHealth tools is detrimental because technology companies are not obligated to incorporate behavior change strategies into their products, therefore many programs exist that are unlikely to change health behaviors.[16] Overall, evidence-informed content is not readily available in these health apps[61] and incorporation of expert recommendations for pediatric obesity prevention are lacking.[12,51]

In conclusion, research suggests that there is a need for the development of interactive and adaptive health behavior interventions delivered via mobile technology.[62] Relying on behavior change theories to guide development of future mHealth programs will likely produce more effective mHealth programs for children and adolescent.[16] Additionally, interdisciplinary

teams, including various health professionals (dietitians, health psychologists, pediatricians, etc.) and app engineers, are needed in order to develop research-based programs for combating childhood obesity. [12]

After exploring the use of mHealth technology for obesity prevention in children and adolescents, a team of researchers, dietitians, and engineers from the University of Connecticut created the EAMAIL app prototype. Through collaborations with the SNAP-Ed team we were able to test this prototype with a high-risk population of income-disadvantaged adolescents. Consistent with SNAP-Ed goals, this prototype focuses on obesity prevention and the promotion of healthy eating and physical activity. The first phase of this study, described below, was to pilot test the EAMAIL platform as a simple system for reporting health behaviors. Our aim was to assess usability, usefulness, and user satisfaction, as well as to gain feedback on the simple health and nutrition messages provided. These preliminary findings are the first step towards creating a more effective obesity prevention mHealth program for children and adolescents.

3.3 METHODS

3.3.1 Program Development

3.3.1a Collaborators

This pilot study was made possible through various collaborations that ultimately formed our research team. First, multiple departments at the University of Connecticut came together to create this prototype. Graduate students and professors in the Department of Allied Health Sciences, as well as dietitians from the SNAP-Ed team, worked to develop the health and nutrition information that was provided via the app prototype, website, and at participant follow-up. Additionally, graduate students and professors in the Departments of Communications and

Engineering developed the smartphone app platform as well as the companion website. Finally, we collaborated with Kelly Middle School in Norwich, CT— specifically their Health Education teacher— who made it possible to test this app prototype in their 7th and 8th grade health classes.

3.3.1b Development of the Eat and Move As I Like (EAMAIL) *App and Companion Website*

EAMAIL is a novel smartphone app prototype developed for children and adolescents. The first stage of the app involved self-assessment surveys of health behaviors, including the use of food preferences as a predictor of eating behaviors,[63] based on evidence from various studies in children, young adults and adults.[64-68] Multiple surveys were created on the app prototype to engage participants in self-reflection about their daily habits, including eating, sleeping, physical activities, and sedentary behaviors. Additional survey items about their mood, food preferences, and perceived/desired body image were also included. A complete list of survey items can be found in Appendix A. Each survey could easily be completed by individuals of all ages, as the majority of questions are answered simply by choosing the desired image on the screen. For example, in the "what did you eat today" survey participants were asked about each meal of the day, including snacks and beverages. They reported what they ate by choosing from nine images that represented various food groups (multiple images could be chosen). Survey questions were carefully worded in order to be simple, clear, and concise. The research team spent a considerable amount of time choosing images to represent various food groups and activities that are both popular and widely available to individuals of all socioeconomic and ethnic backgrounds. Once the survey questions and images were chosen, the technical team built the application platform and made it available for free on Android devices (smartphones or tablets) via the Google Play store.

A companion website also was created by graduate students with the help of the technical team (website link provided in Appendix B). This website provides information about the EAMAIL app and our research study, as well as instructions for downloading and logging into the app. For those without access to the app (i.e. those without an Android device), but with interest in learning more about nutrition and healthy living for children and parents, a companion website provided information on farmer's markets and fun family events throughout Connecticut. The website also had links to additional resources, such as Choose My Plate, Kids Eat Right, End Hunger CT, and food assistance programs (SNAP, WIC, food banks).

3.3.1c Development of Usability Survey

As the primary aim of this study was to pilot test the EAMAIL prototype, a short survey was created to measure four constructs of usability: 1) ease of use; 2) satisfaction of users; 3) learnability; and 4) usefulness. The questions were adapted from two existing usability surveys, the USE questionnaire[69]and the Post Study System Usability Questionnaire (PSSUQ).[70] Fourteen questions were carefully chosen and simplified for children. All responses were given using a child-friendly Likert Scale of seven faces. Usability questions and the response scale can be found in Appendix C.

3.3.1d Development of Health Messages

As previously discussed, the long-term aims of this study include developing an app that utilized theory-based behavioral change principles to promote a healthy lifestyle. As this is a large undertaking, the pilot study aligned with SNAP-Ed goals to provide participants with brief, child-friendly health messages based on individual responses to survey questions. Consistent

with SNAP-Ed goals, these messages aimed to encourage participants to engage in healthy behaviors and provide ideas for simple behavior changes that children can make on their own. These messages also were accompanied by child-friendly images in order to make them more fun and engaging. With the help of dietitians from the SNAP-Ed team, the research team worked to create various health messages for each potential response. The goal was to make these messages brief, impactful, and educational. Participants were asked to evaluate these messages by answering three questions in the final survey. Samples of these messages, as well as the evaluation questions and scale are provided in Appendix D.

3.3.1e IRB Approval and Consent

Approval for this study was obtained from the University of Connecticut's Institutional Review Board. Participation in this study was completely anonymous. Information entered into the app was logged in the MySQL database, which was programmed in such a way that mobile numbers associated with an individual were stored randomly and separate from the interface data. As this is an anonymous study and no names or other identifying information was collected, consent forms were not required for participation. The study protocol submitted to and approved by UConn IRB can be found in Appendix E.

3.3.2 Recruitment Process and Follow-up

3.3.2a Participant Recruitment

Recruitment for this study was done with the help of our SNAP-Ed collaborators at Kelly Middle School (KMS) in Norwich, CT. KMS is classified as a Title I school, which is defined as a school with a high percentage of students from low-income families.[71] The research team

chose to target this population because economically disadvantaged children and adolescents are more likely to experience overweight or obesity,[17] less likely to receive health education in school,[41] and are more exposed to marketing and advertisements for unhealthy items, such as fast food and sugar-sweetened beverages.[72] Additionally, 61% and 48% of low-income teens (<$30K) have access to a smartphone or tablet, respectively,[10] making it likely that they would have had previous experience with apps and the ability to access ours.

Two graduate students collaborated with the health education teacher at KMS to implement this pilot study. The EAMAIL app was introduced to the children through a PowerPoint presentation (Appendix F). This presentation—approximately 10 minutes in length—explained the purpose of our study as well as provided a visual explanation of how to download and use the EAMAIL app. All children were given an Information Sheet (Appendix G) explaining the study and providing contact information for the PI and graduate research assistant. The children were also given an Enrollment Flyer (Appendix H), which described EAMAIL and provided instructions for how to download and log onto the app. The children were instructed to bring both of these sheets home to their parents and/or guardians to inform them of the study they would be participating in and to invite them to participate as well. Two waves of recruitment took place, the first in February/March 2016, and the second in May 2016.

In order to provide each child the opportunity to participate in the study and not discriminate against those who do not have access to an Android smartphone or tablet, the University of Connecticut provided the classroom with two tablets, on which the EAMAIL app was pre-loaded. The health teacher was responsible for monitoring the use of these tablets and provided daily opportunities for the children to log on. This collaboration with KMS was beneficial to both parties: first, to the research team, as this school provided many eligible

participants, and second, to KMS and its children. Including the use of this health app in the students' daily routine allowed students to be exposed to more nutrition education than would normally be delivered. It also provided opportunities for classroom discussion about daily practices that are affecting the child's health, including eating habits, physical activity, and sleeping patterns.

3.3.2b Downloading and Logging on to the EAMAIL App

The children were easily able to download the EAMAIL app for free onto any Android device through the Google Play store. Once downloaded, children were required to indicate that they had reviewed the information sheet and agree to participate in the study by checking the respective boxes. Then, they were asked to log in following the instructions on the Enrollment Flyer. Each flyer was labeled with an ID number and distributed randomly throughout the classrooms. Children were asked to create a nickname ending in the 3-digit number on their Enrollment Flyer. As the flyers were distributed randomly and names were not recorded by the research team, there was no opportunity to link an ID number to a specific child. The ID numbers were only given to match parent and child responses, should they both choose to participate. Matching parent and child responses would allow for further data analysis.

After creating their own nickname and entering information regarding age, sex, height, weight, and location of use (school or home), children and parents were able to play with the app and answer all survey questions (EAMAIL screen shots provided in Appendix I). The participants were free to log in and out of the app at any time and play with the app as many times as they wanted. Multiple usernames could be created on the same device. Moreover, once a participant had logged out of the app, it was impossible to view information that was previously

entered; therefore, there was no breach in confidentiality for those participants who were using the classroom tablets.

3.3.2c Follow-Up

Two weeks after the initial introduction to the app, the graduate students returned to the health classes to distribute reinforcing nutrition education gifts. Each child was given a wristband, which had healthy messages regarding nutrition and physical activity written on them. The research team felt it was important to provide these reinforcement gifts to all children, regardless of participation, in order to promote a healthy lifestyle to everyone. In addition to providing reinforcement gifts, the graduate students provided a nutrition lesson on Healthy Snacking to the classes (Appendix J). The purpose of this lesson was to provide reinforcing information on nutrition, encourage small behavior changes regarding food choices, and promote independence in the kitchen. The lesson concluded with an interactive game and a healthy snack.

3.3.3 Data Analysis

The participant data was downloaded from MySQL on June 5, 2016. All data were analyzed using Microsoft Excel 2011 (version 14.6.5) and SPSS statistical software (version 22.0). Basic descriptive statistics and frequency analysis was completed on the following: characteristics of app users, frequency of app use and survey completion, self-reported health behaviors (eating habits, technology use, physical activity, sleep, and body image), and evaluation of app usability and health messages.

3.4 RESULTS

3.4.1 User Characteristics

The EAMAIL app was presented to 220 7th and 8th grade students during their health class. Of which, 49 successfully logged in to the app at least one time. The majority of students were female, 12-13 years old (mean age=12.8 y.o.). Two-thirds reported logging on from home, as opposed to while in school using the classroom tablets provided by UConn. Eighty-five percent of users reported feeling happy at the time they logged on and interacted with the app interface. Based on self-reported height, weight, and age, 22.4% of students were classified as overweight or obese by CDC BMI percentiles standards[73](Table 1). However, these results should be interpreted with caution. Research shows that children significantly underreport their height and weight, even though older children tend report more accurate values. [74] On average, it took participants less than 6 minutes to create a username, log on, and interact with the survey questions. Additionally, one parent created an account on the app; however, only five questions were answered and therefore will focus our analysis on the 49 child responses.

Table1. Characteristics of child participants

	N=49	%*
Age (y.o.)		
12	16	32.7
13	23	46.9
14	5	10.2
15	1	2
Sex		
Male	17	34.7
Female	29	59.2
Location of Use		
School	16	32.7
Home	33	67.3
BMI Percentile^		
<5th	2	4.1
5th to <85th	20	40.8
85th to <95th	5	10.2
≥95th	6	12.2

*Percent of total sample size (N=49); may not equal 100% due to missing data
^ Based on self-reported height, weight, and age

3.4.2 Frequency of EAMAIL Use and Survey Completion

Of the 21 survey items (Table 2), two-thirds were completed by more than 50% of participants. The lowest number of responses was found in the "About you!" survey. Moreover, no students entered what they ate for dinner or dessert, likely because the app was in use when they had not yet eaten their evening meal. Repeat users were defined as any user who logged into the app at least two separate times. In order to ensure the user had logged on for a second time—as opposed to simply returning to a survey within the same log-in period—date and time stamps were analyzed and only survey responses at least 30 minutes after the initial response were categorized as repeat users. A maximum of 12 students logged into the app at least two separate times; however, not all repeat users answered all survey questions.

Table 2. Frequency of child survey responses

	1st Time Users		**Repeat Users**	
Surveys	**N**	**%***	**N**	**%***
How are you feeling?	48	98	12	24
What did you eat today?				
Breakfast	32	65	8	16
Breakfast beverage	35	71	9	18
Lunch	42	86	11	22
Lunch beverage	42	86	11	22
Dinner	0	0	0	0
Dinner beverage	42	86	11	22
Dessert	0	0	0	0
Snack	39	80	10	20
Snack beverage	39	80	10	20
How did you sleep last night?	30	61	7	14
What did you do after school?	28	57	6	12
How did you move around today?	33	67	7	14
Do you like fast food?				
Typical fast food restaurants	34	69	5	10
Pizza restaurants	34	69	5	10
About you!				
Favorite food	8	16	1	2
Favorite beverage	5	10	0	0

Favorite activity	8	16	0	0
Perceived body image	25	51	3	6
Desired body image	23	47	3	6
How much do you like this app?	22	45	3	6

*Percent of total sample size (N=49)

3.4.3 Self-Reported Health Behaviors

What did you eat today? EAMAIL asked participants to enter information regarding their eating habits throughout the day while providing feedback to encourage healthy choices. Thirty-two children responded to questions about their first meal of the day (breakfast). Twenty-five percent reported eating breakfast at home, 25% at school, and the other 50% gave no response. A peanut butter and jelly sandwich with chocolate milk was the most popular lunch (26% and 41%, respectively). No one reported snacking on vegetables, however fruit was a popular choice at 28%. None of the participants reported their dinner habits, likely because they were using the app in or after school before their evening meal. Thirty-eight percent reported eating pizza from a fast food restaurant in the last week, more specifically, 47% reported eating Domino's Pizza. Table 3 provides a summary of the more popular meal choices.

Table 3. Summary of eating habits from the "What did you eat today?" survey

Meal	n	Top Choice(s)	%*
Breakfast	32	Sugary cereal	43
Breakfast beverage	35	Milk	43
Lunch	42	PB & J Pizza	26 17
Lunch beverage	42	Chocolate milk	41
Dinner	0	N/A	N/A
Dinner beverage	42	Nothing Water	36 26
Dessert	0	N/A	N/A
Snack	39	None Fruit	36 28
Snack beverage	39	Water	41

*Percent of n provided above (differs for each meal based on number of participants who responded)

What did you do after school? EAMAIL also asked about use of technology devices after school. Only 28 participants responded to these questions, results of which are summarized in Table 4. The highest percentage of children (64%) reported watching at least one hour of television, followed closely by playing video games (54%). Only 40% of children reported using their cellphone. Forty percent of children reported using at least two of these devices simultaneously, and 54% reported that a parent/guardian does not put a time limit on the use of these devices.

Table 4. Frequency of afterschool technology use from the "What did you do after school?" survey

	TV		**Video Games**		**Cellphone**	
Hours/day	**n**	**%***	**n**	**%***	**N**	**%***
None	7	25	9	32.1	17	60.7
< 1	3	10.7	7	25	1	3.6
1 to <3	8	28.6	5	17.9	4	14.3
3 - <5	3	10.7	1	3.6	2	7.1
>5	4	14.3	2	7.1	0	14.3
No response	3	10.7	4	14.3	4	8

*Percent of total n=28 (number of participants who responded to these technology questions)

How did you move around today (n=33)? Seventy-nine percent of children reported that they do not walk or ride a bike to school; however, 67% played sports in the last week. The majority of students have gym every week, with 58% reporting 3 – 4 days per week, and 33% reporting at least 1 – 2 days per week.

How did you sleep last night? Thirty children responded to the questions regarding sleeping habits, with 53% reporting sleeping 6.5 – 9 hours per night, and 30% reporting 9 – 12 hours per night.

About you— Fewer than 20% of participants responded to questions regarding their favorite food, beverage, and activity, therefore, analysis was not completed for these items. Only 18 participants reported both perceived and desired body size using the various male and female body image pictures on EAMAIL, results of which are summarized in Table 5. Of these 18 participants, 40% reported a perceived body size greater than their desired body size. In comparing these results to the BMI percentiles calculated from self-reported height, weight, and age (n=16), 50% perceived themselves to be smaller than their BMI percentile indicated (Table 6). Additionally, 22 students responded to the question "did you like this app?", of which 20 (90%) reported that they like the app, the other 2 reported neither liking nor disliking the app.

Table 5. Frequency of perceived vs. desired body image from the "About you" survey

	n	**%***
Perceived > Desired	7	39
Perceived = Desired	10	55.5
Perceived < Desired	1	5.5

*Percent of total n=18 (number of participants who responded to these questions)

Table 6. Frequency of perceived vs. self-reported BMI percentile

	N	**%***
Perceived > BMI Percentile	1	6.25
Perceived = BMI Percentile	7	43.75
Perceived < BMI Percentile	8	50

*Percent of total n=16 (number of participants who responded to these questions)

3.4.4 Evaluating the Usability of the EAMAIL Prototype

Twenty-seven students (55% of total) completed the usability survey. The response scale, which utilized seven faces for ease of understanding (Appendix D), ranged from "strongly agree" (1), "neither agree nor disagree" (4), to "strongly disagree" (7). Overall, more than 75% of participants who completed the usability survey strongly agreed, agreed, or somewhat agreed with all statements and only a very small percentage disagreed. The average scores for each

question can be found in Table 7. As a whole, EAMAIL scored very high for all usability constructs, with an average of 2.07 (agree). Questions regarding ease of use received the best mean score; whereas ability to understand the pictures presented throughout the app received the lowest score, however still achieved a score in the range of "agree."

Table 7. Frequency and mean score of agreement or disagreement with usability statements

	Agree*		**Neither^**		**Disagree°**		**Mean score**
	N	**%****	**N**	**%****	**N**	**%****	
I like using phone apps	25	93%	0	0%	2	7%	1.96
Ease of Use							
This app was easy to use.	25	93%	1	4%	1	4%	1.48
I could answer the questions quickly.	26	96%	0	0%	1	4%	1.48
I could use this app without help.	23	85%	2	7%	2	7%	2.07
Mean "Ease of use" score							1.68
Usefulness							
The questions asked me about what I do daily.	24	89%	2	7%	1	4%	2.07
This app made me think about what I eat and what I do.	22	81%	2	7%	3	11%	2.41
There were pictures of what I ate and did.	22	81%	3	11%	2	7%	2.22
Mean "Usefulness" score							2.23
Learnability							
I could fix my mistakes easily and quickly.	23	85%	1	4%	3	11%	2.22
It's easy to learn how to use the app.	25	93%	1	4%	1	4%	1.81
It's easy to understand the pictures.	21	78%	2	7%	4	15%	2.59
Mean "Learnability" score							2.21
Satisfaction							
This app was fun to use.	22	81%	2	7%	3	11%	2.26
I liked using this app.	26	96%	0	0%	1	4%	1.48
I would use this app again.	21	78%	3	11%	3	11%	2.52
I would tell friends to use this app.	22	81%	1	4%	4	15%	2.30
Mean "Satisfaction" score							2.14
Overall Usability Score							**2.07**

*Rated either 1= strongly agree, 2=agree, or 3= somewhat agree
^Rated 4=neither agree nor disagree
°Rated either 5=somewhat disagree, 6=disagree, or 7=strongly disagree
**Percent of participants who responded to usability survey questions (n=27)

3.4.5 Evaluating the Health and Nutrition Messages Provided in the EAMAIL Prototype

The health and nutrition messages that were provided during use of the app and consistent with the participant's responses were evaluated using three questions and the same Likert Scale used to evaluate the usability statements (Appendix C). Table 8 summarizes these results. Most participants agreed with all three statements, with the mean scores ranging from 2.11 (agree) to 1.37 (strongly agree).

Table 8. Frequency and mean scores of agreement or disagreement with message evaluation statements

	Agree*		**Neither^**		**Disagree°**		**Mean score**
	N	**%****	**N**	**%****	**N**	**%****	
I learned something new about food and activity from this app	26	96	0	0	1	4	1.37
The pop-up messages will help me make healthier choices in the future	24	89	0	0	3	11	2.11
I liked getting pop-up messages related to my day	26	96	0	0	1	4	1.56

*Rated either 1= strongly agree, 2=agree, or 3= somewhat agree
^Rated 4=neither agree nor disagree
°Rated either 5=somewhat disagree, 6=disagree, or 7=strongly disagree
**Percent of participants who responded to message evaluation questions (n=27)

3.5 DISCUSSION

With the rate of childhood obesity rising alongside the use of technology— in particular smartphones and their applications— the idea of using technology as a platform for promoting healthy living and an active lifestyle is becoming increasingly popular. Mobile technology is currently being used in attempts to prevent as well as to treat pediatric obesity; however, not all apps use scientific theories of behavior change to do so. Our long-term goal is to integrate theory-based behavior change principles into an app to help children increase their nutrition and fitness literacy, improve their efficacy for healthy eating and active living, and cultivate a healthy body image and self-esteem. The goals of this project align with those of the SNAP-Ed Obesity

Prevention Program, as a novel way of providing evidence-based, nutrition education to low-income families, focusing on obesity prevention. Toward that goal, the first step was to create and pilot test our app prototype, in order to determine its usability, as well as to gain feedback on the simple health and nutrition messages provided.

EAMAIL is a child-friendly app created by a team of researchers, dietitians, and engineers at the University of Connecticut. This prototype was pilot tested in a Title I school with 7th and 8th grade students. Forty-nine students volunteered to participate in the pilot testing and successfully logged on to the app, twelve of which were repeat users. EAMAIL consisted of multiple surveys regarding eating habits, physical activity, use of technology, sleep patterns, perceived/desired body image, and mood. Two-thirds of the surveys were completed by more than 50% of the participants. The lowest number of responses came from the "About you" survey, possibly because it was the last survey on the list, or because participants were uncomfortable answering more personal questions. Based on self-reported meals, vegetable intake was low, while fast food pizza was very popular. A large percentage of students reported watching television and playing video games, as well as participating in sports. Only 40% reported using a cellphone afterschool, which is lower than expected. However, although research shows a large percentage of low-income children have access to smartphones and tablets, they may be sharing these devices with other family members.[10] It is likely that not all participants owned a compatible smartphone/tablet, as a Pew Research Center study indicates that only 64% of teens from households earning <$50,000 a year report ownership of a smartphone.[10] Finally, of the students who specified their perceived body image, half believed themselves to be smaller than their BMI percentile (based on self-reported height, weight, and

age) indicated. This is supported by previous research that found almost 30% of children and adolescents underestimate their weight status.[75]

Various constructs of usability were evaluated for this app, including ease of use, satisfaction of users, learnability, and usefulness, via fourteen questions rated on a 7-point scale (1= strongly agree; 4=neither agree nor disagree; 7=strongly disagree). Overall, more than 75% of students agreed with all usability statements, indicating that EAMAIL was easy to use, likable, easy to learn, and useful. The "usefulness" questions are of particular importance. The majority of students agreed that the app asked them about their daily habits/activities, it included relevant pictures, and it made them think about their health-related behaviors. Overall, this indicates that EAMAIL, on the short-term, was a good platform for reporting health-related behaviors. Additionally, as an initial step towards incorporating tailored feedback into the EAMAIL prototype, health and nutrition messages were provided based on user responses. These "pop-up messages" were evaluated and the vast majority (89-96%) of students reported that they enjoyed receiving the messages, the messages taught them something new about food and activity, and that the information provided will help them make healthier choices in the future. In summary, we found that the EAMAIL app was a feasible prototype that participants enjoyed using. Short-term success was found in that it made participants think about their daily health behaviors and may influence future health-related choices, as well as provided information to them on health and nutrition. Overall, this prototype provides us with an exceptional platform for the next phase of the project.

This pilot study is an essential step towards meeting our long-term goals for many reasons. First, the entire research team was able to establish excellent working relationships. The collaboration between departments at UConn, as well as with the staff and students at Kelly

Middle School (KMS) was invaluable to this project's success. Furthermore, in accordance with SNAP-Ed, the EAMAIL prototype, as well as the follow-up presentation, provided nutrition and obesity prevention education that was a valued part of the KMS health classes. Title I schools, such as KMS, are key stakeholders in projects such as EAMAIL, as they have a vested interested in their students' health, as well as successful nutrition programs that may results from pilot studies such as this one. Previous research suggests that health apps are more effective when they are used within another setting, such as a school.[50] Therefore, continuing to develop EAMAIL and integrating it into the KMS health curriculum may produce ideal results.

As with any study, there were limitations. First, this app prototype was built solely on the collaboration of departments within the University of Connecticut, without any funding. Therefore, this was not produced as a commercial app. In the future, funding would allow us to obtain additional resources for building the app. Furthermore, many children were unable to use this app at home because they owned an Apple device (iPhone or iPad). With funding, future versions of the app can be made available on both Android and Apple platforms. We also had a relatively small sample size, which is likely due to our recruitment technique. It is difficult to ensure that young children will remember to provide parents/guardians with handouts given to them at school. Additionally, since the app could not be downloaded directly after the introduction presentation, due to restricted Internet access in the school, we had to rely on students to take the initiative to download the app at home. Previous studies[76] have come across similar obstacles and researchers suggest taking a more active recruitment role. For example, being present at after-school events would allow researchers to discuss the study with both parents and children, in order to ensure parent knowledge of the project and further promote healthy living. In addition, the ability of users to respond with freestyle text would have allowed

for even more information to be collected. Finally, although this study was completely anonymous, response bias is always a possibility, particularly if a child felt as if they needed to respond in a certain way. In the future, additional steps can be taken to avoid response bias by altering the format of survey questions and asking the same question in various ways.

Despite these limitations, the success of this pilot study allows us to move forward with the EAMAIL app with the goal of creating a fun and educational mobile app to combat childhood obesity while also incorporating behavior-change theories. Knowing that this interface is easy to learn and use, as well as pleasing and useful, steps can now be taken to further improve the app's aesthetics (e.g. colors, font size, images) and content. Conducting focus groups with parents, children, and other key stakeholders will be crucial to the future development of this app. Focus group results will provide us with direct feedback on how best to deliver nutrition education that is interactive and facilities behavior change in our target audience. Additionally, future versions of the app should be evaluated using the Mobile App Rating Scale (MARS), as this tool helps rate engagement, functionality, aesthetics, appeal, and quality of information provided in order to determine the quality of the health apps.[77] Finally, as the development of EAMAIL continues, behavior-change techniques, such as goal setting, motivational messaging, outcome feedback and reinforcements, cues to action, behavioral contracting, and rewards, will be incorporated, in order to reach our long-term goals.

3.6 ACKNOWLEDGEMENTS

We would like to thank all of those involved with the EAMAIL project: the UConn engineering graduate students, Michael Zuba and Ioannis Papavasileiou, who built and programed the EAMAIL app prototype and companion website; the health promotion graduate

student, Alexandra Dagenais, who worked to create the app and recruit students; the SNAP-Ed team and registered dietitians, Tina Dugdale and Donna Zigmont, who helped develop the health and nutrition messages and for connecting us with community partners for this project. We would also like to thank Norwich Kelly Middle School and the Health Education teacher, Mr. Mileski, for embracing this project, as well as all the students for participating in this pilot study.

3.7 APPENDIX A: EAMAIL App surveys

1. How are you feeling today?
2. What did you eat today?
    a. Meals: breakfast, lunch, dinner, snacks, desserts, and beverages
    b. Location of meals: home, school, on-the-go
3. How did you sleep last night?
    a. Total hours of sleep
4. What did you do after school?
    a. Time spent using technology devices (cell phone, television, video games)
5. How did you move around today?
    a. Transportation to school
    b. Time spent in gym class
    c. Afterschool physical activities
6. Do you like fast food?
    a. Preferences for various fast food restaurant
    b. Consumption of fast food this week
7. About you
    a. Favorite foods, beverages, and activities
    b. Perceived and desired body image
    c. How much do you like the app

3.8 APPENDIX B: EAMAIL Companion Website Link
Eamail.uconn.edu

3.9 APPENDIX C: Usability Survey

General introduction question:
1. I like using phone apps.

Ease of use:
2. This app was easy to use.
3. I could answer the questions quickly.
4. I could use this app without help.

Usefulness:
5. The questions asked me about what I do daily.
6. The app made me think about what I eat and what I do.
7. There were pictures of what I ate and did.

Learnability:
8. I could fix my mistakes easily and quickly.
9. It's easy to learn how to use the app.
10. It's easy to understand the pictures.

Satisfaction:
11. This app was fun to use.
12. I liked using this app.
13. I would use this app again.
14. I would tell friends to use this app.

Statements were rated on the following scale:

Strongly disagree (7) Neither (4) Strongly agree (1)

3.10 APPENDIX D: Sample of Health Messages for EAMAIL App

- **Favorite activity**
  - Sports — Keep movin'
  - Music — Keep dancing!
- **Favorite beverage**
  - Soda – Too sweet, watch your teeth
  - Sports drinks – Refuel with water
- **Favorite Food**
  - Vegetables – Veggies Rule!
  - Fruit – Eat the Rainbow!
  - Cheese – Go calcium!
- **After school** activity – Keep studying & Keep movin'
- **Fast food –** Try eating at home too!
- **Breakfast/Breakfast beverage**
  - Did you eat breakfast: Yes – Nice work!
  - Did you eat breakfast: No – Energize with breakfast!
  - Yogurt – Yay calcium!
  - Cereal – Top it off with a !
  - Orange juice – Get your vitamin C!
  - Nothing – Remember – stay hydrated!

- **Lunch/Lunch beverage**
  - Pizza – Yum! Try adding veggies!
  - Cookie – Cut back on sweets- try fruit!
  - Water – Great choice!
  - Juice – Try whole fruit!
- **Dinner/Dinner beverage**
  - Veggies – Awesome! Go veggies!
  - Chicken – Build strong muscles!
  - Milk – Got milk? Strong bones!
  - Fruit punch – Try 100% fruit juice!
- **Snack/Snack beverage**
  - Fruits & veggies are the best snacks!
  - Nothing to drink– Carry a water bottle!
- **Dessert** – Try fruit for dessert!
- **Feeling**
  - Stay smiling!
  - Tomorrow is a new day!
- **Sleep** – Try for 8 hours a night!

Evaluation of Health Messages:

1. I learned new information about food and nutrition from this app.
2. The messages I received were helpful when I made food choices.
3. I liked getting nutrition messages related to my day.

Statements were rated on the following scale:

Strongly disagree Neither Strongly agree

3.11 APPENDIX E: IRB Approved Study Protocol and Addendum

UCONN
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DATE: February 12, 2016

TO: Valerie Duffy, Ph.D.
Allied Health Sciences

FROM: Brandi Simonsen, Ph.D.
Vice-Chair, Institutional Review Board
FWA# 00007125

RE: Protocol #H15-327: "Usability Testing of a Pilot Mobile Phone App Designed to Assess Food and Physical Activity Preferences among Low-Income Families"
Please refer to the Protocol# in all future correspondence with the IRB.

The request for approval of an amendment received February 4, 2016 for the above-referenced protocol was approved by the Institutional Review Board (IRB) on February 12, 2016. This amendment is eligible for expedited review under 45 CFR 46.110(b)(2): minor changes in previously approved research during the period (of one year or less) for which approval is authorized. The amendment includes:

1. One or two Android devices with the app loaded onto them will be made available to all children within the classroom to allow for free access.
2. For amendment 1, the IRB found that the protocol meets the criteria for approval stated in 45 CFR Part 46, Subpart D, Section 404: The research presents no greater than minimal risk to the minor subjects and adequate provisions have been made to solicit assent of the minor subject. The IRB has determined that the study referenced above meets the criteria for Waiver of Informed Consent for waiving parental permission as stated in 45 CFR 46.116(d) as follows:
   - The research involves no more than minimal risk to the subjects;
   - The waiver or alteration will not adversely affect the rights and welfare of the subjects;
   - The research could not be practicably carried out without the waiver or alteration; and
   - Whenever appropriate, the subjects will be provided with additional pertinent information after participation in the study.

   The principal investigator must notify the IRB immediately of any changes that may affect the status of the research study referenced above.
3. Short nutrition messages will be provided based on participant responses to the questions posed in the app. The messages encourage healthy behaviors.

Amendment Approval Date: February 12, 2106
Approval is Valid Until: December 3, 2016

Office of the Vice President for Research
Research Compliance Services
438 WHITNEY ROAD EXTENSION, UNIT 1246
STORRS, CT 06269-1246
PHONE 860.486.8602
FAX 860.486.1044
compliance.uconn.edu

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Please keep this Amendment Approval letter with your copy of the approved protocol.

Attachments:
1. Validated IRB-3 Amendment Review Form
2. Validated Revised IRB-1 Protocol
3. Validated Revised Parental Information Sheet

H15-327

IRB-3 — Amendments

Page 1

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OFFICE OF THE VICE PRESIDENT FOR RESEARCH

Attach two (2) copies of the revised documents (e.g. Consent forms, questionnaire, etc.) inclusive of all amendment(s) proposed. In one copy, the amendments should be identified by using the track-changes feature of Microsoft Word to facilitate the IRB review; the other copy should be a "clean" copy incorporating the revisions. If you are changing the key personnel on the study, submit the Appendix A form only (inclusive of all active study personnel).

Amendment Review Form (IRB-3)

Institutional Review Board, Research Compliance Services

Whetten Graduate Center, Rm #214, 438 Whitney Road Ext., Unit 1246 Storrs, CT 06269-1246 860-486-8802

Any amendment to an approved protocol must be reviewed and approved by the IRB **before** the amendment is implemented. Such amendments could include changes to the study design, procedures, enrollment, methods of recruitment, personnel, funding source or the consent form/information sheet. This includes changes that appear to reduce risks to subjects. There are NO EXCEPTIONS to this rule.

Protocol #: H15-327

Principal Investigator: Duffy, Valerie B

Study Title:
Usability Testing of a Pilot Mobile Phone App Designed to Assess Food and Physical Activity Preferences among Low-Income Families

RECEIVED
FEB 04 2016
OFFICE OF RESEARCH COMPLIANCE

*1. Describe each proposed amendment(s) and explain why it is being made.

I. Amend the IRB1 (see track changes) and information sheet (see track changes) to allow the child to interact with the health-related app within the classroom.

◆ Based on new information from nutrition education researchers from an added webinar, we will have a difficult time assess the study objectives by sending an information sheet home with the child and requesting app participation. Thus, we want the child to participate with the app within the classroom as part of classroom activity and allows access of all children. We will provide the classroom with one or two Android pads to allow participation of all children in the classroom. The child will pick their own identification in the classroom and then be encouraged to continue to use the app at home with the family downloaded on the family or parent device.

◆ We had already had permission of the IRB for waiver of parent consent. The participation with the app in the classroom can encourage use at home too.

2. Short nutrition messages will be provided based on participant responses to the questions posed in the app. Messages will encourage participants to engage in healthy behaviors.

◆ Tailored health messages are most effective. Based on the child's or parent's responses, the app will deliver very short messages to reinforce healthy behaviors (see attached messages)

*2. For each amendment listed above, explain whether the proposed amendment increases or decreases the level risk to participants (thereby changing the risk/benefit ratio) and, if so, describe. If the level of risk remains the same, describe this as well.

I. The responses to the app are not sensitive information and the content is appropriate for classroom activity. Thus we do not believe that the risk/benefit ratio is changed with the addition of allowing the child to interact with the app in the classroom.

II. Providing short nutrition messages to participants does not pose any risk.

2/12/16
12/3/16
BSI

*Has the funding source or the status of funding changed since initial or last re-approval review? ☐ Yes ☑ No

*Does the study have a Certificate of Confidentiality? ☐ Yes ☑ No

*Is this a change to personnel? ☐ Yes ☑ No

H15-327

IRB-1 Study Protocol

Protocol Version # and/or Date: [The protocol version must be revised each time a modification is submitted to the IRB to change the protocol.]

February 4, 2016

Study Protocol Title: Is the Healthy Living Mobile App Useful?

Research Plan

Purpose/Introduction: [State the reason for the study, the research hypothesis, and the goals of the proposed study as related to the research question(s). Provide a clear and succinct summary description of the background information that led to the plan for this project. Provide references as appropriate and, when applicable, previous work in animal and/or human studies. Provide previous UConn protocol number, if applicable.]

Healthy eating and active living are two important prevention strategies in the Surgeon General's Vision for a Healthy and Fit Nation (2010). Information communication technologies, such as eHealth and mHealth, have been utilized to facilitate dietary and/or fitness goals to reduce obesity.[1] Preliminary reviews[2] and meta-analysis[3] find mobile apps a potentially useful obesity prevention tool but are in need of key behavior change features. Research shows that at least 19% of smartphone owners downloaded health apps in 2012, with exercise, diet, and weight apps being the most popular categories.[4] While parents considered teen attachment to mobile phones a source of parent-child conflict, most teens owned a mobile a phone (78%) and downloaded mobile apps (58%) in 2013.[5] Engaging both parents and adolescents in the same intervention program improves healthy eating and psychological well-being, while lowering obesity risk and tensions between parents and children.[6]

The proposed research aims to pilot and improve an innovative mobile app for promoting a healthy weight and preventing childhood obesity. The app will incorporate theory-based behavior change principles to promote healthy eating and active living. The long-term goals of our study are to help children increase their nutrition and fitness literacy, improve their efficacy for healthy eating and active living, and cultivate a healthy body image and self-esteem. Since 25% of teens primarily access the Internet via cell phones,[7] and over two-thirds of low-income parents have reported daily use of Smartphones for Internet access,[8] we aim to primarily reach children whose families are receiving or eligible to receive SNAP or free/reduced school-based meals.

Research questions for this exploratory study include the following:

RQ 1: How do users perceive the interface usability of the prototype?
RQ 2: How do users perceive the usefulness of the prototype features?
RQ 3: How satisfied are users with their interface experience?

References:

2/12/16
12/3/16
BS/MW

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[6] Van Ryzin, M. J., & Nowicka, P. (2013). Direct and indirect effects of a family-based intervention in early adolescence on parent youth relationship quality, late adolescent health, and early adult obesity. *Journal of Family Psychology, 27*, 106–116.

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[8] Swindle TM, Ward WL, Whiteside-Mansell L, Bokony P, Pettit D. Technology use and interest among low-income parents of young children: Differences by age group and ethnicity. *J Nutr Educ Behav*. 2014;46(6):484-490.

Design, Procedures, Materials and Methods: [Describe the study design, including the sequence and timing of all study procedures. Include screening procedures, if any. The IRB strongly suggests that investigators incorporate flexibility into the study design to accommodate anticipated events (i.e. explain how missed study appointments can be made up by participants). If the research involves study of existing samples/records, describe how authorization to access samples/records will be obtained. If the study involves use of deception explain the reason why this is necessary. If applicable, describe the use of audiotape and/or videotape and provide justification for use. If this study offers treatment for the participants' condition, complete the Treatment Study Supplemental Form (IRB-1C) and attach it to this application for review. If the study includes measures, survey instruments and questionnaires, identify each and, if available, provide references for the measures. Describe what they intend to measure (relate to purpose/hypothesis) and their psychometric properties (e.g., reliability and validity). Identify any that were specifically created for the study.]

This study plans to recruit up to 200 children in Title I schools or parent-child dyads from households with children in these schools or who are enrolled or eligible to be enrolled in the Supplemental Nutrition Assistance Program (SNAP). Members of the research team will distribute program flyers and study information sheets and provide a brief presentation on downloading and using the app in school-based health programs within schools that have approved the study or sharing of information about the study.

In the classroom: In order to provide equal access to all children, an Android tablet will be made available to participating classrooms. As part of a classroom nutrition activity, all children will

have the opportunity to interact with the app interface and respond to the usability questions. To complete the app interface and questionnaire, each child picks their own, confidential identification nickname.

At home: Children will bring the flyer and the information sheet home to be reviewed with parents. Parent-child dyads who are interested in enrolling in the study will review the information sheet (containing the hyperlink to the study website) and the program flyer (for instructions on how to create an account and log in to the app). After reviewing these documents, parents and children who wish to enroll in the study will access the study website to 1) download the app on an Android smartphone or tablet, ~~2) click the separate buttons to indicate that they have reviewed the information sheet and agree to participate in the study on the initial app screen,~~ 2) complete the app interface and 3) respond to the short usability questionnaire on the app. To complete the app interface and questionnaire, each parent and child will pick their own identification nickname. In order to create a more interactive environment, throughout the app interface brief health behavior messages will be provided based on the participant's responses. The program flyer, the study information sheet, screenshots of the app, survey items, and a sample of the health behavior messages are attached for review.

Commented [XV1]: Since we already have a waiver of signed consent approved during the full IRB review, this statement is not needed.

A short survey will be used to directly assess our three research questions stated above via self-reported data. This usability survey intends to measure the following aspects of the pilot app: 1) Ease of use, 2) Satisfaction of users, 3) Learnability, and 4) Usefulness. This questionnaire was adapted from two existing usability surveys, the USE questionnaire[1] and Post Study System Usability Questionnaire (PSSUQ).[2] Fourteen questions were chosen and simplified for this target audience and will be answered using a child-friendly scale of seven faces. Results from this usability survey will guide us in improving this pilot app for future use in health promotion and prevention of childhood obesity.

Toward our long-term goal and to indirectly assess the app usability, the app interface contains questions regarding diet (food patterns and liking), behaviors (sedentary and physical activity), sleep patterns, and body image. Our published data[3,4] suggests that reporting liking/disliking of foods and activities is statistically reliable and valid as an assessment of child health behaviors, and has also shown to be a proxy for food intake. Participant responses will indirectly assess usability of the app for promoting health. These questions also act as the first step to promoting healthy behaviors in children. By interacting with the app interface and receiving health behavior messages children will gain awareness of their current health behaviors and learn quick tips for continued or improved health behaviors. Mindfulness of health behaviors is the first step to reaching our ultimate goal of helping children to increase their nutrition and fitness literacy, improve their efficacy for healthy eating and active living, and cultivate a healthy body image and self-esteem.

The information that parents and children enter into the app will go into a MySQL database. The identity of the parents/children is anonymous. The MySQL database that stores the app interface and survey data will be programmed in such a way that the mobile phone numbers associated with the interface/survey data are stored in a random order and separate from the data. As the randomized phone number and the data are stored separately, the researchers will not be able to match the phone numbers with the data.

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[2] Lewis, J. R. (2002). Psychometric evaluation of the PSSUC using data from five years of usability studies. International Journal of Human-Computer Interaction, 14(3&4), 463–488).
[3] Sharafi M, Perracchio H, Scarmo S, et al. Preschool-adapted liking survey: A brief and valid method to assess dietary quality of preschoolers. [Manuscript awaiting publication]. 2015:11.

[4] Vosburgh K, Stachelek I, Sobieski D, et al. Simple tool to evaluate healthy diet and behaviors in children in primary care. [CT Academy of Nutrition and Dietetics Annual Meeting 2015: Poster Presentation]. 2015.

Justification of Sample Size/Data Analysis: [Justification of Sample Size: For qualitative and pilot studies, describe how the proposed sample size is appropriate for achieving the anticipated results. For quantitative studies, provide a power analysis that includes effect size, power and level of significance with references for how the sample size was determined. Explain the rate of attrition, with references as appropriate. Data Analysis: For all studies, provide a description of the statistical or qualitative methods used to analyze the data.]

We believe the proposed sample size of 200 child and parent-child dyads is appropriate for various reasons. First, this number of participants will allow us to partner with a school system, inviting all interested students to participate, as well as allow us enough participants to address the proposed research questions regarding usability and work towards the long-term goal. Second, based on our previous work[1], we believe 200 children/parents will allow us to evaluate usability and assess variability among children and adolescents with differing health behaviors, (diet, physical activity, sleep, and body image).

Data will be analyzed in various ways. First, we will assess the health behavior descriptives and examine relationships between health behaviors and differences across participants with varying health behaviors. The second is to summarize descriptive and parametric/ non-parametric statistics of the app usability survey.

[1] Vosburgh K, Stachelek I, Sobieski D, et al. Simple tool to evaluate healthy diet and behaviors in children in primary care. [CT Academy of Nutrition and Dietetics Annual Meeting 2015: Poster Presentation]. 2015.

Inclusion/Exclusion Criteria: [List major inclusion and exclusion criteria. Any proposed exclusion criterion based on gender (women of childbearing potential), age, or race must include justification for the exclusion. Describe the conditions under which participants may be removed from the study, i.e., noncompliance with study rules, study termination, etc.]

Inclusion criteria: Children/adolescents (>5 years old) and their parent/guardian from school-based health programs at the designated Title I schools or who are enrolled/eligible to be enrolled in the Supplemental Nutrition Assistance Program (SNAP). This population was chosen for multiple reasons. Obesity rates are high for both children (6-11 years old, 18%) and adolescents (12-19 years old, 21%).[1] The use of "smart" mobile devices, particularly smartphones, among this population is very high. In 2013, 63% of children (0-8 years old) had access to a "smart" mobile device at home[2], and 78% of adolescents (12-17 years old) had a cell phone, half of which were smartphones.[3] Title I schools and those participating in SNAP were chosen because the goals of our study align with these program's efforts in promoting healthy living among low-income individuals. Also, in 2015 13% of low-income families are smartphone-dependent[5], with 44% of low-income adolescents owning a smartphone.[4]

Exclusion criteria: None; All children and parents at designated schools can participate, as long as they wish to participate. All children will be given access to an Android tablet in the classroom as part of a usual classroom type of activity. The only difference is that this activity will be on a tablet vs. a full computer. Parents and children who wish to participate from home are able to download the app on a personal Andriod device at no cost. If a child does not have his/her own smartphone or tablet at home, s/he can use a parent/guardian's to participate in the study. Each child and parent will create their own account on the app and multiple accounts can be made on the same device.

[1]Centers for Disease Control and Prevention (CDC). Childhood obesity facts. Centers for Disease Control and Prevention (CDC) Web site. http://www.cdc.gov/healthyyouth/obesity/facts.htm. Updated August 2014. Accessed September 28, 2014.
[2]Common Sense Media. Zero to eight: Children's media use in america 2013. Common Sense Web site. https://www.commonsensemedia.org/research/zero-to-eight-childrens-media-use-in-america-2013. Published October 28, 2013. Updated October, 2013. Accessed 9/28, 2014.
[3] Madden M, Lenhart A, Duggan M, Cortesi S, Gasser U. Teens and technology 2013. Pew Research Internet Project Web site. http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_TeensandTechnology2013.pdf. Published March 13, 2013. Updated 2013. Accessed 9/28, 2014.
[4] Pew Research Center, April, 2015, "The Smartphone Difference" Available at: http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015
[5] Wartella E, Rideout V, Zupancic H, Beaudoin-Ryan L, Lauricella A. Teens, health, and technology. . 2015:2-3-5, 22-24. http://cmhd.northwestern.edu/wp-content/uploads/2015/05/1886_1_SOC_ConfReport_TeensHealthTech_051115.pdf. Accessed June 2, 2015.

Risks and Inconveniences: [Describe the potential risks to participants (and secondary participants, if applicable) and *steps taken to minimize risks.* Assess the likelihood of the risk occurring and, if it were to occur, the seriousness to the participant. Types of risks to consider include: physical, psychological, social, legal, employment, and financial. Also describe any anticipated inconveniences the participants may experience (time, abstention from food, etc.).]

We believe there is minimal risk associated with this research study; however, an inconvenience may be up to 10-15 minutes of time it takes to complete the study.

Benefits: [Describe anticipated benefits to the individual participants. If individual participants may not benefit directly, state so here. Describe anticipated benefits to society (i.e., added knowledge to the field of study) or a specific class of individuals (i.e., athletes or autistic children). Do not include compensation or earned course credits in this section.]

There are not direct benefits to the participants. The study will benefit society in general by 1) enabling researchers to determine if a mobile phone app is a user friendly tool to reach teens and families about healthy eating and active living for future research and 2) increasing our knowledge about dietary, physical activity, and lifestyle behaviors of low-income families via an anonymous platform; and

Risk/Benefit Analysis: [Describe the ratio of risks to benefits. Risks to research participants should be justified by the anticipated benefits to the participants or society. Provide your assessment of anticipated risks to participants and steps taken to minimize these risks, balanced against anticipated benefits to the individual or to society.]

We believe there is minimal risk associated with this research study, with only a possible inconvenience being the 10-15 minutes of time it takes to complete the study. Although there are no direct benefits to the participants, the study will benefit society and the research community, as stated above. Therefore, we believe the benefits far outweigh the potential risk/inconvenience.

Economic Considerations: [Describe any costs to the participants or amount and method of compensation that will be given to them. Describe how you arrived at the amount and the plan for compensation; if it will be prorated, please provide the breakdown. Experimental or extra course credit should be considered an economic consideration and included in this section. Indicate when participants will receive compensation.]

There is no payment for participating in the study. Each child in the designated school-based health programs will receive a reinforcing item (i.e., small gift) that carries a health promotion message (valued $4 or less), regardless of participation in the study. At the conclusion of the study (2-4 weeks after initial school visit), graduate research assistants will return to these school-based health programs and give *all* students a small nutrition education reinforcement gift. We decided to provide small gifts regardless of participation in order to promote a healthy lifestyle to all students.

Data Safety Monitoring: [This is a prospective plan set up by the study investigators to assure that adverse events occurring during studies are identified, evaluated, and communicated to the IRB in a timely manner. Although the investigators initially propose a Data Safety Monitoring Plan (DSMP), the IRB must approve the plan and may require revision of the plan. A DSMP is required for all human studies at the University of Connecticut except for studies determined to be exempt from continuing IRB review. For studies that present more than minimal risk to participants, the IRB will review and determine on a case-by-case basis whether a data safety monitoring board is most appropriate. Please refer to the IRB's policy regarding data safety monitoring *before* completing this section - http://research.uconn.edu/policies-procedures.

Issues that should be addressed in the DSMP include the following:

1. frequency of the monitoring
2. who will conduct the monitoring (Under UConn policy a student cannot be the sole person responsible for monitoring the data and safety of the protocol procedures.)
3. what data will be monitored
4. how the data will be evaluated for problems
5. what actions will be taken upon the occurrence of specific events or end points
6. who will communicate to the IRB and how communication will occur

Sample response to issues listed above for minimal risk/slight increase over minimal risk – "Survey results will be monitored by the PI in conjunction with the student investigator once every two weeks (items 1, 2 and 3). Survey responses will be reviewed to monitor for clarity (i.e., the same question is skipped by 5 or more participants). In that case, the question will be revised and an amendment will be submitted to the IRB (items 4, 5 and 6)."

Our Data Safety Monitoring Plan:

1. Frequency of the monitoring: Survey results will be monitored once per week.
2. Who will conduct the monitoring (Under UConn policy a student cannot be the sole person responsible for monitoring the data and safety of the protocol procedures.): Dr. Valerie Duffy, PI, in conjunction with the graduate research assistants will monitor results.
3. What data will be monitored: App and/or computer generated survey data.
4. How the data will be evaluated for problems: By evaluating and assessing concerns reported by partnering schools and teachers.
5. What actions will be taken upon the occurrence of specific events or end points: Working with research team and school partners to address any problems and assess the app/website.
6. Who will communicate to the IRB and how communication will occur: Dr. Valerie Duffy, PI, will communicate any problems with the IRB using the InfoEd system.

Privacy/Confidentiality: [Explain how the privacy interests of participants will be maintained during the study (note that privacy pertains to the individual not to the data). Describe procedures for protecting confidentiality of data collected during the study and stored after study closure. Describe how data will be coded. Describe plans for storage and security of electronic data (plan must comply with the University's Policy on the Security Requirements for Protecting University Data at Rest). If identifiable, sensitive information (illegal drug use, criminal activity, etc.) will be collected, state whether a Certificate of Confidentiality will be obtained. Be sure to state whether any limits to confidentiality exist and identify any external agencies (study sponsor, FDA, etc.) that will have access to the data. If participants will be screened, describe the plans for storage or destruction of identifiable data for those that failed the screening.]

The identity of the child or parents-children dyads is anonymous. Children and/or parents will log on using a nickname of their choice and the ID number provided on the EAMAIL flyer. The sole purpose of these ID numbers is to link parent and child responses. Since participants will not be providing us with their full names (on the app nor on any other forms), providing an ID number will not cause a breach in confidentiality. The MySQL database that stores the app interface and survey data will be programmed in such a way that the mobile phone numbers associated with the interface/survey data are stored in a random order and separate from the data. As the randomized phone number and the data are stored separately, the researchers will not be able to match the phone numbers with the data. There is no way for the researcher to link the mobile phone numbers or ID numbers used for the app interface to the study participants.

References / Literature Review:

Over the past 10 years the prevalence of childhood obesity has remained steady for children ages six to 19 years old,[1] with more than one third of children and adolescents being classified as overweight or obese in 2012.[2] Children from economically disadvantaged households are even more likely to fall into these categories.[3,4] Childhood obesity is not only a risk factor for cardiovascular disease, stroke, and type II diabetes in adulthood, but can also cause social and psychological issues such as discrimination and low self-esteem.[5]

The use of technology, particularly by children, is greatly increasing in the United States. In 2013, twice as many children were using mobile media, with the average amount of time spent using mobile devices tripling compared to 2011.[6] Eighty-eight percent of teens own or have access to a mobile phone, 73% of which are smartphones, and nearly 25% report being online "almost constantly" due to access through smartphones.[7] Smartphones and apps are widely available and have the ability to reach various demographic groups, including minorities and low-income populations.[8,9] Not only are children and adolescents using these forms of technology more readily, parents are interested in acquiring child nutrition information via technology.[10] Swindle et al. found 69.9%, 80.6% and 68.4% of low-income parents reported daily use of the Internet, text messaging, and smartphones for Internet, respectively.[10]

Due to the increase in technology usage by both children and adults, texting and smartphone apps have become a viable platform for health education and intervention programs. Many studies show that mHealth approaches are feasible and acceptable tools for the prevention and treatment of pediatric obesity[11] and are potentially a great resource for reaching typically underserved, low-income populations.[9,10] Although 38% of African American children under 18 are living below the poverty line,[3] in 2015 Pew Research Center reported 85% of African-American teens have access to a smartphone, compared to only 71% of White and 71% of Hispanic teens.[7] Swindle et al. suggest that technology-based

nutrition interventions may be an effective alternative to traditional programs for low-income families, due to barriers such as lack of transportation and work scheduling conflicts; however, the use of health apps should be further examined.[10]

Although a mobile technology approach to combating pediatric obesity is promising, multiple reviews have found a similar limitation: the majority of these apps are not created based on scientific theories of behavior change and do not include expert recommendations for reaching health goals.[9,11,13] Since behavior-change theories have been successfully used as a framework for traditional health promotion and interventions programs, we aim to integrate these theories into future versions of the mobile app to promote healthy eating and active living, particularly in income-disadvantages populations.

References

[1] Centers for Disease Control and Prevention (CDC). Overweight and obesity: Childhood obesity facts. Centers for Disease Control and Prevention (CDC) Web site. http://www.cdc.gov/obesity/data/childhood.html. Updated 2014. Accessed March 20, 2015.

[2] Centers for Disease Control and Prevention (CDC). Adolescent and school health: Childhood obesity facts. Centers for Disease Control and Prevention (CDC) Web site. http://www.cdc.gov/healthyyouth/obesity/facts.htm. Updated December 2014. Accessed March 20, 2015.

[3] The State of Obesity project. Analysis: Obesity prevention in black communities. The State of Obesity Web site. http://stateofobesity.org/disparities/blacks/. Published September 2014. Updated 2014. Accessed March 20, 2015.

[4] Lee H, Andrew M, Gebremariam A, Lumeng JC, Lee JM. Longitudinal associations between poverty and obesity from birth through adolescence. *Am J Public Health*. 2014;104(5):e70-6.

[5] Centers for Disease Control and Prevention (CDC). Childhood Obesity Causes & Consequences. Centers for Disease Control and Prevention (CDC) Web site. http://www.cdc.gov/obesity/childhood/causes.html. Updated 2012. Accessed September 23, 2015.

[6] Common Sense Media. Zero to eight: Children's media use in america 2013. Common Sense Web site. https://www.commonsensemedia.org/research/zero-to-eight-childrens-media-use-in-america-2013. Published October 28, 2013. Updated October, 2013. Accessed 9/28, 2014.

[7] Lenhart A, Pew Research Center. Teens, social media & technology overview 2015. Pew Research Center Web site. http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/. Published April 9, 2015. Updated April 2015. Accessed May 5, 2015.

[8] Madden M, Lenhart A, Duggan M, Cortesi S, Gasser U. Teens and technology 2013. Pew Research Internet Project Web site. http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_TeensandTechnology2013.pdf. Published March 13, 2013. Updated 2013. Accessed 9/28, 2014.

[9] Schoffman DE, Turner-McGrievy G, Jones SJ, Wilcox S. Mobile apps for pediatric obesity prevention and treatment, healthy eating, and physical activity promotion: Just fun and games? *Transl Behav Med*. 2013;3(3):320-325.

[10] Swindle TM, Ward WL, Whiteside-Mansell L, Bokony P, Pettit D. Technology use and interest among low-income parents of young children: Differences by age group and ethnicity. *J Nutr Educ Behav*. 2014;46(6):484-490.

[11] Turner T, Spruijt-Metz D, Wen CK, Hingle MD. Prevention and treatment of pediatric obesity using mobile and wireless technologies: A systematic review. *Pediatr Obes*. 2015.

[12] Azar KM, Lesser LI, Laing BY, et al. Mobile applications for weight management: Theory-based content analysis. *Am J Prev Med*. 2013;45(5):583-589.

[13] Brannon EE, Cushing CC. Is there an app for that? translational science of pediatric behavior change for physical activity and dietary interventions: A systematic review. *J Pediatr Psychol*. 2014.

Informed Consent

As PI, you are responsible for taking reasonable steps to assure that the participants in this study are fully informed about and understand the study. Even if you are not targeting participants from "Special Populations" as listed on page 4, such populations may be included in recruitment efforts. Please keep this in mind as you design the Consent Process and provide the information requested in this section.

Consent Setting: [Describe the consent process including *who* will obtain consent, *where* and *when* will it be obtained, and *how* much time participants will have to make a decision. Describe how the privacy of the participants will be maintained throughout the consent process. State whether an assessment of consent materials will be conducted to assure that participants understand the information (may be warranted in studies with complicated study procedures, those that require extensive time commitments or those that expose participants to greater than minimal risk).]

Requesting waiver of signed consent.

Capacity to Consent: [Describe how the capacity to consent will be assessed for participants with limited decision-making capacity, language barriers or hearing difficulty. If a participant is incapable of providing consent, you will need to obtain consent from the participant's legal guardian (please see the IRB website for additional information).]

Requesting waiver of signed consent.

Parent/Guardian Permission and Assent: [If enrolling children, state how many parents/guardians will provide permission, whether the child's assent will be obtained and if assent will be written or oral. Provide a copy of the script to be used if oral assent will be obtained.]

Requesting waiver of signed consent.

Documentation of Consent: [Specify the forms that will be used for each participant population, i.e., adult consent form, surrogate consent form, child assent form (written form or oral script) or an information sheet. Copies of all forms should be attached to this application in the same format that they will be given to participants (templates and instructions are available on the IRB website).]

Requesting waiver of signed consent.

Waiver or Alteration of Consent: [The IRB may waive or alter the elements of consent in some minimal risks studies. If you plan to request either a **waiver of consent** (i.e., participants will not be asked

to give consent), an **alteration of consent** (e.g., deception) or a **waiver of signed consent** (i.e., participants will give consent after reading an information sheet), please answer the following questions using specific information from the study:]

Waiver (i.e. participants will not be asked to give consent) or alteration of consent (e.g. use of deception in research):

Requesting waiver of *signed* consent.

- Why is the study considered to be minimal risk?

- How will the waiver affect the participants' rights and welfare? The IRB must find that participants' rights are not adversely affected. For example, participants may choose not to answer any questions they do not want to answer and they may stop their participation in the research at any time.

- Why would the research be impracticable without the waiver? For studies that involve deception, explain how the research could not be done if participants know the full purpose of the study.

- How will important information be returned to the participants, if appropriate? For studies that involve deception, indicate that participants will be debriefed and that the researchers will be available in case participants have questions.

Waiver of *signed* consent (i.e. participants give consent only after reading an information sheet):

- Why is the study considered to be minimal risk?

  The participants will respond to questions that are not sensitive in nature. Responding to the questions associated with the mobile app features will evoke minimal risk to the participants.

- Does a breach of confidentiality constitute the principal risk to participants? Relate this to the risks associated with a breach of confidentiality and indicate how risks will be minimized because of the waiver of signed consent.

  Even if a breach of confidentiality is to occur, it will not constitute a principal risk to participants because the study data are not tied to and cannot identify the participants.

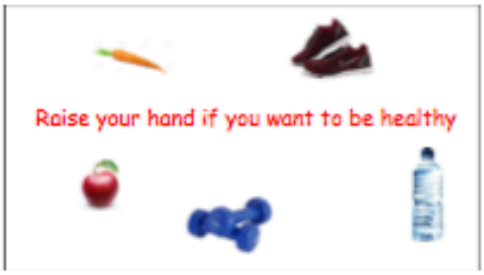
- Would the signed consent form be the only record linking the participant to the research? Relate this to the procedures to protect privacy/confidentiality.

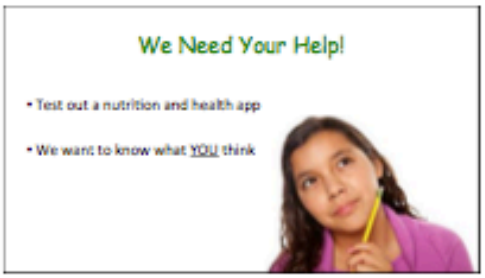
  A signed consent form would be the only record linking the participants to the research. Hence, we ask for a waiver of obtaining signed informed consent, as this act would result in loss of anonymity.

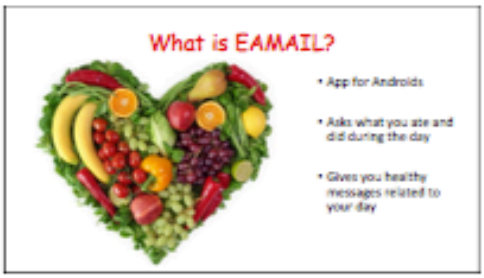
- Does the research include any activities that would require signed consent in a non-research setting? For example, in non-research settings, normally there is no requirement for written consent for completion of questionnaires.

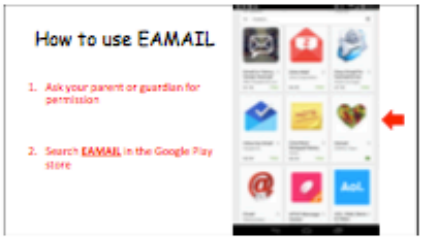
  No.

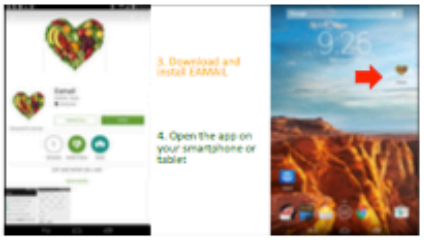
3.12 APPENDIX F: PowerPoint Presentation Introducing EAMAIL App

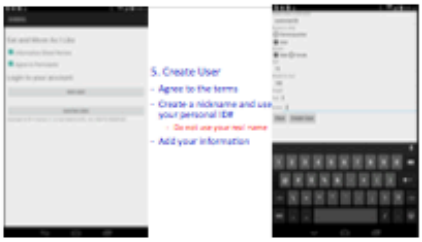




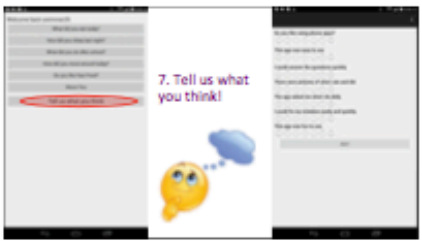



How to use EAMAIL
1. Ask your parent or guardian for permission
2. Search EAMAIL in the Google Play store

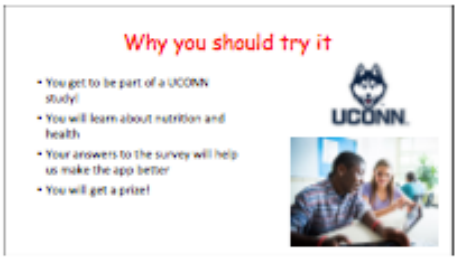

3. Download and install EAMAIL
4. Open the app on your smartphone or tablet


5. Create User
- Agree to the terms
- Create a nickname and use your personal ID#
- Do not use your real name
- Add your information

6. Start playing!


7. Tell us what you think!

What you need to do
- Download the app with parent/guardian permission at home
- Make an account
- Answer the daily log questions honestly
- There are no right or wrong answers!
- Complete the "Tell Us What You Think" survey
- Come to class in 2 weeks to receive a prize!
*With Mr. Milewski's permission, you can also play on the tablets in class!


Why you should try it
- You get to be part of a UCONN study!
- You will learn about nutrition and health
- Your answers to the survey will help us make the app better
- You will get a prize!
UCONN

Who's ready to try EAMAIL?

3.13 APPENDIX G: EAMAIL Information Sheet

Information Sheet for A Mobile App Survey

UCONN
UNIVERSITY OF CONNECTICUT

Principal Investigator: Valerie Duffy
Title of Study: Is the Healthy Living Mobile App Useful?

You and your child are invited to participate in this study. The study involves an Android smartphone or tablet app to promote healthy living — eating right, physical activity, getting a good night's sleep. We are interested in whether you or your child thinks this mobile app is useful.

As part of a health activity in school, your child will have the opportunity to interact with this app on an Android device. To participate outside of school with your child, you can download the mobile app your own personal Android device. Next, you will each create an account and try the app. The app asks you about the food that you like to eat and the activities that you enjoy. While in the app, your child can receive short messages to support healthy behaviors. Finally, you will complete a short survey about your app experience. This study should take about 10-15 minutes to complete.

You and your child's participation will be anonymous. Your mobile phone numbers are not identified. You will not be contacted in the future. You or your child's participation (or not) will not influence your relationship with your child's school. You and your child will not be paid for being in this study but your child will receive a small gift with a healthy message. This study does not involve any risk to you; however, a possible inconvenience may be the time it takes to complete the study. Your opinions will help us build a better app for health promotion.

You do not have to be in this study. You do not have to answer any questions that you do not want to answer. If you have any questions about this project, please contact Valerie Duffy at 860-486-1997 or Kayla Vosburgh 860-486-4262.

If you have any questions about your rights as a research participant you may contact the University of Connecticut Institutional Review Board (IRB) at 860-486-8802. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

To participate in this study, please access the study website at:

http://eamail.uconn.edu.

Thank You

UCONN IRB
Approved On 2/12/16
Approved Until 12/3/16
Approved By BS/MW

3.14 APPENDIX H: EAMAIL Enrollment Flyer

EAMAIL

Eat and Move As I Like!

Smartphone/Tablet Application

What is EAMAIL?

A kid-friendly nutrition app with fun and easy "picture surveys" about your favorite foods, drinks, and activities

Who should log on?

- **Kids:** Log on to answer the questions for yourself
- **Parents/Guardians:** Log on to answer the questions for *yourself*, not your child

Why should I log on?

- Kids and parents can learn about healthy foods and fun activities to enjoy together!

How do I log on?

After you log in to your Google account and download the FREE App:

- Make your own **nickname** and use these ID #'s:
  - **Child:** _____
  - **Parent/Guardians:** _____P
    *Be sure to include "P" in the ID
- Kids, add this information to make your account:
  - **Height** in feet and inches
  - **Weight** in pounds
- You can make one account on your own phone/tablet or more than one account on a shared phone/tablet

Download the **EAMAIL App** for FREE on any Smartphone or tablet with the **Google Play Store!**

Coming soon to the EAMAIL App:

Healthy eating tips, fun physical activities, easy recipes, videogames, and more for kids and parents to enjoy together!

Log on and play with the app as many times as you wish!

Thanks for logging on to the EAMAIL App!
Have a happy, healthy day!

This protocol has been approved by the UConn IRB – Protocol #H15-327

Nutrition Websites and Apps

Interested in learning more about good nutrition for you and your child?

Visit the following websites for more information:

Choose My Plate: www.choosemyplate.gov

- Information on MyPlate
- Nutrition and exercise tips for kids and adults
- Recipes, cookbooks, and menus
- Fun nutrition games, videos, and activity sheets for kids!

Kids eat right: www.eatright.org/kids

- Get healthy eating tips for children of all ages
- Find out how to get your child involved in the kitchen
- Discover healthy, delicious recipes in the "cook healthy" section

Nutrition for Children: www.nutrition.gov/life-stages/children

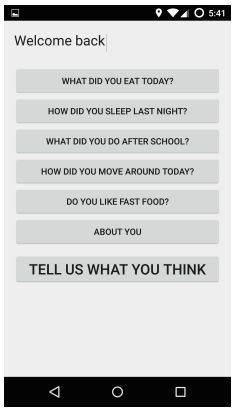
- Parents can learn about healthy foods for kids
- Kids can have fun with interactive games in the "Kids Corner"

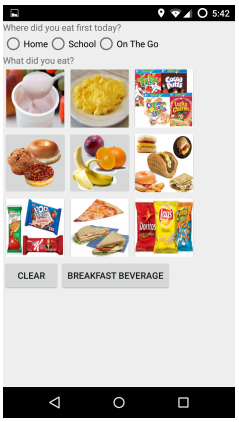
Here are some more fun apps for your child to try on their smartphone or tablet to get them up, moving, and eating healthy!

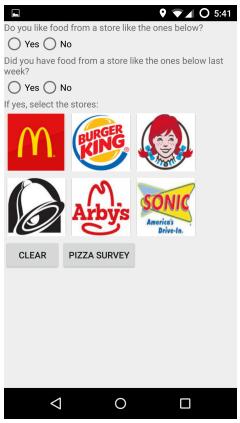
- Awesome Eats – Sort and stack vegetables as they come down the conveyor belt and learn healthy eating tips! (Free)
- Healthy Heroes – Feed the monster healthy foods to keep it from destroying the city ($1.99)
- Nutrition and Healthy Eating! (iLearn With) – Play games while learning about balanced meals and food groups (Free)
- Smash your Food – Kids guess what's in the food then watch as it is "smashed" and the answer is revealed. This app also provides tips for parents ($0.99)
- Easy Eater 2: Get your Kids to Eat More Fruits and Veggies – Use this app to get your whole family eating more fruits and veggies (Free)
- Workout in a Bag For Kids – Fun and challenging workout games for kids ($2.99)

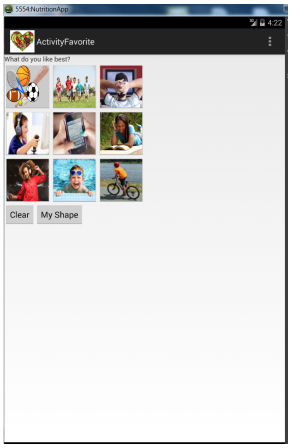
This protocol has been approved by the UConn IRB – Protocol #H15-327

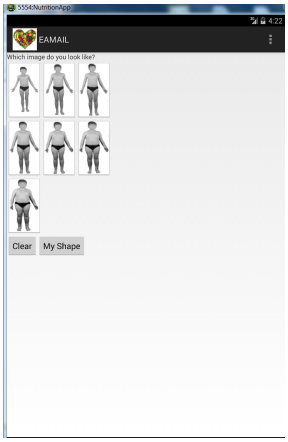
3.15 APPENDIX I: EAMAIL Screen Shots



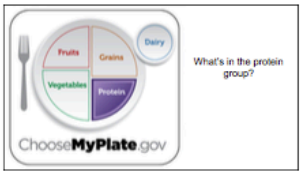


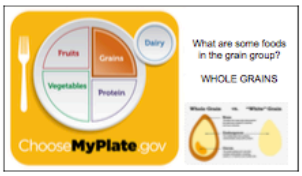


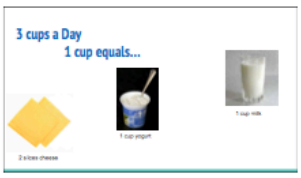




3.16 APPENDIX J: Healthy Snacking Lesson







Healthy Bodies

Need food from ALL food groups to GROW

Fruits, Vegetables, Protein, Grains, Dairy

Eat for ENERGY

Build strong BONES

Food gives BRAIN POWER

*Eat HEALTHY snacks to stay FULL, FIT, and FOCUSED!

How Do We Know How Much We're Eating?

Look at the food label:

Snack Ideas

Protein & Veggies

Hummus & Carrots/Peppers/Cucumbers

Snack Ideas

Protein & Veggies & Fruit

Ants on a Log:

Peanut butter or Cream cheese & Celery & Raisins

Snack Ideas

Grains & Protein & Fruit

Monkey Roll

Peanut butter and banana in a whole wheat wrap

Whole wheat toast with sunbutter and sliced bananas

Snack Ideas

Fruit & Dairy & Grains

Fruit Nachos:

Sliced apples with yogurt drizzle, topped with granola

Parfait:

Fruit, yogurt, and granola layers

Snack Ideas

Dairy & Grains

Cheese and whole grain crackers

Graham crackers dipped in yogurt

Snack Ideas

Make your own trail mix:

Whole grain cereal, nuts (walnuts/almonds/peanuts), seeds (pumpkin/sunflower), dark chocolate chips, and dried fruit (raisins, cranberries, cherries)

What are your healthy snack ideas?

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CHAPTER FOUR

CONCLUSION

With the increasing rates of childhood obesity, the purpose of this research was to investigate two novel and complimentary approaches to childhood obesity prevention in income-disadvantaged populations. In order to enhance our efforts towards obesity prevention, these two projects were designed in accordance with SNAP-Ed's Obesity Prevention Program goals, as well as the SNAP-Ed Guiding Principles. We were able to serve low-income individuals, specifically children, who are at an increased risk of obesity. In addition, we combined various evidence-based, behavior-focused educational strategies within these projects. Finally, we were fortunate enough to be able to coordinate efforts with various stakeholders in the community.

First, we found that a simple Pediatric-Adapted Liking Survey can be used to generate a feasible, valid, and reliable index to screen for obesity-related behaviors in pediatric care settings. We also found that among healthy weight children, parents with healthier behaviors had children with lower levels of adiposity. This finding has significant implications for future obesity prevention research because it indicates the importance of investigating parents, as well as their children, for lifestyle behaviors that may increase the risk of obesity. Additionally, our results reveal the importance of examining overall lifestyle behaviors, including diet and activities, when constructing a quantitative measure of health.

We know from this research, as well as from previous work cited throughout this report, that liking of foods and activities is predictive of health behaviors and outcomes. Therefore, the Pediatric-Adapted Liking Survey was used as a platform for creating an original smartphone application prototype to promote healthy weight in children and adolescents. We found that the EAMAIL (Eat And Move As I Like) app was user-friendly, enjoyable, and educational, making

it a viable platform for future mHealth research. This app provided children an opportunity to reflect on their daily health behaviors, an essential step towards behavior change. Participants also indicated that the messages provided based on individual responses will help them make healthier choices in the future.

Results from these studies can potentially be used to enhance future obesity screening and prevention tools. First, the Pediatric-Adapted Liking Survey and Healthy Behavior Index can be used as simple screening tools in pediatric care settings, including emergency departments and primary care centers. Additionally, healthcare practitioners may be able to use the self-reported information from both the Pediatric-Adapted Liking Survey, as well as the EAMAIL app, to tailor behavioral prescriptions to individuals, providing them with reinforcing health and nutrition messages that support positive behavior changes. Finally, after the integration of behavioral change theories and techniques, the EAMAIL app should be further examined to determine its ability to influence long-term behavior change in this population.