EXAMINING THE ASSOCIATION BETWEEN CHILDREN'S FRUIT AND VEGETABLE INTAKE AT AND AWAY FROM SCHOOL

by

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A thesis submitted in partial fulfillment
of the requirements for degree

of

MASTER OF SCIENCE

in

Nutrition and Food Sciences

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2015

ABSTRACT

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Utah State University, 2015

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In recent years, the problem of childhood obesity has gained a public platform in the United States of America. The food choices of children have been a target for obesity prevention programs because eating patterns developed early in life often continue into adulthood. Eating patterns that include few fruits and vegetables may predispose children to the risk of obesity and associated co-morbidities in their early life as well as later in life. The Fit Game is a school-wide game-based intervention that has produced significant increases in children's fruit and vegetable consumption at school.

The Fit Game requires few resources to support and may provide a more sustainable approach to influencing fruit and vegetable intake of children at school than previous methods. Though several programs have been successful at increasing children's intake of fruits and vegetable at school, little is known about how these programs influence children's fruit and vegetable intake at home. The aim of this thesis is to examine associations between factors that influence consumption of fruits and

vegetables at and away from school among children who are participating in a school-based intervention, which has been shown to increase fruit and vegetable consumption at school. The study population was 37 parent-child pairs who participated in the Fit Game intervention conducted at one elementary school in 2013 (n = 252).

(119 pages)

PUBLIC ABSTRACT

Examining The Association Between Children's Fruit and Vegetable Intake at and Away From School

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Several school-based interventions aimed at increasing fruit and vegetables (FV) intake among children have demonstrated success in short-term interventions. The Fit Game is a school-based intervention aimed at encouraging children to consume increasing amounts of FV during a game, which is a narrative. Just as children are being encouraged to eat FV at school, so is it equally important for them to eat FV at home. Parents strongly influence the amount of FV children consume at home. The aim of this thesis is to examine associations between factors that influence consumption of fruits and vegetables at and away from school among children who are participating in a school-based intervention, which has been shown to increase fruit and vegetable consumption at school. Associations between factors of the home environment and FV intake of children at and away from school are also explored. The study population was 37 parent-child pairs who participated in the Fit Game intervention conducted at one elementary school in 2013 (n = 252).

This study showed that there was an increase in FV intake of children at school during the period they played the Fit Game; however there was no change in fruit and vegetable intake away from school during that same period of time. In addition, though parents and children's intake of FV were correlated, parents did not change their FV

intake during the period of time their child participated in the Fit Game at school. There was no significance between children's intake and the factors in the home environment including family meals, FV accessibility and availability as well as parental knowledge. This study used rigorous methods to assess dietary intake. It is, however, important that this study is replicated with a larger sample that is more diverse.

DEDICATION

This thesis is dedicated to my late mother, Veronica Owusu-Ansah (Afia Abrafi), who saw me start this journey but did not live to see me graduate.

ACKNOWLEDGMENTS

I would like to express my deepest appreciation to my advisor and mentor, Dr. Heidi Wengreen, for her continuous motivation, assistance and guidance and immense knowledge. I thank you for your support throughout my stay in Logan, most especially when I lost my mum just a few months after I arrived in the United States. Thank you for seeing the best in me and encouraging me to press on even at my lowest point.

In addition, I would like to thank my committee members, Stacy Bevan and Dr. Gregory Madden, for their insightful comments, time and assistance during the writing of my thesis. My sincere thanks also go to research dietitian Sheryl Aguilar for her guidance, encouragement and direction during the clinical phase of this study as well as providing us with dietetic students to assist in the measurement process. I thank Dr. Angelina Danquah of University of Ghana for her constant support and encouragement. I also thank the United States Department of Agriculture for their grants, which made this study possible.

Finally, I would like to thank my dad, Colonel Augustine Ansu, and my late mum, Veronica Owusu-Ansah, as well as my siblings Isaac, George, Augustine and Genevieve for being my inspiration and giving me much love and support throughout my life.

Velarie Yaa Ankrah Ansu

CONTENTS

Page

ABSTRACT……...iii

PUBLIC ABSTRACT……v

DEDICATION……...vii

ACKNOWLEDGMENTS……....viii

LIST OF TABLES……xii

CHAPTER

1. INTRODUCTION AND BACKGROUND……1

ABSTRACT……1
INTRODUCTION……...2
BACKGROUND AND LITERATURE REVIEW…….....3

Statement of the Problem…….3
Previous Studies……...4
Assessing intake of fruits and vegetables in children……10
Digital observation…….10
ASA24-25 Hour Recall……..11
Food Frequency Questionnaire……..13
Resonance Raman Spectroscopy to measure Skin Carotenoids ……...17
Overview of diet assessments used in this study……...17

SPECIFIC AIMS…….……..18
HYPOTHESIS…….……..18
REFERENCES…….…….19

2. FACTORS THAT INFLUENCE WHAT CHILDREN EAT AT AND AWAY FROM HOME: A LITERATURE REVIEW……..……26

ABSTRACT……...26
INTRODUCTION…….27
REVIEW OF FACTORS THAT AFFECT WHAT CHILDREN EAT AT AND AWAY FROM SCHOOL ……....29

Fruit and Vegetables Availability and Accessibility……29
Family Meals……32
Parental Control……33
Parents Nutritional Knowledge……35
Modeling……38
Rewards……40
Conclusion……42

REFERENCES ……43

3. THE IMPACT OF THE FIT GAME PROGRAM ON CHILDREN AT HOME AND SCHOOL……52

ABSTRACT……52
INTRODUCTION……54
METHODS……56

Participants……56
Procedures……57
Measurements……58
Skin carotenoid scans……59

DIET ASSESSMENT METHODS AND OTHER INFORMATION……59

Online Survey……60
24-Hour Diet Recalls……60
Digital Observations……61
Statistical Analysis……62

RESULTS……62

Demographics……62
Correlations……68
Paired t-tests……71
Repeated measures analysis of variance……73

DISCUSSION……75
REFERENCES……80

4. CONCLUSION AND IMPLICATIONS……85

CONCLUSION……..85
IMPLICATION FOR FUTURE RESEARCH……..86
REFERENCES……..87

APPENDICES……88

A. Family Fit Survey I……..89
B. Family Fit Survey II…….98
C. Food Tracker……..102
D. Permission Letter……...104

LIST OF TABLES

Table		Page
1-1	Previous studies that assessed children's home intake…….....	9
1	Comparison of the fit game data to the family fit sample……	65
2	Factors in the home environment by mean intake of children……..……..	65
3	Demographic data of parents and kids in the family fit study…….....	66
4	Descriptive information about the home environment of parents and children…….....	67
5	Correlation coefficients comparing children's overall total FV consumption, school and home FV consumption and skin carotenoids……..……	70
6	Correlation coefficients comparing children and parents FV consumption skin carotenoid scores, BMI and taste preferences...…….……....	71
7	Baseline Fruit and vegetables intake of parents and children……...	72
8	Average fruit and vegetable intake at school measured at baseline and again during the final 3 days of the intervention……...	73
9	Average total fruit and vegetables intake at home measured at baseline and again during the final 3 days of the intervention……..……....	73
10	Average fruit and vegetables consumption of parents; baseline assessment compared to post intervention assessment…….....	74
11	Baseline and post carotenoid scores of parents and kids in the family fit study……	74
12	Fruit and vegetable intake of children compared to the factors in the home environment……...…….….	74

CHAPTER 1

INTRODUCTION AND BACKGROUND

ABSTRACT

The intake of fruits and vegetables (FV) among children in the United States of America is below the recommended five servings a day intake. There are many benefits of consuming FV such as prevention of cardiovascular diseases, some cancers, and strokes among many others. Obesity is on the rise among children in the US and there is the need to encourage children to consume more FV so that good eating habits can be inculcated in them now and continue into adulthood.

The home environment and school environment are two areas that need to be focused on when promoting healthful eating habits. This is because children spend more time there and hence have most of their meals in these environments. Parents are also an important target in increasing children's intake since they influence what children eat in the home environment as well as what they take to school, if they choose to bring their lunch from home. Parents are the key determinants in what food items are purchased at home, therefore, examining what factors in the home environment influence intake is critical in making decisions for future interventions.

This study sought to examine if children are increasing their FV intake at and away from school during a period in which they are playing the Fit Game at school. The Fit Game is a game, that when played at the school level, consistently produces increases in group level consumption of FV at school. Factors in the home environment that could influence children's intake at and away from school will also be explored.

INTRODUCTION

According to the World Health Organization (WHO) low fruit and vegetable (FV) intake is among the top 10 risk factors for global mortality.[1] Low consumption of FV contributed to approximately 1.7 million deaths in the year 2003. Consuming insufficient amounts of FV is a factor in 14% of gastrointestinal cancer deaths, about 11% of ischemic heart disease deaths and about 9% of stroke deaths worldwide. Research has shown that a diet high in FV reduces the risk of developing many chronic diseases.[2] Food habits and preferences that are developed during childhood and adolescents continue into adulthood. This makes childhood a very crucial period to initiate a lifelong eating habit to achieve a maximum preventive effect against diet-related chronic diseases.[3]

School-based intervention programs aimed at increasing FV intake among children while at school are the most common type of obesity related intervention for young children. There are many benefits to designing school-based interventions. Children have about 1-2 meals per day at school and consume 1/3 or more of daily kilocalories at school on school days. According to the National Center for Education Statistics (NCES), enrollment in elementary public schools in the United States for fall 2012 was 35.1 million and an increase of 7% has been estimated between 2012 and 2021. According to the National School Lunch Program, as of 2012, more than 31 million children were eating school lunch. On average, for both lunch that were offered and served to school children, it contained about 34% and 11% of energy from total fat and saturated fat respectively.[4] School meals help to provide a significant proportion of children's total energy intake. This is usually achieved through their federally reimbursable school meal programs and other food sources like vending machines and a la carte areas.[5,6]

The kinds of intervention programs that have been implemented in school meals include both single and multicomponent programs. Multicomponent programs may offer an advantage over single component programs. In multicomponent programs, a range of programs are used such as the addition of nutrition education in school curriculums, involving parents to increase family support and the improvement of the school environment to enable healthy choices. An example of a single-component program are those that provide free or subsidized foods to children at snack or during lunch in hopes that this will increase children's consumption.[7]

Few multicomponent programs include strategies that address and evaluate home consumption of FV. Evaluating and targeting the home environment is important because though children consume 1-2 meals per school-day at school, they are also eating meals and snack away from school. Programs that only impact children's consumption at school may do little to improve the overall health of children. There are many factors that may influence children's FV intake at home, some of these may be parental influence,[8,9] their socioeconomic status,[6,10] availability and accessibility[11] as well as family meal times.[12-14] Parents are very important in the determination of the diet of children because they influence their intake by controlling the factors in the home environment that promotes children's intake.

Statement of the Problem

Several interventions have targeted children's consumption of fruit and vegetables away from school [8,15-17] while others have targeted children's consumption of FV at school; [5,7,18,19] however few studies[5,20 21] have focused on the importance of both settings and the impact each has on the other. Understanding the factors in the home environment

that influence the eating behaviors of children may inform future interventions so as to target long term changes in eating behavior at home and at school, which may better improve the health of children. Parents use different strategies at home that influence the intake of children and this makes examining them vital.

The purpose of this research is to assess total dietary intake of children and parents of children who are actively participating in the Fit Game, a multi-component school-based incentive program aimed at increasing FV intake at one elementary school during August- November of 2013. In addition to assessing and examining correlations between dietary intake of parents and children, information about the home environment will also be assessed to see how these factors influence consumption patterns of both children and parents at and away from home, while children actively participated in the intervention at school.

Previous Studies

The Food Dudes program is an example of a successful multi-component school-based intervention aimed at increasing the FV intake of children. The Food Dudes program was developed by psychologists in Wales[22,23] and was implemented in over 100 elementary schools in the UK with great success. In the Food Dudes (FD) program children are introduced to the Food Dudes cartoon characters that are role models for the behavior of eating more FV. Children are exposed to additional amounts of fruits and vegetables in the school cafeteria, and then rewarded after consuming prescribed amounts of fruits and vegetables. Rewards included small tangible prizes such as an eraser, pencil, etc. as they consumed fruit and vegetables. The FD has shown statistically and clinically significant results in the UK.[21]

Horne et al implemented the Food Dudes program at school and examined fruit and vegetable consumption at school and away from school. Horne found that children participating in the Food Dudes program at school increased fruit and vegetable intake at and away from school *(P<0.05).*[23] This study used one weekday and one weekend day at both baseline and intervention due to missing data. [23] Similarly Lowe et al also found an increase *(P<.001)* in children's FV intake at school during the intervention while intake away from school during the intervention was significantly higher on weekdays *(p<0.05),* but not on weekends. Children 7-11years old increased their consumption per weekday by 0.55 (131g) cups following the intervention.[22]

In contrast to these findings, Taylor et al found that the Food Dudes program (UK) did not produce either short or long term increases in the children's FV intake away from school. There was no baseline difference found between control and intervention schools in fruits *(t=0.38(32), p≥.05)* and vegetable consumption *(t=-1.42(32), p≥.05).* This study excluded lunch meals since the children ate lunch from school, only intake away from school was measured; hence all lunch was excluded from this study. [7] However most of the children in their sample size (n=34) were from areas of poverty, making generalization of their results difficult. In this study home intake was measured using a 7-day whole diet photographic diet diary where parents photographed their children's meals before and after consumption. The researchers visually estimated portions of FV consumed using standardized procedures.[7]

Both Lowe et al.[22] and Horne et al.[23] used the same methods in the measurement of intake of children. They used parental 24-hour food recalls where parents were telephoned daily to ask them what their children had eaten at home the previous day using a standardized interview. The parents used the 'size of serving' card to help them

with reporting. This method could have potential bias due to errors in the estimation of portion sizes. If parents do not spend time with children, have family meals together at home or get home late it means they will have to depend on recall by children or a caretaker. These situations may be more common among families of lower socio-economic status, especially when both parents are working outside of the home. Older children may also report foods that their parents permit them to eat and may not inform them about what they are not allowed. Many parents now work out of the home and this has made accurate parental reporting difficult and is especially problematic in studies of young children where parental recall is the only method being used. Individuals who care for children can be included in studies however there is likelihood that they may need some form of motivation and interest.[10] Lastly, if the parents are aware that there is a target on healthy eating they may tend to overestimate their consumption of food perceived as healthy, and underestimate their consumption of food perceived as less healthy.

Due to the success of the FD, researchers in the United States of America adapted and implemented the Food Dudes program in seven U.S. schools in which two of them were used as control schools to see whether or not it would produce increases in FV intake similar to those observed in the U.K. In a small pilot study 253 students attending one school participated in the Food Dudes program. Fruit and vegetables intake was increased by 0.49 cups per day during the 16 day intervention among children participating in the Food Dudes program. Participants who consumed no FV during baseline (fruit=40%, vegetables=47%) had consumed an average of 0.28 cups of fruit and 0.22 cups of vegetables at the end of phase 2. It was concluded from the findings that the

intake of fruit and vegetables increased significantly during and after this implementation (*P< 0.001 for both Phases 1 and 2*).[18]

In a randomized-controlled trial study of the Food Dudes program that examined students that attended one of six public elementary schools in northern Utah it was found that when the FD program is implemented with tangible prizes there was increase in FV consumption. However, replacing prizes with praises from teachers saw smaller increases in consumption during implementation and had no long term effects. In the first phase of this study there was a combined FV increase of 0.21 cups (control vs. Praise), 0.32 cups (Control vs Prize), and 0.11 cups (Praise vs Prize). The second phase also saw a combined increase of FV intake by 0.08 cups (Control vs. Praise) and 0.13 cups (Control vs. Prize). In the follow up of this study there was a combined increase of FV intake of 0.12 cups (Control vs. Prize), and 0.13 cups (Praise vs Prize). Although the FD program as implemented in U.S. schools was successful at increasing FV intake at school, there has been no previous report of intake at home during or after the intervention. Despite the success of the Food Dudes program in the United States there were some challenges due to the amount of resources needed to implement the program. This was mainly due to the lack of time on the part of teachers to assist children through the study process and resources needed to provide tangible rewards to children.

These challenges led our research team to the development of the Fit Game. Unlike the Food Dudes program, there are no tangible rewards in the Fit Game. Instead, the reward for eating prescribed amounts of fruits and vegetables is playing the game. In the Fit Game, the amounts of FV consumed is computed by weighing the amount of FV provided to the children and the amount of FV children do not eat and instead throw away, at the school-level. Children are rewarded for eating increasing amounts of FV by

playing a game, which is a space-odyssey narrative where children actively participate in the development of the narrative.

Several school-based intervention studies have been successful at increasing fruit and or vegetable intake of children at school, but only three have assessed FV intake at home during the period of intervention at school and these were Food Dudes programs, as previously discussed. Evans et al. [24] recently conducted a meta-analysis of school-based intervention studies aimed at increasing fruit and vegetable intake among children 5-12 years of age. In their analysis of the 21 available studies, they observed only modest improvements in FV intake at school, with the majority of the effect observed coming from increases in fruit and not vegetable consumption. Overall there was an increase of FV intake in children in the meta-analysis by 0.25 of a portion as compared to the FD[18] in the US increasing children's intake by 0.49 cups while the Fit Game increased their intake by 0.16 cups (34 grams) None of the studies included in this review reported on total FV intake or FV intake at home during the intervention period at school.[24] A summary of the previous school-based intervention studies that assessed the home environment as described above is shown in Table 1-1 below.

Table 1-1 Previous Studies that Assessed Children's Home Intake.

References	Methods	Results
(Taylor et al.,2013)[7]	N=34 children (4-11 years) Intervention & control groups 7-day photographic food diary. Researchers visually estimated portions ate using portion guidelines.	FD program had no effect on changing children's FV intake at home. Weekday Fruit intake *(P>.05)* Weekday Vegetable intake *(P>.05)*
(Lowe et al.,2004) [22]	4-11 year old N=402 Videos of heroic peers (FD) Rewards Home: parental 24hr- recall by telephone interview School lunch- visual estimation and rated on a five point scale	After intervention children's FV intake increased *(P<.001)* Overall estimate baseline (8-12 days) followed by intervention (16-day) 4-7years increased intake of FV by 153g (0.65 cups) weekday.) 7-11 years increased by 0.55(131g) cups per weekday.
(Horne et al.,2004) [23]	N=749. Experimental and control 5-11years Videos of heroic peers Rewards Home: parental 24hr- recall by telephone interview. School lunch- visual estimation and rated on a five point scale	Higher consumption in experimental schools than control schools. Lunchtime intake in experimental school was higher at intervention and follow-up than baseline *(P<0.001)* Significant increase of FV at home *(P<0.05)* Baseline (12 days) followed by intervention (16-day) and then 4-month
Home component means that the factors in the home in relation to FV intake were also assessed.		

Assessing intake of Fruit and Vegetables in Children

The importance of dietary assessment cannot be overlooked in any study, since inaccurate information on individuals' dietary intake will lead to a misleading conclusion. There is difficulty in accurately estimating the dietary intakes of children since there is always some degree of misreporting.[25] Nutritional biomarkers are reliable for objective estimates of diet in anthropometric and clinical assessment, while the 24-hour recall, food frequency questionnaire (FFQ), and dietary history have been used in subjective estimates. It has been suggested in recent research that there is a need to combine some of the dietary methods for a more accurate estimation of dietary intakes as compared to the use of single methods.[25] Research examined in this study that focused on FV intake at and away from school used methods like visual estimation, 24-hour recalls,[22,23] and photographic data.[7] The present study used the ASA24 a 24-hour recall method, FFQ, and the Resonance Raman Spectroscopy.

Digital observations

The digital photographic method is relatively a new method for assessing individual's intake. It has being validated in children[26] and adults[27,28] using different camera technologies that included mobile phones, disposable cameras and personal digital assistants with a camera. This method helps with recall challenges that respondents face, especially children, in the estimation of portion sizes. One of the major challenges in research with children is that they sometimes over-estimate or under-estimate portion sizes. This method will reduce the burden on children and assist with more accurate data collection.[29,30] The digital photographic method also has an advantage for collecting data on larger population samples.

The digital photographic method may be a better approach to frequently used food diaries, food frequency questionnaires, weighed food records, diet histories, and the 24-hour dietary recalls which are commonly used in the estimation of individual's dietary intake. These methods rely on self-reporting by respondents and hence lead to a high burden on respondents.[31] A study in Colorado found no difference between photographic and diet diary estimates of total energy, fat, carbohydrate, calcium, iron, fiber, protein, and vitamins A, D and E. Ninety-six percent of participants reported that the photographic method was quicker (95% CI=82-100) while 89% reported its ease of use (95% CI=72-98) as compared to the food diary.[26]

ASA24-24 hour recall

The 24-hour diet recall interview is a quantitative research method used in nutritional assessment that asks individuals to recall all foods and beverages they have consumed in the last 24-hours before the interview. Twenty-four hour dietary recalls have minimal bias and is the preferred tool to monitor the diets of individual's as well as populations. However, traditional 24-hour dietary recalls are expensive and not practical for larger studies, since interviewers are needed. In the need to address this challenge the National Cancer Institute developed the Automated Self-Administered 24-hour dietary recall (ASA24).[32]

ASA24 is a web-based 24-hour recall tool for researchers, educators and clinicians and is also available for public access. It enables a self-administered and automated 24-hour recall and automates the delivery of nutrient and food-level estimates of intake over designated periods of time. The participant is guided to recall what they consumed for the previous day from midnight to midnight. It has an audio-enabled

animated penguin that assists participants through the process. Participants report their intakes using a list of foods and beverages from USDA's most current food and nutrient database for dietary studies. The respondent is able to choose from multiple images to help estimate portion size, browse foods and beverages, edit a meal, review the final list of the day's intake, and access help.

The ASA-24 has options to specify the time food was consumed and other factors associated with food consumption including where the food was consumed and whether or not the food was consumed with others. It also asks questions that are associated with the eating occasion, including who an individual ate with, meal times, if meal was consumed watching TV or on the computer and also where the meals were eaten.[33-35]

The ASA24 was built from the USDA Automated Multiple-Pass Method (AMPM), which has been validated in children[33-35] and is accurate to measure the mean total energy and protein intakes when these intakes are compared to recovery biomarkers including nutritional biomarker. Recovery biomarkers have a known quantitative time-associated relationship between dietary intake and recovery (excretion) in human waste and are able to give important information about the measurement errors in the self-reported FFQ. [36]

The 24-hour recall being adapted to an automated tool can transform dietary assessment by improving the practicability and cost-effectiveness of the collection of dietary data. Young children (<8 years old) have a limited ability to cooperate in dietary assessment and this has made parents ability to recall what their children consume very important. Children may not be able to remember quantities and may not always be able to give a detailed description of the food they eat.[37]

The automated 24 hour recall may be a useful tool to evaluate children's food intake as Weber et al found no significance difference between recalled and observed energy intake for third-grade students' school meals. Out of 702 foods that were observed, 527 foods (75%) were recalled correctly by the children. The Pearson correlation for energy and energy providing nutrients was from 0.61 to 0.86 for school breakfast and 0.55 to 0.86 for school lunch. There was also more than 70% recall of observed foods for 9 out of the 15 food groups.[35] Likewise fourth grade students in 10 public elementary schools were examined to determine their level of accuracy in recalling their school breakfast and lunch. The children were observed during breakfast and lunch at school and then they were interviewed by phone or in person in the evening of the day they were observed. This study found no significance difference between how accurately children reported their intake *(p=0.62)*. [38] It was however found that whether interviewed in person or on phone children failed to report 33% of the items they were observed eating and 17% of the items they reported as eaten were not observed.

Food Frequency Questionnaire (FFQ)

In epidemiological studies the FFQ is the most commonly used tool. It is designed to assess the frequency of individual's habitual dietary intake over a reference period of time. With just one administration and are able to show an association between an individual's habitual intake and an outcome of interest.[39] It is inexpensive and is quicker to use than recall based methods, such as the ASA24. FFQs may be an extensive list of foods or a short list of specific foods. The listed foods should be a major source of a specific group of nutrients of interest or foods commonly consumed by the study population that contributes to the variability in intake between individuals in the

population. They can be self-administered (paper or web-based) or interviewer administered (face-to-face or telephone). The frequency of consumption is assessed by multiple responses which range from 'never' or 'less than once a month' to '6+ per day'.

FFQ is best for assessing the long-term usual intake of individuals over weeks, months or years and it is very efficient for this purpose. The main sources of error in the use of FFQs are the respondent's memory, how they interpret questions, and their perception of portion sizes as well as the restricted food lists. These issues become more problematic in children due to their limited ability to recall what has been eaten previously.[39]

Many question the use of the FFQ among children. This is because it requires abstract thinking, the knowledge of food groups and names, basic reading and skills in arithmetic. Children have a limited memory as well as a limited concept of time. It is also most likely that children do not pay attention to the frequencies at which they eat food.[10] Children younger than about fourth grade or 10 years of age often don't have the cognitive ability to accurately answer FFQs.

Using Resonance Raman Spectroscopy to measure carotenoids (RRS)

The concentration of carotenoids in an individual's skin is an indicator of the amount of FV they consume and can be measured non-invasively using Resonance Raman Spectroscopy. The RRS is a type of vibrational Raman spectroscopy in which the incident laser frequency is close to an electronic transition of the molecule or crystal studied. It is a non-invasive technique using visible light and a small probe with a laser at a blue wavelength (λ=488nm) to measure the total carotenoid status in the skin.[40] Self-reported dietary interventions have been found to be biased and prone to measurement

errors; [41] therefore including skin carotenoid measures in this study will help obtain a valid assessment of FV consumption among study participants.

Research has found RRS to be a feasible biomarker of FV intake and may help with research on diet as well as the health of children. [42] It has also been found to be a very useful tool in determining the nutritional status of children's dietary measurements.[43] A study assessed how feasible the RRS biomarker was and also examined the distribution of skin carotenoids status in children. They found that there was a higher carotenoids status positively associated with fruit or vegetable intake, (P=0.02) and fruit/vegetable preference *(P<0.01),* however there was lower carotenoids status in younger children and those who had greater adiposity *(P<0.05).* This study showed that there was a wide variability in skin carotenoids of children. [42]

Carotenoids are pigments found in some plants. Fruits and vegetables that are orange, green, yellow, and red contain carotenoids. Carotenoids serve a protective role in the skins antioxidant defense system preventing against diseases like cancer and heart diseases. Lycopene, α-carotene, β-carotene, lutein, zeaxanthin, cryptoxanthin, phytoene and phytofluene with lycopene and the carotenes are about 60-70% of the total carotenoid content and are the eight most concentrated carotenoid antioxidants in human skin. Concentrations of carotenoids are considered to be a biomarker of FV intake because FV are the best source of carotenoids.[42] These act as scavengers for free radicals, singlet oxygen and other harmful reactive oxygen species. The metabolic process or excessive exposure of the skin to UV components of the sun causes formation of the free radicals.

To measure carotenoids in plasma or tissue samples, biochemical analyses like high-performance liquid chromatography can be used. [44,45] HPLC is the gold standard technique for the measurement of carotenoids. It works well for the measurement of

carotenoids in serum and it has been used in the assessment of the carotenoid antioxidant status after the collection of blood samples in this process. Skin carotenoid HPLC measurement requires highly invasive tissue biopsies. The way to overcome these limitations is by using the optical detection approach for skin carotenoids done directly in the skin tissue of interest in a complete non-invasive fashion. These methods can be used to trace carotenoid status over time and can also allow for inter-subject comparison of skin carotenoid levels in vivo. [44,45]

Measurements using serum carotenoids reflect shorter-term consumption of carotenoids. Skin carotenoids reflect longer-term consumption patterns but can be impacted by factors that influence the production of reactive oxygen species due to smoking and UV light exposure. The preferred body site for measurement has been the palm of the hand because of the stratum corneum that is the outer skin tissue layer where carotenoids concentrate. This area is relatively thick and also has less melanin content that is variable in different races and ethnicities. [40]

Carotenoids measured by biochemical methods in blood as well as other tissues after extraction and blood/tissue carotenoid concentrations have been associated with dietary intake of fruits and vegetables in children.[46] The Food and Nutrition Board panel of dietary antioxidants and related compounds found Blood concentrations of carotenoids to be the best biological markers for FV consumption. [46] Aguilar et al [47] found serum levels of carotenoids to be strongly associated with concentration of carotenoids in the skin *(R^2=0.62; p<0.001).* This was used as a valid biomarker of FV intake among children (5-17years).[47] Similarly another study examined the reproducibility and validity of RRS measures of dermal total carotenoids and lycopene in humans, however they recruited smokers and non-smokers since plasma carotenoid concentrations were known

to be lower in smokers. The total dermal carotenoid assessed by RRS was significantly correlated with the total dermal carotenoid assessed by HPLC of dermal biopsies *(r=0.66, P=0.0001)*. Lycopene assessed by RRS was also significantly correlated with lycopene assessed by HPLC of dermal biopsies *(r=0.74, P<0.0001).* These results show that RRS is a feasible and valid method for assessing dermal carotenoid as a biomarker. [43]

Overview of the diet assessment used in this study

This study employs the use of ASA-24 hour recall, RSS skin carotenoid status, and a FFQ. The combination of the various dietary measurements in assessing intake ensures that the assessment is more rigorous and gives more accurate results. The use of digital images at the school level helps with reduction in input error hence resulting in greater precision. Direct observation from the digital observation was compared to reported estimation from questionnaires to ensure that there is consistency which will lead to more accurate results. The use of the ASA-24 assists respondents in estimating portion sizes through visual images that helps access intake. It also helps respondents with low literacy to be able to understand better the questions and process through the guidance that is provided from the automated system. FFQ helps with assessing long-term dietary intakes in a simple and more cost effective and timely manner. [25]

One approach that has been suggested to assess the relative validity of dietary assessment methods included the comparison of the various methods. For example, by comparing the results of the food frequency questionnaire with the 24-hour recall the results can be validated.[48]

In children there are more complications in the assessment of their intake which could be mainly due to inaccurate recalls, and portion size estimation, which can lead to bias. Due to the reports of bias in self-reported carotenoid intakes in dietary assessment

the RRS was also used in this study for more accurate results. Carotenoids which are found mostly in FV are the best biomarkers of individuals FV intake. The RRS which has been shown to be an objective indicator of carotenoid status in both adults and children was used in addition to all the other methods mentioned. These rigorous methods used in this study will yield more accurate results.[42]

Specific Aims

The purpose of this study is to answer the following research questions

1. Does the FIT game increase children's consumption of FV at and away from school during the 6-days the children are playing the game at school?
2. Does the FIT game increase parent's consumption of FV at home during the 6-days their child/children are playing the game at school?
3. How do factors of the home environment impact children's FV consumption and their response to school- based interventions aimed at increasing FV intake at school?

Hypothesis

We expect that the Fit Game program will increase children's FV intake both at school and at home and also to find a positive correlation between children's intake and that of their parents. Some factors in the home environment are also likely to impact the children's FV intake at home and school, including the availability of FV and diet related attitudes and behaviors of parents and other family members at home.

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CHAPTER 2

FACTORS THAT INFLUENCE WHAT CHILDREN EAT AT AND AWAY FROM SCHOOL: A LITERATURE REVIEW

ABSTRACT

Low intake of FV is among the risk factors of many chronic diseases. School-based programs like the Food Dudes have helped increase the intake of FV at schools since most children spend a good amount of time at school and have about 1-2 meals there. The assessment of the home environment has become very important since there may be some factors at home that could increase or decrease children's FV intake at both home and school. Factors in the home environment such as FV availability and accessibility, family meals, parental role modeling, rewards, control and nutritional knowledge may influence children's intake.

There have been various controversies about whether the use of rewards and excessive control by parents is the best tool to increase children's FV consumption. However, it has been shown that when rewards are used effectively they can be a very important means to increase children's FV intake. This has been found to be the case in the Food Dudes and other programs that use rewards to increase children's intake of FV.

These home environment factors when assessed may provide more information to be used for public health awareness to inform the development of interventions that target eating behaviors at and away from school as to increase children's FV intake.

INTRODUCTION

In the United States of America, most children do not consume the daily recommended amount of FV and hence do not have the added benefit of maintaining the appropriate body weight and a reduced risk of chronic diseases in the long term.[1] The American Heart Association (AHA) recommends that children aged 4-13 consumed 1.5 cups of fruits per day while 4-8 year old females consumed 1 cup of vegetables and males 1.5 cups. Female children 9-13 are to consume 2 cups of vegetables as compared to 2.5 cups for males. The USDA reports that children aged 6-19 consumed about half the recommendation for fruit while children 6-11 consumed slightly half the minimum recommendation for vegetables.

The dietary habits of children determine what they consume as they become adults and hence a diet higher in FV in early life may help to decrease chronic diseases in adult life. [2,3] This is because there is always a greater probability that food preferences developed earlier on in life will continue into adulthood. This makes childhood an important stage in the development of healthy foods in a child's life. Parents have a greater role in helping children in establishing their taste preferences.[4] This is because they have more control over what their children eat, can serve as good role models by eating healthy foods, and expose their children to a wide variety of healthy foods at an early age. Once children start school most of their food preferences would have been developed already, therefore inculcating a healthy lifestyle in children by parents should be paramount.[4] Children may have less autonomy in decisions about what they eat at home compared to what they eat at school, most will be consuming what FV their parents provide them. For the most part, parents control this environment making it an important place for investigation. Some of the factors that influence children's intake are the socio-

economic characteristics of their families, individual preferences as well as the characteristics of their environment. [5-7] Grossmans health model [8] (the application of consumption and investment theory on the analysis of human health) elaborates on how the social economic status (SES) of parents can affect the health of children. Budget constraints restrict parents on what to buy and this may lead to the purchase of foods that may not be healthy. Also the educational status of parents may play an important role in food choices as well as behavioral modifications.[8]

Rosenkranz et al. [9] also examined the home food environment in their ecological model of the home environment. They proposed three environmental domains that affect children's diet in the home setting. These domains included the built and natural environment (physical structures), political and economic environment as well as the socio-cultural environment. The political and economic environments are made up of financial resources, policies and laws while the sociocultural is made up of social interactions, characteristics of demographics as well as secular trends. [9] Individual eating behavior was found to be influenced by factors including individual food preferences, socio-cultural environments like the diet of their parents, family eating patterns and habits, culture and the physical environment such as food availability.[9] Such factors influence children's dietary decisions and intake both at and away from home.

In the home environment, individual's behavior is important in the assessment of intake. The theory of planned behavior (TPB), which is a health behavior theory as proposed by Ajzen has been used to explain the psychosocial factors that influences FV intake. It is made up of four psychosocial constructs: attitudes, intention, subjective norms and perceived behavior control. According to Ajzen, these four predictors should reflect factors that contribute to individual's behavior. [10] TPB offers an explanation for

the reason why psychosocial factors influence behavior related to FV intake. It shows intentions and perceptions of behavioral control as useful predictors, however there is the need for additional research to determine whether the constructs are enough to account for the variance in behavior.[10] Understanding what psychosocial factors influence FV intake is important because it will help in understanding the possible factors that influences children's intake.

Review of factors that affect what children eat at and away from school – A literature review

This literature review will be presented in sections with regard to factors that influence what children eat at and away from home. These sections include FV availability and accessibility, family meals, parental control and nutritional knowledge. In addition, modeling and rewarding of children and how it influences their intake, especially away from home will also be discussed.

FV availability and accessibility

Children cannot consume food if it is not available and accessible to them. Research supports associations between socio-economic status and food availability and accessibility. Generally lower-income homes have low availability and accessibility of FV. [11-13] However, availability does not always guarantee consumption. Some children do not like eating FV and will not do so even if it is available. FV are foods often less preferred by children, and children often make negative remarks about eating them and will prefer sweets, desserts and other snack foods as the most preferred meal choices instead of fruits.[13] In addition, children learn to prefer foods that are readily available and accessible to them. [14-16] This makes the role of parents very important since they are the

ones who must expose children to a wide variety of healthy foods as well as making them accessible (e.g. peeling oranges) in a way that will facilitate consumption. The intake patterns of children can be altered if their early environment is structured to promote the exposure to healthier foods. When young, most of stimuli are new. Familiarization through repeated exposure including exposure to new foods is an important form of learning.[17,18] Some children may need just one exposure to a new flavor and will like the food however others may need repeated exposures. [4]

Banduras Social Cognitive theory states that individuals learn by observing others through social interactions and experiences. The diet related behavior of individuals is influenced by the environmental and personal factors. The availability and accessibility of food at home is a factor that can increase or decrease an individual's consumption. While availability is the presence of food in an environment, accessibility is whether the food available is in the form at a particular time and location that will make its consumption easier for an individual. [19]

Parents should be encouraged to make FV available at home for their children and to limit other food and beverages that are not healthful. Although having fruits and vegetable available to children does not guarantee consumption, several studies have found positive correlation between home FV consumption and availability of FV in the home. [20,21] Cullen et al. [22] and Koui and Jago [23] observed positive associations between home availability and FV intake. Those who consumed less FV were likely to live in homes with low FV availability. Cullen et al. found that the accessibility of fruit, juice and vegetable in the home were significant predictors a child's intake *($p<.05$).* There was a positive correlation between FV intake and fruit *($r=17$; $p<0.05$)* and vegetable *($r=0.28$; $p< 0.001$)* availability.[22] The Greek study also showed that the availability of fruit was

significantly correlated with vegetable availability *(r=0.589, P<0.001*), fruit intake *(r=0.707, P<0.001)* and vegetable intake *(r=0.459, P<0.001).* Vegetable availability was also significantly associated with fruit intake *(r=0.472, P=0.001)* and vegetable consumption *(r=0.510, P<0.001).* [23] Similarly, the study by in the U.S. among 4th -6th graders (seven parochial schools in greater Houston, TX) showed that fruit and vegetable consumption were significantly correlated with fruit *(r=17; p<0.05)* and vegetable *(r=0.28; p<0.001)* availability in the home.[19]

Some studies have also found a positive relationship between environmental influences like parental availability and accessibility of FV on dietary behavior among children. [24-26] A study done in Belgium and Netherlands aimed to identify the personal, social and environmental associations of children's (n=2468) FV intake and found that children who reported eating FV more frequently often brought them to school, perceived their parents to be more demanding about the intake of FV and also had high availability of FV at school.[25] Similarly, another study found that the availability of FV in the home could be a moderator of FV intake at and away from home. The results of this study showed that homes that had more FV available motivated intake more than homes with low availability.[24] The easier it is for children to get FV, the more likely they are to consume them. [26]

Changes in the eating patterns of families have also influenced the availability and accessibility of FV in homes. People are eating less at home and more away from home.[27] Fast food restaurants have become very common since mothers are now working and do not have much time to prepare foods at home. There are fewer FV choices at fast food restaurants. This has given the children more access to sweets and soda drinks. Manufacturers have introduced several convenient FV options in recent years, but there

are still additional opportunities for the food industry to help consumers make healthier choices in the face of many barriers encountered by young people today.[27]

Family meals

Research suggests that family meals are important in the promotion of healthful dietary intake in adolescents. Family meal time is thought to play a role in the healthy development of children and young people by operating through ways such as increased family communication, parental monitoring as well as improved family trust and relationships.[28-30] Parents should be provided with support to address challenges such as lack of time and food security and should be encouraged to share breakfast meals with their children, in addition to the dinner. [31] This is because during adolescence there are major physical changes in the growth, development and the psychosocial changes in young people. It is the period where they seek a greater autonomy from their parents. This is a very critical stage because they are at risk of various health outcomes as a result of inadequate dietary intake. [32]

Children who report eating more meals together with their families report higher FV intake than do children who report eating fewer meals together with their families. [11,13, 33] In a study that assessed the diets of over 2000 primary school children in London, it was found that on average the children ate 293g (1.24 cups) a day of FV. However the children who sometimes had family meals ate 95g (0.40 cups) more of FV everyday than those who never ate together, whilst those who always had family meals ate an average of 125g (0.53 cups) more than those who never had family meals together.[33]

Eating family meals together have been associated with an increase in the consumption of other healthier food choices in addition to fruit and vegetable intake

among children.[15-18] Neumark-Sztainer et al found an inverse association between family meals and snacks such as potato chips, pretzels and nachos (P=0.001). [17] Lower consumption of snack foods were reported for children who had at least seven family meals a week as compared to those who had none. Cooke et al found companionship experienced by children during family mealtimes is associated with children's consumption of the basic food groups. [34] In a cross-sectional study that examined the relationship between family meals to four to ten year old children's intake of FV, soda and chips in San Diego, it was found that children who had breakfast, lunch or dinner with their families (at least 4 days per week) consumed FV five times more a week (P<0.001) than those who did not.[35]

Parental Control

Parenting styles and parental control over eating are other factors known to influence the eating behaviors of children at home. Restriction and the pressure to eat are two important forms of parental control. In restriction, there is a limited access to sweets and fatty snacks, whereas there are attempts to increase children's intake of healthy foods like FV. In practice parents often use a combination of styles to obtain the desired result.[36] The idea of food rules is such that parents usually develop a custom which determines what and how much their children are allowed to eat. In some cases parents restrict their child/children's access to certain foods. Restricted foods are often foods the parent perceives as being less nutritious, such as snack-type foods that are high in added sugar and fat. For example some food may be out of reach for children, allowed in a limited quantity, or allowed only when another food has been eaten. The goal of restricting access to food is variable, but most parents who practice this strategy report

that they are attempting to promote a moderate eating pattern.[36] However, these types of methods of controlling food intake used by parents may undermine the ability of children to developed self-control in their eating behavior.[32]

Nicklas further characterized the parenting styles practices by parents related to the dietary intakes of their children. Authoritarian, permissive and authoritative parenting practices were referred by Nicklas et al.[37] as the three common food-related parenting styles. In authoritarian parenting there is a one-side attempt to control the child's food intake and eating practices through commands, instructions, directives or coercion. For example, a parent promptly refuses a child's request for candies because it is against their rules. Parents who allow their children to eat what they want practice a permissive style of food-related parenting. In this style of parenting, parents allow their child to eat whatever candy they wanted. Parents who utilize authoritative parenting employ questions, negotiations and reasoning to shape and guide their child's behavior. An authoritative parent may encourage their child to have a fruit instead of candy.[29]

When parents control or permit their children's eating behaviors to extremes it may negatively affect the children's eating habits. Too much control disrupts the development of a child's self-control in eating, while children who are free to choose whatever they want often choose foods that are high in saturated fats, sodium and sugar, as these are universal taste preferences for children.[28] Studies provide evidence to support the idea that when children are being restricted they may end up enjoying the foods that their parents intend to restrict.[28]

Fisher et al. examined the effect of parental restriction of young girls' access to palatable foods and how that promoted consumption of those foods. It was found that young girls (5 years old, n=197) evaluated their eating habits negatively when they

perceived being restricted from certain foods. Restriction not only increased the child's desire to eat the restricted foods, but also resulted in a child associating this restriction with parent's disapproval. One third reported that they felt bad when their mother (30%) or their father (37%) found out about the food they ate.[38] In addition, a higher degree of parental control has been associated with decreased intake of FV. Wardle et al replicated the negative association between parental control and children's FV consumption using a cross sectional survey, and observed higher degrees of parental control was associated with lower FV consumption levels of children *($r=-0.17$; $p<0.01$).* Interestingly, there was also a negative correlation between parental control and parental intake of FV *($r=-0.16$; $p<0.01$.* [39]

Parent's nutritional knowledge

Higher education and a higher socio-economic status of parents have been associated with higher FV availability at home and hence higher intake of their children. Individuals with a higher socio-economic status are often more educated and have also been linked with an increase in FV intake. For example, a cross sectional survey amongst 564 parents /caregivers of 2- to 6- year- old children in London nursery schools found that parents with more education had children who ate more vegetables *($P=0.007$),* however there was no effect for their fruit intake *($P=0.45$).*[34] The degree of parental nutritional knowledge is consistently associated with greater consumption of fruits and vegetables.[40-42] Parental education or nutrition knowledge specifically appears to be a very important determinant of fruit and vegetable intake among children. Most studies [40, 41] have found that when the educational levels of parents are high there is a higher consumption of healthy foods. A nutrition education intervention implemented in the

U.K. encouraged adults to consume the recommended amounts of FV. Cost and availability were seen as a big barrier that influenced individual's intake of fruits in the intervention group.[43] Most [20,34,40,42] but not all [41,44,45] studies report positive associations between education, socioeconomic status, and FV intake of family member.

It is logical that the food habits of children are associated with their family's SES. In developed countries irregular meal patterns and snack intake is common among girls from areas that have low SES whilst adolescents with a higher SES have a higher intake of FV, high fiber foods and a lower intake of meat and fat products than those from a lower SES. The consumption of FV is less among the poor than the rich in most parts of the world. In Great Britain, the consumption of FV is about one and one-half times as high in the highest income group as compared to the lowest group.[30]

The need to improve nutritional education of parents, especially mothers, is well recognized. Improving the nutritional knowledge of parents should help to improve the nutrition environment for children in the home. A study by Campbell et al. examined school-aged children and mothers living in a socioeconomically disadvantaged neighborhood in Melbourne, Australia and found that the maternal nutritional knowledge was significantly and directly associated with the child's consumption of fruit (*P=0.049)* and vegetables *(P=0.017)*. It was suggested in this study that it is important to implement nutritional education in design interventions to help increase intake of FV. [20]

Similarly, another study conducted within south London, England accessed the nutritional knowledge and beliefs in mothers and children. It was found that, children with mothers who were not employed outside of the home consumed more fruit juice than those in the manual occupational group. Both fruit and fruit juice consumption by the children were positively related to their mother's level of education (N=80, r_s=0.31,

$p<0.01$, $r_s=0.23$, $p<0.05$, respectively). From this study fruit and fiber consumption was slightly lower ($r_s =-0.26$, $p<0.05$) in children from more deprived families however socio-economic status seemed to have very little effect on the fruit or vegetable intake.[41]

Most studies also demonstrate associations between higher parental SES and children's consumption of less healthy foods. Mothers especially in the higher social class have been found to limit their children's intake of sweets, soft drinks, chips and white bread more, while mothers in the lower social class were found to consider the taste of food as the most important thing. As long as the children from the lower social class were consuming three meals per day, their mothers allowed them to have snacks while those children by the higher social class were prevented because their mothers put their health risk first. This influence of mother's educational level on food parenting practices and food habits of young children was examined by Vereecken, amongst 862 parents of preschoolers in Belgium. Socio-economic status was measured by level of education, occupational class and income level (Kunst, Bos, Mackenbach, &the EU Working Group on Socio-economic inequalities in Health, 2001). Mothers with a higher level of education were found to be praising their children more often when they consumed more FV as well as being less permissive (mean=1.92, SD=0.47) as compared to mothers who were of a lower educational background (mean= 2.23, SD =0.64, $p<0.001$). Their results (Kruskall-Wallis tests) showed significant differences for fruit ($p< 0.002$), vegetables ($p<009$) and soft drinks ($0<001$); but not for sweets.[42]

Modeling

Models are individuals, a fictional person, a system or things that are used as examples with the intent to be imitated or followed. Bandura introduced the Social Cognitive theory which states that people can learn by watching the behavior of others. [46] He stated that through the process of observational learning behavior is learned. Children are able to observe people around them as he illustrated in his 'Bobo doll' experiment. In this experiment, children were made to watch a model behave aggressively towards the doll and others watched models who did not behave aggressively towards the doll. Aggressive behavior was seen in children who watched adults act aggressively towards the doll unlike those who watched adults who did not show aggressive behavior towards the doll when they were later put in a room to play with the doll. This experiment provided evidence to support the hypothesis that children learn through observational learning.[46]

The process of observational learning can be utilized in a child's dietary practices at and away from home. This occurs when the parent acts as a model and the child observes their eating behavior and practices it. This can be a positive (trying new FV by watching parents do the same) or a negative behavior (avoiding FV that parents dislike).[46] Parents should be encouraged to be positive role models in future interventions by targeting their intake and creating a supportive home environment through the increased availability of fruits and vegetables as well as rules to govern eating behaviors.[47]

Parental role modeling is of paramount importance when it comes to the diet of children. Children love to imitate their parents so if the parents do positive acts like eating FV it can help to boost the health of their children.[48] Parents being their role models or caretakers are being targeted to help inculcate the right attitude in terms of

their FV choices in their children. The influence of children's food consumption by parents is a complex issue that involves parental modeling, this explains as to whether the parents eat certain foods in front of their kids and also enjoy eating them[48] and social influences in various forms such as encouragement.[49] Several studies have shown that parental role modelling of healthy foods is positively correlated with children's dietary intake and also their preference for FV [19,50] while other studies have contradicted this.[51] There has also been a positive association between parental role modeling and girls' intake of FV.[52] Draxten et al. in their study examining the role of parental modeling of FV and its association with children's adequate consumption found a positive correlation with child FV and juice intake (r=0.21, P=0.008, r=0.20, P=0.01 respectively).[53] Pearson et al, 2009 in their observational research concluded that because parental role modeling is such a strong predictor of eating behaviors in children, there is the need to target the family environment to promote healthy eating behaviors among children and adolescents.

Parents to a larger extent dictate which foods are available, how it is prepared and the quantity for their children. The food behavior of parents may affect the eating habits of their children as evidenced by the strong positive relationship between the mothers and their children's intake of specific foods as reported in the literatures.[34,41,54]

Parents are strong role models for children, but other real and fictional people and characters can also serve as influential role models. In school-based interventions like the Food Dudes (a school-based intervention designed to increase children's consumption of FV) observational learning or modelling is used by letting children watch videos of heroic figures at school and also to eat and enjoy a variety of FV. These children who watch their heroes are more likely to eat more FV. Peers, cartoon characters and teachers have been shown to be effective in modelling in school-based interventions.[55] The peer

modelling approach showed a significant increase in FV consumption in the Food Dudes[55-57] as described in the previous studies section of this study

Rewards

Rewarding desired behaviors may also be used as a strategy to influence the dietary behaviors of children. Rewards are used in influencing children to eat FV; the outcome of this is very controversial because of the conflicting views on the effects of its use. To be effective, rewards should be highly desirable and also be an indicator to the child that it is for behavior purposes and should be enjoyed.[44]

Social psychologists and economists have however seen contradictory effects of rewards in some situations. They state that there is always a mixture of intrinsic (enjoyment of work) and extrinsic (incentives) motivation that determines behavior. Intrinsic motivated behaviors is when there is no apparent reward except with the activity itself whilst extrinsic motivated rewards occurs when an activity is rewarded with incentives not inherent in the task.

The effects of reward have been explained using the over-justification and self-determination theories.[58] These theories propose that when an individual is rewarded for something they have a high level of intrinsic motivation for; the reward may weaken the foundation of their intrinsic motivation resulting in a decline in performance when the reward is removed. In the theory of over-justification, the individuals may credit their behavior to the external reward and overlook the intrinsic aspect of the task. The theory of self-determination is focused on internal rewards making concession with the feelings of competence and autonomy. For example a child who eats fruits because they love them and not because their parents have promised them any rewards. [58] Other research

has also shown that when a child receives a reward immediately for a good behavior it enhances the chance that there will be a repetition of that behavior. This finding is in agreement with the Social Cognitive Theory (SCT) which also emphasizes the acquisition of knowledge from observing others.[59] Research conducted with 21 parents of 6-12 year olds in Belgium found that the perceived effective and ineffective ways of parenting was found in one or both theories of Social Cognitive theory or Self Determination theory (the internal motivation behind ones choices without any external influence). It was advised that there should be a combination of the practices that work with children in each group instead of pushing a specific theory on kids. [59]

Parents and teachers have also used praise as another form of reward to change the behavior of children. They stated that praise creates a positive mood and can also be given immediately after a positive behavior. Praise is given unannounced whilst a tangible incentive is promised before a desired behavior. [58]

There has being a contradiction in some psychological studies about the effect of extrinsic motivation. The view is that when people are rewarded for activities they already enjoy and do, their levels of motivation will decrease in performing the activity once the rewards are not given again.[60,61] In a meta-analysis of 128 studies that examined how extrinsic rewards affects motivation it was found that when children were given a positive feedback there was both a free-choice behavior (d=0.33) as well as self-reported interest (d=0.31) as compared to rewards. External rewards were found to reduce internal motivation of individuals especially children.[60]

However, in school-based interventions[55-57 62] the use of rewards as an incentive have increased FV intake in children. For example the FD program used rewards to encourage children to taste FV that were given to them repeatedly and this brought about

an increase in their consumption and liking for them. [55-57] Likewise a cluster-randomized trial (N=422) that examined the effects of incentives on children's enjoyment of vegetables found that external rewards do not always promote a negative feedback when the reward is taken away but rewards can be used to promote healthy eating practices among children. Children who were in the exposure and tangible reward group (11.34, SD=1.45) had higher means of intake as compared to those in the exposure alone group (9.97, SD=2.87). [62]

Conclusion

The factors in the home environment that was examined in this literature were FV availability and accessibility at home, family meals, parental role modeling, rewards and nutritional knowledge of parents. Parents have a fundamental role to play in the healthy eating of FV of their children since they control the factors in the home environment and children may have less autonomy in what they eat at home. [5,6] It is important that parents make FV available and accessible to children to increase their intake. Research examining FV availability and accessibility and consumption have found in some cases a positive relationship [24-26] while others observed that these factors do not always guarantee consumption. [13,23,27] Regular family meals were seen to increase children's intake of FV in the studies that were reviewed. [11,13,33,34,35] It was also observed that during family meals there is increased communication as well as parental monitoring which leads to the increase of other healthier food choices in addition to fruit and vegetable intake among children.[15-18]

The use of parental styles and control over children was also examined. The main parenting styles parents employed were authoritarian, permissive and authoritative

practices. [29] Restricting children were found to lead to them enjoying the foods the parents restricted [28 38 39] while a permissive style also led children to eat whatever they wanted hence making unhealthy choices at times. [29] Most studies [34 40 41 42] but not all [41,44,45] have found that individuals with a higher socio-economic status are more educated and they have also been linked with a higher intake in FV. Children love to imitate their parents making parental modeling very important. Parents are encouraged to adopt healthy eating practices so that their children can observe them and imitate. Modeling has being found to increase children's intake in many studies. [53 19,34,41,50,48] The effects of rewards on children have some contradictory results. While some studies found that giving rewards to children may undermine their intrinsic motivation[60,61] to perform an activity, other studies in school children have found that when children are given a reward as an incentive they this increased their FV intake. [55-57,62] It is important to consider these factors in the home environment when making decisions about children's intake during interventions so as to help increase their intake by examining these factors.

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CHAPTER 3
THE IMPACT OF THE FIT GAME PROGRAM ON CHILDREN AT HOME AND SCHOOL

ABSTRACT

Objective: To examine associations between children's fruit and vegetable intake at and away from school during 6 days when children were participating in a school-based intervention that resulted in significant increases in school-wide FV intake at school. Associations between parent's and children's fruit and vegetable intake, and factors of the home environment known to influence children's consumption of FV will also be examined.

Methods: Fruits and vegetable intake of children and their parents were assessed on three days prior to and immediately following a school-based intervention known to produce significant increases in children's FV consumption at school. Consumption was measured by 24-hour recalls, food frequency questionnaire, skin carotenoids assessment and photo analysis of what children ate at school. Participants also completed an online survey about their home environment.

Results: The average daily FV consumption at school and home was 0.31 cups (SD= 0.20) and 1.45 (SD=0.98), respectively. FV consumption at school increased after playing the 6-day Fit Game to 0.64(SD=0.39; $p<0.001$). There was no change ($p=0.50$) in FV consumption at home, or in skin carotenoid concentrations ($p=0.48$), over this same period of time for either children or parents.

Conclusion and Implications: The Fit Game program produced significant increases in FV consumption at school. FV intake away from school did not change over this same period of time. Including gaming components that target FV consumption at home may result in increases in FV consumption at home as well as at school.

INTRODUCTION

In the United States of America, most children are not consuming the recommended amounts of FV. A higher intake of FV has been associated with the reduction of many chronic diseases like stroke, cardiovascular diseases, many cancers as well as obesity.[1] This lower intake of FV has led many researchers to conduct school-based interventions to help increase intake.

The FIT Game, a school-based intervention was developed to address some of the challenges regarding cost and time that are often barriers to wide-scale implementation of other successful school-based programs targeting FV consumption. The Fit Game is played at the whole-school level. FV consumption is measured by a plate waste method, and children are rewarded when they meet consumption goals. The reward is making progress in the Game. The Game is a science-fiction narrative where the children are supposed to help the fictional heroes known as the FITs capture the villainous VAT (Vegetation Annihilation Team). Children are encouraged to actively participate in the narrative game. [2] Students met goals when they consumed 60th percentile or above that over the last 10 target days.[3] In the FIT game, children are rewarded when they eat more FV as they play a game. The game utilizes role models in addition to rewards; however the rewards are non-tangible and more cost effective than used in many FV interventions. Children were given virtual rewards when they consumed FV as illustrated by Jones et al. using the seven principles of gamification.[2] The Fit Game has produced significant increases in children's school fruits (24gm; $p<0.01$) and vegetables (14gm; $p<0.05$) consumption at school.

The home environment is a very important area to investigate when assessing children's intake and may influence children's response to school-based interventions.

Several studies describe success of school-based interventions aimed at increasing FV intake of children at school, but only a few include assessments of FV intake at home. The theory of ego depletion describes how an individual's will power may be depleted by changing a behavior (e.g. FV intake at school) in one instance (at school) that an individual doesn't have a high degree of self-efficacy to meet outside of that instance (away from school). We hypothesized that increasing FV intake at school may deplete consumption at home and that this effect may be mediated by the home environment. Though many children in the U.S. eat 1-2 meals per weekday at school, many studies find that the home setting has the greatest influence on children's long-term consumption of FV.[4-6]

In previous school-based interventions that employed role modeling and rewards, two found increases in both school and home consumption of FV, while a third did not. While Horne et al. ($P<0.05$) and Lowe et al. ($P<0.01$) saw an increase in FV intake at and away from school, Taylor et al saw no effect ($P>0.05$) on changing children's intake of FV at home. In the Taylor et al study, they examined the home environment to find out if the school-based intervention (the Food Dudes study) intervention had an influence of children's FV intake at home and the extent to which the changes in the children's eating behaviour were maintained over a 12-month follow-up period. They found that the FD program had no influence on the children's intake of FV ($p>0.05$) at home. The objective of this study is to examine associations between children's fruit and vegetable intake at and away from school during 6 days when children were participating in a school-based intervention that resulted in significant increases in school-wide FV intake at school. Associations between parent's and children's fruit and vegetable intake, and factors of the home environment known to influence children's consumption of FV will also be

examined. It was hypothesized that the Family Fit program will increase children's FV intake both at school and at home. It was also expected that there will be a positive correlation between the intake of parents and their children.

METHODS

Participants

The participants of this study included children and parents of children who were attending one elementary school in Northern Utah and participating in a school-based intervention program aimed at increasing FV intakes of children at school, known as the Fit Game. There were 252 children who were involved in the school-based intervention [2] and out of this 37 children (37 parent-child pairs) agreed to participate in this additional sub-study. The parent involved in this study was the parent most involved in cooking and shopping for their child.

Letters were sent home with all 1^{st} – 5^{th} graders addressed to their parents. The letter described the study procedures and invited them to participate. Only one child per family was accepted in the study. There was an orientation for all families before the study where each process was explained by trained researchers and letters of consent and information about the study were given to parents to take home and review before endorsing.

The study was reviewed and approved by the USU IRB. Of the 252 children who were invited to participate, 42 parents and 52 children agreed to participate, however only 37 parent-child pairs met the study inclusion criteria. Parents and children reported to the clinic before the start of this study for training on how to record their food, how to use the

ASA 24-hour recall online and all other questions were answered. They also signed a letter of consent. Each parent-child pair was paid $60 for the completion of this study.

Procedures

The Fit Game was played at the school cafeteria; students were oriented on how the game was played. On the first seven days of the FIT Game, teachers told students about their progress by reading a brief script (< I minute) to them. [1] They had to help the heroes (FITS) of the game and capture the villains (Vegetation Annihilation Team). They were made to believe that they were competing against three schools (fictional) in three elimination rounds (the three days the game was played). They had to win against each school by consuming more of the target fruit or vegetable. When the school met or exceeded the criterion level of intake they were told they had won against the fictional school and were given a whimsical medal. At the third elimination round the school qualifies to help the FITS capture the villains. During the second part of the FIT Game (22 days) the teachers read a three minute story to the student before lunch. This story depicted the role of children in consuming the target fruit or vegetable .When this target was met there was progression in the narrative if not met then the script is read to prompt them to consume more FV to help their heroes.

Participants reported to a clinic in the USTAR BioInnovations center, North Logan. Participants came in to take their weight, height, skin carotenoid measures as well as fill their surveys and recalls with the assistance of trained researchers. Height, weight, and skin carotenoids were done during the first three days of the study. Skin carotenoids were measured again during the last three days of the intervention. Participants recorded

[4] The scripts read by teachers, and all materials used in the FIT Game, are available upon request: greg.madden@usu.edu.

three days in October and three days in November. The phases were one month apart. Training sessions were provided for all participants to ensure that they understood how the ASA-24 worked.

Fruit and vegetable consumption was assessed for three days that immediately followed the intervention, and again on the last three days final 3 days of the intervention. Each assessment period included two weekdays, and one weekend. The weekend days were only for the completion of the ASA-24. The photographic images were taken only at the school level (pre and post). The time of measurement were termed Pre (the first three days at the beginning of the study) and Post (the last three days of the intervention).

Measurements

The height, weight and skin carotenoids of the parents and the children were measured with a portable stadiometer, digital scale and biophotonic scanner, respectively. The height and weight of participants were measured without shoes but with clothes. Two measurements were taken for each individual and the average was used for the assessment. A third was taken if there were inconsistencies (a difference of more than 2000 between the two measurements for the carotenoid scan). The carotenoid scan was done by asking the parents and children to place their palm in front of the scanners to obtain an immediate reading (about a minute) of skin carotenoid. This was done at the beginning of the study and during the last three days of the intervention at the clinic at USTAR BioInnovations center. The exclusion criteria for the skin carotenoid measurements included self-tanners, individuals who have a known health history that affects carotenoid levels, major illness in about two weeks before the study as well as chronic diseases like Type I diabetes and asthma.

Skin Carotenoids scans

The Pharmanex Biophotonic Scanner (S2 Everest Edition, Pharmanex, Provo, UT, 2007), which uses Raman spectroscopy was used to obtain the skin carotenoid scores of the children and their parents. This scanner uses resonant Raman light in detecting carotenoid in humans as an indicator of nutritional intake. Other information about participant's height, weight, smoking status or people they lived with who smoked and their supplemental use was also asked.

Carotenoids are lipophilic molecules and are abundant in the skin acting as chain-breaking antioxidants that protects the epidermal polyunsaturated fatty acids from oxygen peroxidation.[7] Resonance Raman light scattering spectroscopy (RRS) is a form of laser spectroscopy that is able to detect the vibrational or rotational energy levels of a molecule. Carotenoids and RRS are well suited since they both have a strong absorbing conjugated carbon backbone molecule structure that provides the basis for an efficient resonant laser excitation of the molecules.[8] The dietary assessment of individuals especially children is difficult to do and RRS is a very useful biomarker of nutritional status in this group since alternatives to venipuncture is very attractive to children.

Diet Assessment methods and other information

Participant parents completed an online survey at the clinic on the same day that their height, weight, and skin carotenoids were measured. The Family Fit question survey was administered through survey monkey. Trained researchers were available to assist all who needed help with recall input.

Online survey

The baseline questionnaire was completed by the parents or caregivers (n=37) online at the first clinic visit. A second survey was completed at the last clinic visit. Information of FV consumption, availability of FV at home, socioeconomic status (educational level and number of people living at home) of parents and children were included in the questionnaire. Characteristics of the home environment assessed in the questionnaire were defined by FV accessibility and availability, family meal times, parental role-modeling, and the availability of junk foods. Survey questions were adapted from those asked in the Project EAT survey. Project EAT was a five-year longitudinal follow-up of 2,516 adolescents that assessed personal, behavioral, and social environmental factors that influence eating behaviors. These included family meals, home FV availability, and taste preferences for FV, etc.[9] The questionnaire assessed FV availability using a response that was a four point scale (never =0, sometimes =1, usually =2, always =3), as well as a checklist of FV available in the area of study. Taste preferences as well as meal times were also established using a four point scale response (Strongly Disagree =1, Disagree =2, Agree= 3, Strongly Agree =4).

24-hour diet recalls

All participants recorded what they ate using the ASA 24-hour recall, an online 24-hour recall tool. Younger children (8-years and below) were assisted by their parents. A food tracker helps an individual to analyze what they eat. It is used to document the food eaten in the day and was used by participants to aid in the recall of foods when children or parent's completed the ASA24. All further questions related to the input of data in this system were also addressed. Phone numbers were provided to be reached

anytime in case of problems with software. The parents and children were made to track their intakes on the same six days (3 days at the beginning of the study and 3 days at the end of the intervention) to ensure accuracy in assessment. Some children and parents tracked on different days during the week, if these days were part of the days where a photo data was taken at school for the child the data was used. The participants completed the ASA24 at home, however individuals who had questions or who required help were invited to complete their ASA24 at the clinic.

Digital observations

A digital photograph was used to take pictures of the children's tray at school during lunch before and after eating at beginning of baseline and the last days of intervention. Children and parents were asked to keep track of and record their total diets using the ASA24 as previously described on these same days. Trained research assistants used the photos to estimate how much fruit and vegetable was eaten by each child. The photos were uploaded on a computer and sorted as before and after lunch photos. The estimates of fruits and vegetables were independently recorded by two different researchers who were blinded to the estimates of each other. This estimation of intake was measured in cups, 1/2 piece, or ¼ cup depending on the food type. A third estimation was done by another trained researcher when any of the two estimates did not match then a matching estimate was kept. The use of digital photographs in assessing food intake of children has been used in a number of settings and has been validated in children. It is a better method than plate-waste or real-time estimates.[10,11] This method allows researchers to quickly estimate food intake, reduce participants burden as well as eliminating the need for errors that results from the need of respondents to estimate intake.

Statistical Analysis

The SPSS computer software was used to analyze the data of this study. Descriptive statistics were used to look at the frequency reports and the distributions of the data. Pearson's rank order correlation coefficients were used to look at associations between different continuous variables (skin carotenoids vs. FV intake, etc.; parent's consumption vs. child's consumption, etc.) Paired sample t-tests and GLM repeated measured analysis of variance were also used to examine difference in mean FV intake and skin carotenoid scores over the period of observation (baseline vs. end of intervention). The GLM repeated measures analysis allowed us to control for factors in the home environment that were seen to be associated with intake. These factors included home availability and accessibility, parental education as well as family meals. The Partial Eta Squared was used to find the effect size. The effect size helps to quantify the difference between two groups. It is linked to the power of a test as well as the sample size and the significance. They will be categorized as small (0.01), medium (0.06) and large (0.14).[12]

RESULTS

Demographics

The majority of children were non-Latino White (89%) and the age range was 5 to 11 years old attending grades 1 through 5. Ninety-four percent of the parents who were involved in this study were responsible for family meals almost all the time. Parents (n=37) were highly educated, 71% held at least one degree from an institution of higher education. Fifty-two percent of the parents were obese or overweight (BMI overweight=25-29.9, obese=30 or >) as compared to 22 % (overweight- 85th to < 95th percentile, obese-≥ 95th percentile) of their children. Seventy percent of the children and

46% of parents had a healthy weight (see Table 3). Twenty-three percent of the parents said they had family meals at least 4-5 times per week, while 40% agreed that it was hard to find time to eat together as a family (see Table 4). The parents (78%) agreed that the Fit Game introduced in their children's school increased their intake of FV.

Two hundred and fifty-two children participated in the Fit Game. One hundred and nine students provided valid data to estimate vegetable consumption and 133 for fruit consumption. (Table: 1) Students who had data for only one day were dropped, hence the reduction in the number. Thirty-seven students participated in the additional sub-study requiring measurements outside of school; this is known as the Fit Family.

Analysis of variance and chi-squared tests were used to examine differences in characteristics and baseline FV intake between the Fit Game and Fit Family Participants. There was no difference in the amounts of fruits and vegetables (post) consumed by the Fit Game (fruit =133, vegetable109) and Fit Family participants (n=35) at the conclusion of the Fit Game. However, the Fit Family participants had a higher mean of pre-vegetable consumption than did the Fit Game (0.37 cups vs. 0.32 cups, p=0.03).

Table 1 Comparison of the Fit Game data to the Fit Family sample

	Fit Family	Fit Game	P-value
Fruit			
Pre fruit	0.33 (0.14)	0.38 (0.11)	0.07
Post fruit	0.42 (0.25)	0.39 (0.15)	0.30
Vegetable			
Pre vegetables	0.37 (0.10)	0.32 (0.14)	0.03

Post vegetables	0.38 (0.11)	0.40 (0.12)	0.25
Note: One way Anova shown**; bold** indicate**s** P<0.05			

We examined associations between children's consumption of FV and factors known to influence FV consumption in the home environment. (Table: 2) In these analyses, FV consumption was categorized into low and high intake by their mean.

Table 2 Factors in the home environment by mean intake of children. (n=35)

	Below Mean (< 1.79 cups/day)	Above Mean (>= 1.79 cups/day)	P-value
Availability Usually (%) Always	 15.2 27.3	 6.1 51.5	 0.08
Regular family meals Agree (%) Strongly Agree	 12.1 30.3	 9.1 48.5	 0.38
Grade (%) Younger Kids Older Kids	 20 22.9	 40 17.1	 0.16
Gender	0.2 (0.41)	0.45 (0.51)	0.13 *****
Family Meals (%) 1-2 times/week 4-5 times/week Once a day Twice a day	 3 15.2 6.1 18.2	 0 6.1 21.2 30.3	 0.14
Note**: *** one way Anova and all other analyses in table crosstabs			

Table 3 Demographic data of parents and kids in the family fit study (n=37 pair)

	Children	Parent
Age	5-11	N/A
Gender (% female)	68	97
Race (% non-Latino white)	89	89
College education (%)		
Less than a degree	N/A	29
Degree and above	N/A	71
BMI (Mean)	16.95 (3.28)	24.79 (7.77)
Healthy (%)	70	46
Obese /Overweight	22	52
Underweight	5	3
Pre Fruits		
School Intake (Pre)	0.16 (0.11)	N/A
Home Intake (Pre)	0.90 (0.60)	N/A
Total Pre	1.13 (0.60)	1.20
Pre Vegetables		
School Intake (Pre)	0.16 (0.15)	N/A
Home Intake (Pre)	0 .63 (0.15)	N/A
Total Pre	0.89 (0.51)	1.62

Note: N/A= not applicable BMI Parent: Overweight=25-29.9, Obese=30 or > Underweight= Below 18.5 Healthy= 18.5 to 24.9

BMI Kids: Overweight=85th to < 95th percentile, obese-≥ 95th percentile Underweight= less than 5th percentile. Healthy=5th to less than the 85th percentile

Table 4 Descriptive information about the home environment of Parents and Children. (n=35 pairs)

	Children (n=35)	Parent (n=35)
Number of people living at home (Mean)	N/A	5 (1.48)
Responsible for family meals and snacks (%)	N/A	94
Sometimes had junk food (%)	N/A	63
Agreed that was hard to find time and eat family meals (%)	N/A	40
Had family meals at least 4-5 times per week (%)	N/A	23
Agreed that the Fit Game introduced in school increased children's FV intake (%)	N/A	78
Vegetables taste bad (%)		
Strongly Disagree	83	60
Disagree	17	40
Like Fruit taste		
Disagree	3	6
Agree	97	94
Importance of family meals		
Agree	N/A	20
Strongly agree	N/A	80
Milk tastes good		
Disagree	14	11
Agree	86	89

Fruit served at meals		
Never /Sometimes	N/A	63
Usually/ Always	N/A	37
Junk food at home		
Never /Sometimes	N/A	63
Usually/ Always	N/A	37
Potato chips/salty snacks		
Never /Sometimes	N/A	71
Usually/ Always	N/A	29
Fruit juice at home		
Never /Sometimes	N/A	62
Usually/ Always	N/A	38
Chocolate/ other candy		
Never /Sometimes	N/A	66
Usually/ Always	N/A	34
Soda pop at home		
Never /Sometimes	N/A	89
Usually/ Always	N/A	11
Wheat bread at home	N/A	17
	N/A	83
Eating out (%)		
Pizza- place		
Never/ Rarely	N/A	17
1-2 times/month	N/A	83
Eating out (%)		
Sandwich and Subways		

Never/ Rarely	N/A	34
1-2 times/month	N/A	66
Note: N/A= not applicable. Survey filled by parents		

Correlations

We examined correlations between parents and children using Pearson's rank order correlation. Correlations were made between children's overall FV intake, FV consumption at school, FV consumption away from school, and skin carotenoid measures at pre and post assessments. We also examined correlations between parent's and children's intake and skin carotenoid measures.

Children's school fruit *(r=0.48, p=0.00)* and vegetable consumption *(r=0.40, p=0.02),* at the pre-assessment was associated with their fruit and vegetables consumption at the post-assessment. Their overall fruit *(r=0.29, p=0.09)* and vegetable *(r=0.31, p=0.08)* correlations were not significant.

The correlation coefficients of parents pre and post measurements that compared their fruits *(r=0.54, p<0.01),* vegetables *(r=0.48, p<0.01)* and skin carotenoid scores *(r=0.92, p<0.01)* were all significant.

Table 5 Correlation coefficients comparing children's overall total FV consumption, school and home FV consumption and skin carotenoids. (n=35)

	Correlation coefficient	P-value
Total Fruit (Pre & Post)	0.29	0.09
Total Vegetable (Pre & Post)	0.31	0.08
Pre home and school fruits	-0.18	0.31
Post home and school fruits	0.04	0.84

Pre home and school vegetables Post home and school vegetables	-0.12 -0.32	0.48 0.06
Pre and post school fruits Pre and post school vegetables	0.48 0.40	**0.00** **0.02**
Pre and post home fruits Pre and post home vegetables	0.28 0.42	0.10 **0.01**
Skin Carotenoid scores Pre and post scores	0.74	**0.00**
Pre child score and pre vegetables	0.24	0.18
Pre child score and pre fruit	0.11	0.53
Note: Pearson's rank Correlation coefficients; all correlations are statistically significant at P<0.05 as shown in **bold.**		

We examined correlations between parents' and children's baseline and post intervention fruit, vegetables, skin carotenoids, BMI and taste preference. (Table: 6) There was a significance difference for their post intervention fruit consumption *(r=0.42; r=0.01),* baseline skin carotenoids scores *(r=0.32; p=0.01)* and their taste preferences *(r=0.42; p=0.01).* There was however weaker associations between their baseline fruit consumption, post intervention vegetables and their BMI score *(r=0.10; p=0.57).*

Table 6 Correlation coefficients comparing children and parents FV consumption skin carotenoid scores, BMI and taste preferences

	Correlation coefficient	P-value
Baseline fruit consumption	0.15	0.39
Post intervention fruit consumption	0.42	**0.01**
Baseline vegetable consumption	0.34	0.05
Post intervention vegetable consumption	0.26	0.13
Skin carotenoids		
Baseline score	0.42	**0.01**
Post intervention score	0.32	0.07
BMI	0.10	0.57
Taste preferences	0.42	**0.01**

Note: Pearson's rank Correlation coefficients; all correlations are statistically significant at $P<0.05$ as shown in **bold.**

Using paired sample t-tests we examined changes in FV intake at baseline and post intervention. The average total fruit consumption prior to the intervention was 1.13 (SD=0.60) for children and 1.17 (SD=1.05) for parents. The average total vegetable consumption prior to the intervention was 0.89 (SD=0.51) for children and 1.63 (SD=0.83) for parents. (Table: 7) The measurements were in serving sizes which is equal to a ½ cup.

Table 7 Baseline Fruit and vegetables intake of parents and children. (n=36)

	Children	Parents
Fruit (servings/day) Total		
School Intake (Pre)	0.16 (0.11)	N/A
Home Intake (Pre)	0.90 (0.60)	N/A
Total Pre	1.13 (0.60)	1.17 (1.05)
Vegetable (servings/day)		
School Intake (Pre)	0.16 (0.15)	N/A
Home Intake (Pre)	0 .63 (0.15)	N/A
Total Pre	0.89 (0.51)	1.62 (0.82)
Skin carotenoid concentration (unit)		
Pre score Mean (SD)	24961.69 (8549.50)	28778.24 (10426.54))
Pre Fruit Count. Mean (SD)	N/A	8(2.57)
Pre Vegetable Count	N/A	13 (3.18)
Note: N/A= not applicable	Serving size= ½ cup	

Children's School and home FV consumption (baseline- Intervention)

We tested the mean consumption of fruits and vegetables at the baseline and intervention using a paired sample t-test. The school intake of FV was greater after the intervention *($p< 0.01$);* however there was no difference in these measures for the home intake (*$p>0.05$).* The school intake of fruits increased over time and home intake *($p=0.43$)* did not change. (Tables: 8 &9). While the school intake of vegetables increased *($p<0.01$; partial eta squared for fruit= 0.37, vegetables=0.35)* the home intake did not change overtime *($p=0.81$).*

Table 8 Average fruit and vegetable intake at school measured at baseline and again during the final 3 days of the intervention; n=36 children.

	Baseline	Post-intervention	P-value	Effect size (n^2)
Fruit (servings/day)	0.16 (.11)	0.37 (0.30)	0.00	0.37
Vegetable (servings/day)	0.16 (0.15)	0.30 (0.18)	0.00	0.35
FV combined (servings/day)	0.31(0.20)	0.67 (0.52)	0.00	0.48
(p<.05) Statistical test used paired samples t-test. Serving size= ½ cup				

Table 9 Average total fruit and vegetables intake at home measured at baseline and again during the final 3 days of the intervention; n=35 children

	Baseline	Post intervention	P-value
Fruit (servings/day)	0.90 (0.60)	1.29 (1.06)	0.43
Vegetable (servings/day)	0.63 (0.53)	0.61 (0.49)	0 .81
FV combined (servings/day)	1.45 (0.98)	1.90 (1.24)	0.50
(p<.05) Statistical test used paired sample t-test Serving size= ½ cup			

Parents FV consumption (baseline- Intervention)

There was also no statistically significant difference in the fruits *(p=0.26)* and vegetables *(p=0.86)* consumption of parents from the baseline to the end of the study as shown in Table 10.

Table 10 Average fruit and vegetables consumption of parents; baseline assessment compared to post intervention assessment; n=34 parents

	Baseline	Post intervention	P-value
Fruits (servings/day)	1.20 (1.05)	1.02 (.66)	.26
Vegetables (servings/day)	1.62 (.85)	1.60 (.80)	.86
FV combined (servings/day)	2.82 (1.70)	2.62 (1.40)	0.58
(p<.05) Statistical test used paired sample t-test Serving size= ½ cup			

Skin Carotenoid scores of parents and children

The skin carotenoids measures of the children and parents showed no difference in the measures.

Table 11 Baseline and post carotenoid scores of parents and kids in the family fit study

	Skin carotenoids concentrations	Post intervention	P-value
Parents	28630.51 (10540.47)	28373.21 (10955.24)	0.73
Kids	24478.24 (8667.66)	25208.35 (7180.45)	0.48
(p<.05) Statistical test used paired sample t-test			

Repeated measures analysis of variance

The repeated measures of analysis of variance was used to assess change over time controlling for some factors in the home environment like parental education, family meals importance and frequency as well as FV availability and accessibility. These

factors were controlled for to examine how they influence the intake of the children. We found no significant relation between children's FV intake and the factors in the home environment *(p>0.05)*.

Table 12 Fruit and Vegetable Intake of Children compared to the factors in the home environment

Kids	Home environment	Mean (SD)	P-value
Pre Fruit	Parental Education		
	Below Degree	0.93 (0.60)	0.66
	Degree and above	1.21 (0.60)	
Post Fruit N=32	Below Degree	0.98 (0.29)	
	Degree and above	1.79 (3.66)	
Pre Fruit	Family Meals		
	1-3 times/week	0.35 (0.00)	0.79
	4-5 times/week	0.78 (0.56)	
	Once a day	1.13 (0.60)	
	Twice a day	1.35 (0.57)	
Post Fruit	1-3 times/week	0.68 (0.00)	
	4-5 times/week	1.08 (1.06)	
	Once a day	0.77 (0.33)	
	Twice a day	2.32 (4.44)	
Pre Fruit	FV availability		
	Usually	0.66 (0.35)	0.73
	Always	1.24 (0.61)	
Post Fruit N=32	Usually	0.70 (0.38)	
	Always	1.76 (3.43)	
Pre Vegetables	Parental Education		
	Below Degree	0.95 (0.62)	0.73
	Degree and above	0.85 (0.48)	
Post Vegetables	Below Degree	1.01 (0.53)	
	Degree and above	0.84 (0.45)	
Pre Vegetables	Family Meals		
	1-3 times/week	0.61 (0.00)	0.83
	4-5 times/week	0.79 (0.21)	
	Once a day	1.04 (0.43)	

Post Vegetables	Twice a day	0.85 (0.67)	
	1-3 times/week	0.50 (0.00)	
	4-5 times/week	0.87 (0.36)	
	Once a day	0.91 (0.41)	
	Twice a day	0.91 (0.58)	
Pre Vegetables	FV availability		
	Usually	0.67 (0.40)	0.43
	Always	0.93 (0.54)	
Post Vegetables	Usually	0.85 (0.72)	
	Always	0.90 (0.42)	
Note: Repeated measures analysis of variance P-value<0.05			

DISCUSSION

This study examined the factors in the home environment that influenced children's FV intake at home and at school during an intervention aimed at increasing FV intake at school and the relationship between children and parent's intake. This study found that the FV intake of children increased significantly at school during this period *(p<0.01),* however there was no significant increase at home *(p=0.50).*The effect size at school also showed larger increases for both fruits and vegetables.

There was no correlation between parents and children's baseline fruit*(r=0.15, p=0.37),* post intervention vegetable intake *(r=0.26, p=0.13)* as well as their BMI status *(r=0.10, 0.57).* We observed no change in intake of parents FV skin carotenoids. Factors of the home environment were not associated with FV intake in this study.

The school results were found to be consistent with previous research on FV interventions at schools where there was an observed increase in intake during our prior observations implementing the Fit Game [2,13] The lack of change in intake of FV of

children at home, which was assessed by using a multi 24-hr recall method, could be explained by the fact that the parents also did not change their intake and may have influenced their kids. The theory of ego depletion by Roy Baumeister and colleagues explains that when an individual engages in a controlled action in a first task there is a loss of personal resource or a breakdown in performance in the second.[14] Even though the children in this study increased their FV intake at school there was no decrease of their intake at home therefore there was no evidence of ego depletion in this study.

Research has found a positive correlation between the intake of children and that of their parents.[15,16] The influence of parents on the diet of children is a complex issue and there has being various techniques like modeling, parental education, availability and accessibility that has being reported to influence children's intake at home.[15,17] In a focus group discussion by African, Euro, Mexican and Asian American students in grade 4-6, they reported that the examples of parents such as not consuming fruit, juice and vegetables was an important reason why their children did not also consume them.[18] Since children are more likely to learn from parents by consuming what they eat or available to them at home it is likely that there was no motivation at home by the parents to help increase the children's intake.

This present study found a positive correlation *(r=0.42; p=0.01)* between parents and children's post intervention fruit intake but not for post vegetables intake. *(r=0.26; 0.13).* There was no relationship between parents and children's baseline FV intake. Parental intake has been found to be positively correlated to children's intake in a systematic review of 3-12 year old children.[19] This finding has been found to be consistent with previous reviews.[20,21]

There was no significance found between the factors of the home environment examined and the children's intake of FV that were measured and the children's FV consumption. ($p>0.05$) These factors included availability and accessibility of FV at home, family meal times and parental education. It was found from this study that the educational level of parents was not significantly related to the FV intake of their children ($p>0.05$), but this could be due to the fact that our population were all highly educated. Other research has found that parents with a lower educational status had children who consumed foods that were of poorer quality and higher fat. [20,22,23] Our sample may not be generalizable to other populations as this could be due to the sample size of the parents being small (n=37).

Family meals have been found to increase children's FV intake[19,24,25] in many studies. It has been reported that during family meals parents are able to observe what their children eat as well as encourage the intake of healthier foods. There was no significance between family meal frequency and FV intake of children in this study. Twenty-three percent of our respondents reported having family meals about 4-5 times per week. The lack of significance between family meals and FV consumption in this study could be due to the fact that parents in this study were not consuming more FV. This likely resulted in no form of motivation or encouragement for children to model FV consumption in the home environment. Moreover parents in this study admitted having difficulty finding time for family meals, but viewed family meals as a positive step.

Increased accessibility and availability have been found in some studies to influence FV consumption of children. [18,26,27] We observed no association between these factors and intake. This study found no relationship between children's FV intake at home and home availability and accessibility. Their parents were not increasing their

intake of FV and this could also be a possible demotivating factor for children. Availability at home may not necessarily be linked to intake because some families eat most meals away from home. This study reported 83% of the respondents buying pizza and 66% buying sandwiches and subway about twice a month. Qualitative research has also noted that certain foods may be available at home (e.g. a fruit like orange), but not accessible to children (cleaned and peeled), so even though FV are available in the home, children are not eating them. This may be one way that can inhibit consumption. Data collected from the Pro-Children study in Europe support this theory. Children living in 10 European countries were studied. Homes in Greece and Spain had the highest levels of FV availability; however data from the Pro-Children study reported Spanish adolescence having some of the lowest levels of FV intake among the countries that were studied. These results warrant further study on availability and intake since the possible relationship may not always be so among certain groups of people.[28]

Results from the correlations showed stronger correlations of the pre and post skin carotenoid of parents *(r=.92; p=0.00*) and children *(r=.74; p=0.00).* There was also a positive correlations for parents pre and post fruit *(r=.54, p=0.00)* and vegetables (*r=0.48, p=0.00).*

There was however a correlation between parents taste preferences and that of their children *(r=0.42; p=0.01).* Parents who reported that they did not like the taste of some FV were found to be correlated with that of their children. This shows that there is a link between the taste preferences of parents and their children. Research has found that social learning is a powerful tool in the determination of taste preferences. Jansen and Tenney in their study to determine if caloric conditioning or social learning techniques was a dominant factor in the taste acquisition of children found that there was a greater

preference in taste for the children who consumed higher energy drink at the same time as their teacher.[29] Research has also found a link between genes and the taste preference of individuals. Sweet taste has been found to be partly heritable and a locus on chromosome 16 has also being found to affect the use of the frequency of sweet foods.[30] This finding can suggest that with a child observing the model (parent), they can establish a taste preference for certain foods since the innate preference for taste can be modified by experience. Therefore if parents are encouraged to have a greater preference for FV there is a possibility that the children will also learn from them.

Factors in the home environment were not associated with children's intake or skin carotenoid scores. *($p>0.05$)* This could be as a result of the sample size and some bias in the sample.

The strengths of the present research are the various rigorous methods used to assess intake. The biophotonic scanner was used to assess intake, photographic data from children's school consumption were taken, the ASA 24-hour recall were filled for 6 days (baseline and intervention), an online survey about eating behaviors and availability were also filled. The 24-hour recall being automated transforms dietary assessment by improving the practicability and cost-effectiveness of the collection of dietary data.[31] This makes its use in assessing intake a very useful tool. These various methods combined in this study were used as an effective tool to help measure intake more accurately.

It will be important to replicate the findings of this present study with a larger sample size and individuals from a wide range of socio-economic background since this study involved mostly educated people (71% degree and above) who were mostly whites (89%) making the sample bias. This could be a possible limitation to this study.

However, this study was as large as the other three studies[4-6] reviewed for school-based interventions that included the home intake.

The need for fruits and vegetables to be incorporated into the diet of children is very important since it reduces a number of chronic diseases. The Fit Game study being successful at the school level must be introduced to the parents at home so that they can increase their intake which may influence their children when they are away from school. There is also the need to further examine the factors in the home environment and assess how they may influence intake so that such factors may be incorporated into nutritional education for families.

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CHAPTER 4

CONCLUSION AND IMPLICATIONS

CONCLUSION

The purpose of this study was to answer the following questions: Does the FIT game increase children's consumption of FV at school and at home during the 6-days the children were playing the game at school and also if it increased their parent's intake during that period? Do factors in the home environment mediate these relationships? Children in 1st to 5th grade and their parents were recruited to participate in this study. All participants were participating in the school-wide Fit Game.

The game was played at school and was designed to encourage children to consume more fruits and vegetables at school. [1] FV intake of children and parents was measured at the beginning and end of school-based intervention using multiple methods including photo analysis of school intake and then home intake was measured using the ASA-24-hour recall, parental surveys as well as measuring their skin carotenoid status using a biophotonic scanner.

The Fit Game has been successful in increasing children's fruit and vegetables intake at school;[1] however no previous work has assessed change in FV intake at home during the period of time when children are playing the game at school. We observed no change in children's FV intake at home ($p=0.50$) even though their school intake increased ($p=0.00$) during the period that they were involved in the school-based intervention. Previous studies support relationships between the home environment and children's FV intake. We hypothesized that these factors may mediate children's response to the Fit game intervention at school and away from school; however we did

not observe this to be true in this study. In previous work with the Fit Game parents told us that they eat more fruits and vegetables themselves while their children are playing the Fit Game, but we did not find this to be true. The FV intake of parent's was correlated with the FV intake of children, but did not change over the period of observation.

IMPLICATIONS FOR FUTURE RESEARCH

This study adds to the need for nutritional educators to educate parents more on the importance of increasing their intake of FV. Factors in the home environment that may influence children's intake should be further examined to determine how they best help increase intake of fruit and vegetables. FV can be encouraged in the Fit Game by giving children at school educational materials to be taken home to parents. These materials should address some of the challenges that decreases intake at home for example ways in which parents can increase accessibility and availability at home, encouraging family meals and increasing parental intake of FV so that children can emulate that behavior.

There is also the need for more researchers who are involved in school-based interventions to include gaming components that target FV intake at home, this can help increase parents intake at home so that they can influence their children as well. The Fit Game should also be played for a longer period of time while including educating the parents so that its impact can be assessed as well. This can help establish the importance of school-based interventions and to ascertain if children increase their intake during these interventions and hence compensate for this at home or not. It will also be important to replicate this study with a larger sample.

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APPENDICES

APPENDIX A: Family Fit Survey I

1. Parent ID number……

2. What is the highest level of education you have completed?

   a) <12 years
   b) High school graduate or earned a GED
   c) Some college credit
   d) Trade/technical/vocational training
   e) Associate degree
   f) Bachelor's degree
   g) Graduate degree
   h) Other (Please specify)……..

3. How many people are there in your family living at home?

   …….....

4. How often are you responsible for providing meals and snacks for your family at home?

   a) Never
   b) Less than half the time
   c) More than half the time
   d) Always

5. How often are the following true?

	Never	Sometimes	Usually	Always
a) Fruits and vegetables are available in my home	O	O	O	O
b) Vegetables are served At dinner in my home	O	O	O	O
c) Whole wheat bread vegetables is Available in my home	O	O	O	O

d) Fruit is served at meals in my home	O	O	O	O

6. How often are the following true?

	Never	Sometimes	Usually	Always
a) I have junk food in my home	O	O	O	O
b) Potato child's or salty Snacks are available In my home	O	O	O	O
c) Chocolate or other Candy is available In my home	O	O	O	O
d) Soda pop is available In my home	O	O	O	O

7. Please check if you have any of these fruits in your home AT THE MOMENT. They could be in any form: fresh, canned, frozen, or dried. Please do not include juice.

a) Kiwi fruit	O
b) Peach	O
c) Banana	O
d) Apricot	O
e) Pear	O
f) Nectarine	O
g) Grapes	O
h) Strawberries	O
i) Mango	O
j) Watermelon	O
k) Orange	O

l) Plum O

m) Apple O

n) Pineapple O

o) Fruit salad O

p) Raspberries or other berries O

q) Grapefruit O

r) Other fruit (Please specify)……

8. Please check if you have any of these vegetables in your home AT THE MOMENT. They could be in any form: fresh, canned, frozen, or dried. Please do not include juice.

a) Carrot O

b) Broccoli O

c) Celery O

d) Peas O

e) Green beans O

f) Cauliflower O

g) Potato (but not chips) O

h) Corn O

i) Lettuce (any type) O

j) Eggplant O

k) Legumes (chickpeas, lentils, kidney beans, black beans, etc.)

l) Tomato O

m) Zucchini O

n) Cabbage O

o) Pumpkin O

p) Other winter squash (acorn, butternut, etc.)

q) Brussel sprouts O

r) Sweet potato O

s) Cucumber O

t) Spinach O

u) Mushrooms O

v) Olives O

w) Mixed vegetables O

x) Olives O

y) Other (Please specify)……

9. How strongly do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
e) Milk tastes good to me	O	O	O	O
f) Most unhealthy foods taste better than healthy foods	O	O	O	O
g) I like the taste of whole wheat Bread	O	O	O	O
h) Most healthy foods just don't taste that great	O	O	O	O

10. Now thinking of your child who attends Edith Bowen and is participating on this research study with you, how strongly do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
i) My child likes the taste of milk	O	O	O	O
j) My child prefers the taste of unhealthy foods to the taste of healthy foods	O	O	O	O
k) My child likes the taste of most fruits	O	O	O	O
l) My child likes the taste of whole bread	O	O	O	O
m) Most vegetables taste bad to my child	O	O	O	O
n) Most healthy foods don't taste that great to my child	O	O	O	O

11. In the past month till now how often did you eat something from the following types of restaurant (Including take-out and delivery).

    1) Traditional burger-and-fries fast food restaurant

        a) Never/rarely
        b) 1-2times/month
        c) 3-4times/week
        d) 5-6times/week1
        e) 1+ times/day

2) Mexican fast food restaurant, Taco Bell.

    a) Never/rarely
    b) 1-2times/month
    c) 3-4times/week
    d) 5-6times/week1
    e) 1+ times/day

3) Fried chicken (KFC)

    a) Never/rarely
    b) 1-2times/month
    c) 3-4times/week
    d) 5-6times/week1
    e) 1+ times/day

4) Sandwich or sub shop (subway)

    a) Never/rarely
    b) 1-2times/month
    c) 3-4times/week
    d) 5-6times/week1
    e) 1+ times/day

5) Pizza place.

    a) Never/rarely
    b) 1-2times/month
    c) 3-4times/week
    d) 5-6times/week1
    e) 1+ times/day

6) Sit-down restaurants.

    a) Never/rarely
    b) 1-2times/month
    c) 3-4times/week
    d) 5-6times/week1
    e) 1+ times/day

12. How strongly do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
a) I enjoy eating meals as a family	O	O	O	O
o) It is important to me that my family eats together at least once a day	O	O	O	O
p) I usually eat dinner with my family	O	O	O	O

13. How strongly do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
q) It is hard to find time to sit down and have family meals	O	O	O	O
r) I tend to eat on the run	O	O	O	O
s) Regular family meals are important to me	O	O	O	O
t) I eat meals at about the same time everyday	O	O	O	O

14. How often do you usually eat meals together with your family?
    Count family meals as times when most of the members of your family are present.

    a) None
    b) Once a day
    c) Twice a day
    d) 2-3 times per week
    e) 4-5 times per week

APPENDIX B: Family Fit Survey II

1. Parent ID ……

2. Child's ID…….

3. Please check if you have any of these fruits in your home AT THE MOMENT.
   They could be in any form: fresh, canned, frozen, or dried. Please do not include juice.

   a) Kiwi fruit O

   b) Peach O

   c) Banana O

   d) Apricot O

   e) Pear O

   f) Nectarine O

   g) Grapes O

   h) Strawberries O

   i) Mango O

   j) Watermelon O

   k) Orange O

   l) Plum O

   m) Apple O

   n) Pineapple O

   o) Fruit salad O

   p) Raspberries or other berries O

   q) Grapefruit O

   r) Other fruit (Please specify)……

4. Please check if you have any of these vegetables in your home AT THE MOMENT. They could be in any form: fresh, canned, frozen, or dried. Please do not include juice.

a) Carrot O

b) Broccoli O

c) Celery O

d) Peas O

e) Green beans O

f) Cauliflower O

g) Potato (but not chips) O

h) Corn O

i) Lettuce (any type) O

j) Eggplant O

k) Legumes (chickpeas, lentils, kidney beans, black beans, etc.)

l) Tomato O

m) Zucchini O

n) Cabbage O

o) Pumpkin O

p) Other winter squash (acorn, butternut, etc.)

q) Brussel sprouts O

r) Sweet potato O

s) Cucumber O

t) Spinach O

u) Mushrooms O

v) Olives O

w) Mixed vegetables O

x) Olives O

y) Other (Please specify)……

5. The Fit Game program introduced in my child's school increased his or her fruit and vegetable intake.

   a) Strongly Disagree

   b) Disagree

   c) Agree

   d) Strongly Agree

APPENDIX C: Food Tracker

This Food and Beverage Tracker belongs to:

_____

My ID number is:

_____

Remember to write down everything you eat and drink every day that your teacher tells you to.

Please write down everything you eat and drink today.

Today is **Sunday February 12**

	List what you ate/drank here:	How much?
What did you eat for breakfast?		
What did you drink for breakfast?		
Did you eat or drink anything between breakfast and lunch?		
What did you eat for lunch?		
What did you drink with lunch?		
Did you eat or drink anything between lunch and dinner?		
What did you eat for dinner?		
What did you drink with dinner?		
Did you eat or drink anything between dinner and going to bed?		

Please write down everything you eat and drink today.

Today is **Wednesday February 8**

	List what you ate/drank here:	How much?
What did you eat for breakfast?		
What did you drink for breakfast?		
Did you eat or drink anything between breakfast and lunch?		
What did you eat for lunch?		
What did you drink with lunch?		
Did you eat or drink anything between lunch and dinner?		
What did you eat for dinner?		
What did you drink with dinner?		
Did you eat or drink anything between dinner and going to bed?		

Please write down everything you eat and drink today.

Today is **Thursday February 9**

	List what you ate/drank here:	How much?
What did you eat for breakfast?		
What did you drink for breakfast?		
Did you eat or drink anything between breakfast and lunch?		
What did you eat for lunch?		
What did you drink with lunch?		
Did you eat or drink anything between lunch and dinner?		
What did you eat for dinner?		
What did you drink with dinner?		
Did you eat or drink anything between dinner and going to bed?		

APPENDIX D: Permission Letter

Introduction/ Purpose Dr. Greg Madden in the Department of Psychology, Dr. Heidi Wengreen in the Department of Nutrition, Dietetics and Food Sciences and Sheryl Aguilar in the Center for Human Nutrition Studies at Utah State University are conducting a research study to find out more about how parent's intake of fruits and vegetables is related to their child/children's intake of fruits and vegetables. All 1st through 5th graders at Edith Bowen Laboratory School, including your child, are invited to participate.

Procedures If you and your child agree to participate, the following will occur. You and your child will also be asked to complete a survey about what fruits and vegetables you eat at home and what fruits and vegetables you have in your house on those days. The surveys will take about 20 minutes to complete each day you are asked to complete them. You will be asked to complete this survey a total of 6 times over a 3-4 month period of time. Then, during a period scheduled by the researchers either at school or at another location on the USU campus, you and your child's palm will be scanned to measure the amount of carotenoids in your skin. Carotenoids are pigments found in fruits and vegetables. To measure this, a small light will be projected onto the surface of the skin of you and your child's palm (separately). This will not damage the skin and involves no pain. The scanning takes about 90 seconds to complete and you will be asked to provide one scan during this period of time.

New Findings During the course of this research study, you will be informed of any significant new findings (either good or bad). If new information is obtained that is relevant or useful to you, or if the procedures and/or methods change at any time throughout this study, you will be notified and given the opportunity to withdraw from the study.

Risks The risks of your child participating in this research are minimal. There is a risk of others gaining access to personal information but this is unlikely because of the measures to protect you and your child's confidentiality. Researchers will **not** know if a child gets free or reduced lunch.

Benefits There may or may not be any other direct benefit to you or your child from this research at this time. The researchers, however, may learn more about how to promote fruit and vegetable consumption in the school lunch setting. This may lead to positive changes throughout the Cache County School District and/or Logan schools that help improve the nutrition status of many children.

Payment/compensation Your family will receive $60 for completing the 6 required assessments.

Explanation & offer to answer questions If you have other questions or concerns regarding this research, you may reach Greg Madden, principal investigator, by phone (435-881-8467) or email (greg.madden@usu.edu), Heidi Wengreen, principal investigator, by phone (435-797-1806) or email (heidi.wengreen@usu.edu) or Brooke Jones, graduate investigator, by phone (785-766-8396) or email (brooke.a.jones@aggiemail.usu.edu).

Voluntary nature of participation and right to withdraw without consequence Participation of your child in this research is entirely voluntary. You may refuse to have your child participate in this study at any time or you may withdraw them from this research without consequence or loss of benefits.

Confidentiality Research records will be kept confidential, consistent with federal and state regulations. Only authorized research assistants will have access to identifying data, which will

be kept in a locked file cabinet in a locked room. Personal, identifiable information will be kept for no more than five years. After that time, it will be destroyed.

IRB Approval Statement This research project has been reviewed by the Institutional Review Board for the protection of human participants at Utah State University. If you have any questions or concerns about your rights, you may contact the IRB at (435) 797-1821.

Investigator Statement "I certify that the information contained in this form is correct and that we have provided trained staff to explain the nature and purpose, possible risks and benefits associated with taking part in this study and to answer any questions that may arise."

Heidi J. Wengr

Gregory J. Madden, Ph.D.	Heidi Wengreen, Ph.D.	Sheryl Aguilar, RD
Principal Investigator	Principal Investigator	Investigator
(435) 797-1460	(435) 797-1806	(435) 797-7327
Greg.madden@usu.edu	Heidi.wengreen@usu.edu	Sheryl.aguilar@usu.edu

Your child will participate in this study unless you wish to withdraw him or her. If you **do not** want your child to participate in this research for any reason, please initial below, fill in your child's name, sign where indicated, and return this form to Sheryl Aguilar.

Please withdraw _____ (your child's name) from this research study.

_____ _____

Parent/Guardian Signature Date