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THE EFFECT OF AN IPAD APPLICATION ON THE QUALITY OF LUNCHES BROUGHT FROM HOME BY MIDDLE SCHOOL CHILDREN

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tTHE EFFECT OF AN IPAD APPLICATION ON THE QUALITY OF LUNCHES BROUGHT FROM HOME BY MIDDLE SCHOOL CHILDREN

BY

CHRISTINA PRYOR

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

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IN

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UNIVERSITY OF RHODE ISLAND

2014

MASTER OF SCIENCE THESIS

OF

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DEAN OF THE GRADUATE SCHOOL

UNIVERSITY OF RHODE ISLAND

2014

ABSTRACT

Objective: To evaluate the mobile application, *LaLa Lunchbox*, on improving the dietary quality of lunches brought from home.

Design: Quasi-experimental design.

Setting: Middle school in East, Greenwich, RI.

Participants: 25 students in the 6th grade who were predominately white (72%) females (76%) with an average age of 11.2 years.

Intervention: For 4 weeks, *LaLa Lunchbox* app was used to create virtual lunchbox for each school day of the following week.

Main Outcome Measure: Lunch Quality Index (LQI) scores calculated based on the presence or absence of fruit, vegetables, protein, or empty calorie snack with a maximum score of 4 points based on four lunch observations at baseline, week 2 and 4 of intervention, and 1 week follow-up.

Analysis: A repeated-measures analysis of variance (ANOVA) measured the LQI score over time between the 2 groups.

Results: Although there were no differences between groups, there was an effect of time on LQI score ($p<.05$). Overall fruit (67.4%) and protein (80.4%) were included in most lunches but a high calorie snack was also frequently included (52.2%) and vegetables rarely included (21.7%).

Conclusions and Implications: The mobile application, *LaLa Lunchbox* was not effective in improving dietary quality as a stand-alone intervention, but could be useful as a tool in combination with nutrition education focusing on increasing vegetables and reducing empty calorie snacks.

KEYWORDS:

Pediatric obesity, child, mobile health, mobile applications, lunch

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PREFACE

This thesis has been prepared in a manuscript format for planned submission to the professional journal Journal of *Nutrition of Education and Behavior*. Manuscript format follows the journal's manuscript guidelines for authors.

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The Effect of an iPad Application on the Quality of Lunches Brought from Home by Middle School Children

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INTRODUCTION

Childhood obesity has more than doubled in children and tripled in adolescents in the past 30 years (1). Risk factors for coronary heart disease (CHD), such as hypertension, dyslipidemia, impaired glucose tolerance, and vascular abnormalities, once thought to be only experienced in adulthood are already present in overweight children (2). Additionally, children and adolescents who are obese are more likely to be obese as adults (3, 4). According to the National Health and Nutrition Examination Survey (NHANES), the majority of 2-17 year olds are consuming excessive amounts of empty calories, which is associated with excess weight gain (5, 6). Children are also are not meeting dietary recommendations for nutrient-dense, high-fiber foods (5, 6).

Because children consume more than one-third (35%) of their daily calories at school, food served by the National School Lunch Program (NSLP) has become an important area of research and intervention (7). As of March 2012, new standards for the NSLP were adopted which more closely aligned them to the 2010 Dietary Guidelines for Americans (8). Although the 62% of students in the U.S. that participate in the NSLP are now receiving more nutritious lunches, it can be assumed that the remaining students bring a lunch from home (9). Research has found that the lunches children bring from home are lower in nutrition quality than the foods offered at school (7, 10, 11).

Several studies have found that lunches brought from home include fruits, vegetables, and dairy at significantly lower percentages than school

lunches, and are more likely to contain foods high in sugar and/or fat and a non-100% juice fruit juice drink (11). One study found that packed lunches contained a mean 21.3 grams of sugar, which is well above the 12-20 grams/day recommendation of the American Heart Association for this age group (12).

Mobile technology has created a new medium for intervention that can reach and affect a vast amount people across the globe. Throughout the world, the number of smartphone users exceeded one billion in the fall of 2012 (13). The usage of mobile apps is likewise increasing rapidly, and grew at a rate of 115% in the year 2013 (14). Today, the U.S. consumer spends an average of 2 hours and 38 minutes per day on smartphones and tablets (15). Out of that time, 80% (2 hours and 7 minutes) is spent using apps and 20% (31 minutes) is spent on the mobile web (15). Approximately half (49%) of middle-school children use a smartphone at home and 39% use a smartphone to complete homework assignments (16). Furthermore, more than one in three (36%) use a tablet at home and 31% of middle school students use a tablet to complete homework (16).

Health smartphone applications (apps) are on the cutting edge of pediatric nutrition practice (17). In 2011, there were more than 40,000 mobile health apps, contributing to the $718 million global industry, according to Research2Guidance, an international market research firm (18). Although consumers are using them, there are few studies to support the effectiveness of smartphones in improving health.

Research on computer-based interventions has generally shown success in improving health behaviors of children and adolescents. A web-based program called *Teen Choice: Food & Fitness* resulted in a significant increase in adolescents who reported eating three or more serving of vegetables per day in the past week compared with the control group (19). Additionally, after using the 10-session multimedia intervention, *Squire's Quest!,* there was a significant increase in fruit, 100% juice, and vegetable intake (1.0 serving) compared to the control for elementary students (20).

Research has yet to evaluate the effectiveness of mobile applications (apps) for improving the dietary quality of children. Lunches from home have been shown to be less healthy than lunches provided at school, and although web-based and multimedia interventions have been found to be effective in promoting behavior change, no one has evaluated the ability of a mobile app to motivate the user (parent or child) to change the nutritional value of lunches from home. The objective of this study was to assess whether the use of a nutrition mobile app will increase the dietary quality of lunches brought from home. We hypothesized that the group receiving the 4-week intervention with the *LaLa Lunchbox* iPad app will have a higher Lunch Quality Index (LQI) score than participants in the control group. A secondary objective of this study was to explore the contents of middle school lunches brought from home.

METHODS

Study Design

This study used a quasi-experimental design to explore the effect of an iPad app on the dietary quality of lunches brought from home by middle school children. This 6-week study compared children's lunches of an experimental group that received an app-based intervention with a delay-treatment control group that did not have access to the app until after completion of the study.

Subjects

Intervention and control group participants were 6th grade students at Archie R. Cole Middle School in East Greenwich, Rhode Island. Two 6th grade teachers volunteered their homeroom classrooms to recruit for intervention and control groups. To be eligible, students had to bring their lunch from home for all 6 weeks and complete parental consent and student assent forms. This study was approved by the Institutional Review Board (IRB) at the University of Rhode Island.

Procedure

The teachers sent an email to the parents in their homeroom classes with a link to an informative video that explained the study and how to participate. Then, packets containing parental consent forms, child assent forms, and demographic surveys were sent home with the children of the two classes. Each homeroom had approximately 30 students (total n=60), but only 37 students from both homerooms brought back completed parental consent and child assent forms. The study was conducted during the 20-

minute morning “study hall” period.

Prior to the study, the *LaLa Lunchbox* app was downloaded on 20 of the iPads at the school. On week 1, at the baseline session, two graduate students conducted a preliminary observation of lunches brought from home by participants for both experimental and control groups. In addition, at the baseline session, the participants in the experimental group used the apps to begin the intervention. Then, on weeks 3 and 5 during the intervention, the graduate students observed the lunches from both groups. Lastly, one week following the intervention the observers performed a final observation for both groups in order to study behavior maintenance. At the end of the study, we emailed the parents a 7-question online evaluation survey (SurveyMonkey.com, LLC, Palo Alto, CA) and the students answered a 6-question paper evaluation in the classroom.

iPad App Intervention

The first week, the graduate student gave a 15-minute lesson on how to use the *LaLa Lunchbox* app. Then, iPads were distributed to each student in the experimental group, and each participant was provided with a unique username and password for the app. Each week of the intervention, the participants created virtual lunchboxes for every school day of the next week by choosing foods listed in the app based on what why would like included in their actual lunchbox. A screenshot of the app-generated grocery list was emailed to the parents on the four Fridays during intervention to facilitate the purchase and packing of the food items selected by their child (figure 1). At

both the beginning and end of the study, every participant in both homeroom classrooms received small non-monetary incentives (a lunch bag, a nutrition card game, and a drawstring backpack). Archie R. Cole Middle School provided the iPads used for this study.

LaLa Lunchbox is an iOS app created by Gillian Fein in 2012 and costs $0.99 to purchase at the Apple iTunes App Store. The app allows children to personalize their lunchbox by choosing items within four quadrants: vegetables, fruit, protein, and snacks. The child is able to choose between four and six items from a variety of pictorial representations for each category. All the foods that are available on the app are minimally processed and are low in fat, sugar, and sodium. Prior to the intervention, we made some modifications to the food choices on the app by deleting brand name, expensive, or less healthy items and by adding in items we thought would be popular healthy choices for this age group. The full list of food item modifications can be found in appendix C.

During these observations, a photograph was taken of the contents of each lunch using a digital camera (Kodak Easy Share Z612). In order to link the student to their lunch, a card with an identification number was placed next to each lunch and was included in the photograph. This protocol is similar to what has been described in previous studies (21, 22). In addition, the participant wrote down the contents of their lunch on a standardized recording form called “What’s in Your Lunch?”. If a sandwich or salad was included in the lunch, the participant circled the ingredients of the sandwich or salad on a

checklist at the bottom of the lunch recording form. If a participant was absent for an observation day, their observation was conducted the following week as long as it was not already a scheduled observation week.

Outcome Measures

Consistent with the iPad app being tested, the materials used in this study were only available in English. The demographic survey requested information regarding age, gender, race/ethnicity, height, weight, and education level of parent. We calculated BMI from the reported height and weight and then determined BMI percentile for age and gender using CDC growth charts (23). The CDC categories for BMI percentiles were used in this study: underweight is < 5^{th} percentile, healthy weight is 5^{th}-84^{th} percentile, overweight is 85-94^{th} percentile, and obese is ≥ 95^{th} percentile (23).

The lunch photographs from the observations were coded for the presence or absence of four different food components: fruit, vegetables, protein, and an empty calorie snack. Fruit was classified as whole or sliced fruit or applesauce with no added sugar. Vegetables included raw or cooked vegetables on the side or vegetables within an entrée. Protein food items were defined as meat, poultry, eggs, peanut butter, dairy foods (yogurt and cheese). Empty calorie snacks included cake/pastries, candy/chocolate, cookies, chips, and granola bars with less than 1 gram of protein or fiber.

In order to calculate a lunch quality index (LQI) score, one point was assigned for each healthy eating behavior (i.e. for the presence of a fruit, vegetable, protein item, and lack of an empty calorie snack). Therefore, the

LQI ranged from 0 to 4. Beverages were not included in the LQI because the *LaLa Lunchbox* app does not offer drink choices. One child was missing an observation at week 3. The LQI for week 3 was imputed as the average of week 2 and week 4.

Two trained graduate students independently recorded the presence or absence of these specific food items by inspecting both the photographs and the completed "What's in Your Lunch?" forms. When decisions by the two observers disagreed, a third observer provided an opinion for the coding of lunch contents. In all instances, the third opinion agreed with one of the two former assessments and was used in the final data set. Between the two observers, there were 25 inconsistencies out of 1296 items. The inter-observer reliability was calculated to be 98.1%.

Statistical Analyses

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS version 22.0, IBM Armonk, New York 2013). A probability value of $p<.05$ was utilized. Independent-samples t-tests and chi-square tests were used to compare demographic characteristics and dietary quality of the two groups at baseline. Independent-samples t-test was used to evaluate differences in the LQI at baseline prior to the intervention. For the primary outcome, we performed a mixed between-within subjects repeated measures analysis of variance (ANOVA) to compare changes in LQI between groups at each of the four time points, one week prior, week 2 and 4 during the intervention, and one week after the intervention, (time by group

interaction), as well as to assess the main effect of time. Post-hoc analyses assessed contrasts between time points for significant effects. To account for attrition, an intent-to-treat analysis included all subjects after imputation of missing time points. Missing data was imputed by carrying information from the previous time point forward; for example, if a subject dropped out after week 2, data from week 2 was imputed for weeks 3 and 4.

RESULTS

Demographics and Baseline LQI

Twenty-seven students returned completed parental consent and child assent form and were present for the baseline observation. The intervention classroom had 14 participants and the control classroom had 13 participants. During the study, 2 participants in the intervention classroom dropped out of the study due to other academic responsibilities. Twelve participants in the experimental group and 13 participants in the control group finished the study. The overall attrition rate was 7.4%. There were no statistically significant differences between the intervention and control groups for any of the baseline demographic or primary outcome variables. The characteristics of the sample are shown in Table 1. Overall, participants were predominately white (72%), female (76%), with an average age of 11.2 years. Over 65% of the parents had a postgraduate degree and all of the participants reported that one of their parents achieved at least a college degree. Approximately 76% were at a healthy weight (5^{th} – 85^{th} BMI percentile) and only about 14% were overweight or obese (> 85^{th} percentile). There was also no statistically significant difference between the intervention and control groups for baseline LQI.

Lunch Quality Index (LQI) Score

There was no significant difference in LQI score between the two groups over the 4 time points in the completers analysis (p=.13), but there was a statistically significant effect of time (p=.047) (Table 2). The intent-to-treat analysis, however, did not confirm this effect of time (F=1.7, p=.17). There

was a nonsignificant trend for a difference in LQI scores between baseline and week 2 (F=4.3, p=.053). In the experimental group, the LQI score decreased from 2.0 at baseline to 1.4 at week 2. For the control group, the LQI score increased from 2.3 at baseline to 2.8 at week 2 (Figure 2).

Individual Food Components

In total, 92 lunches were observed during this study. Overall in both groups, fruit was included in 67.4% of the lunches, and vegetables were present in only 21.7%. A protein food item was found in 80.4% of lunches and an empty calorie snack was included in 52.2% of all lunches.

App Usage

Due to school absences and other obligations during the "study hall" period, some participants were unable to use the app during the allotted time. The children who did not attend the study visit were asked to use the iPad app at some point before Thursday of that week. The first week, 11 out of the 12 students (92%) in the experimental group used the app to create their lunchboxes. During the second week, 11 of the students used the app. In the last two weeks of the intervention, 100% of the students used the app. Overall, the 12 participants completed the lunchboxes on the app 46 out of an intended 48 times (96%) throughout the 4-week intervention.

Process Evaluation

a. Student Evaluation

Ten of the 12 (83.3%) experimental group completers responded to the *LaLa Lunchbox* evaluation survey after the intervention ended. Thirty-percent

of these students liked and 40% felt neutral about using the app. When asked why they liked or disliked using the app, the responses varied. Some were positive about the app with comments such as, it gave me “the chance to see and try different varieties of foods that I did not know about” and “it is good for my parents to know what I want to eat”. Others found the app a little restrictive. One student was dismayed with the lack of choices stating they did not like the app because it “didn't have pickles!” Another student suggested allowing the app user to type in their desired food choices. Sixty-percent reported that their parents were neutral about the weekly emails detailing their lunchbox choices, while 30% reported that their parents found the emails helpful. The majority (90%) of the students said their parents tried to purchase and pack the foods they selected for their lunchbox. More students (40%) agreed or strongly agreed that their lunches were healthier after using the app, whereas only 20% disagreed or strongly disagreed. However, none of the students responded that they would use the app in the future.

b. Parent Evaluation

Only 5 of 12 (41.7%) parents of intervention program completers responded to the study evaluation that was sent by email after completing the study. Four parents (80%) responding that they used the app every week while 1 said they never used the app. When asked what they liked about the app, one parent expressed that the weekly emails of the lunchbox choices “made it easier to shop” and that “the suggestions were very helpful”. Another parent thought the app was an “interesting concept,” but was concerned how

practical it would be in reality. Two parents said they would not use the app in the future, 1 parent said they would use it again, and 2 said they might. The final question asked for some ideas or recommendations (including educational material, recipes, or another app) that they think might be helpful to other parents in packing healthy lunches for their children. One suggestion was to have "a newsletter or app for unique kid friendly lunchbox ideas/recipes to try". Another parent recommended encouraging exercise in addition to healthy lunches and they felt that high school students are in greater need of a healthy lunch intervention because they are probably "making poorer choices than 6th graders". One parent ended the survey with an encouragement to "please keep doing this" because it "made me and my daughter more aware of what she eats."

c. Teacher Evaluation

The teacher of the homeroom used for the experimental group was also asked a few evaluative questions through email. Overall, she felt the app was easy to use by the students since "the reporting was completed in just a few minutes" and commented saying, "the kids love any technology." She thought the app "was great" but wished we would have been able to teach the students more about nutrition. She felt the study could have been improved by higher student participation. She also expressed doubt that Archie R. Cole Middle School's population accurately represents "most of the nations eating habits". She thought, "the study would have been more useful if it were done in Providence, RI [school district with a predominantly minority population]."

DISCUSSION

This study evaluated the effectiveness of a mobile nutrition app for improving dietary quality of home-provided lunches for middle school students. The iPad application, *LaLa Lunchbox* was found to be ineffective for improving the dietary quality of lunches brought from home.

Although there was no difference in change in LQI score between groups, there was an effect of time. There was a non-significant trend between baseline and time 2. The LQI score of the lunches from home decreased after the intervention began in the experimental group and increased in the control group. These results are inconsistent with other studies that had interventions to improve lunches brought from home. Many of these other studies found more favorable results (24-26). The *Healthy Lunchbox Challenge* intervention, which found significant increases of fruits, vegetables, and water in lunches from home, used both an incentive program and direct education for parents (24). Incentives were provided if participants brought fruits, vegetables, and water in their lunches, so these participants were likely motivated to increase the dietary quality of their lunch based on the promise of a reward (24). In the current study, incentives were provided regardless of lunch content to both control and experimental groups so that they would not be an influencing factor to the provision of healthier lunches in the intervention group versus the control group.

There was, however, another lunch intervention study that found similar results to the current study for primary school children aged 4-11 (27). This

study had a 16-day intervention with a program called *Food Dudes* that consists of a series of DVD episodes promoting fruit and vegetables. The *Food Dudes* program had previously been effective in improving fruit and vegetable consumption for lunches provided by the school (28), but for lunches brought from home it was found to be limited in its effect on both short-term and long-term fruit and vegetable consumption (27). There were no significant increases in fruits and vegetables in the experimental group, but a significant increase was found in the control group.

These conflicting results are likely related to the complexity of the problem of altering lunches brought from home. In order to change lunches brought from home it is necessary to change the home environment. If the home environment does not have healthy foods available, healthy foods cannot be packed in lunches. Likewise, for these types of interventions to be successful they need to affect parent behavior. Parental involvement was critical to the execution of this study, so their level of involvement likely had an impact on the extent of behavior change in the children. Since only 5 out of 12 parents responded to the study evaluation, we can likely conclude that this study suffered from a lack of parent involvement. We may have found more success if we had elicited a direct engagement with the parents such as face-to-face meetings rather than merely weekly emails. These interactions could have provided accountability and led to greater adherence to each child's lunchbox choices especially if parents were anticipating a follow-up meeting after the intervention.

There is evidence that interventions that exclusively use technology are less effective than face-to-face interaction. For example, Harvey-Berino et al. compared the effectiveness of a weight maintenance program administered through 3 different modes (29). They found the internet program to be less effective than either dose of face-to-face contact as the internet group sustained a significantly smaller weight loss at the 1-year follow-up than either in-person groups (-5.7 kg vs. -10.4 kg) (29).

It has also been shown that print media is more effective at promoting behavior change in children than computer-based media. One study investigated the effect of a web-based physical activity intervention versus a print-based physical activity workbook in adolescent girls. Although the content of the two interventions methods were kept constant, the print-based intervention was found to increase physical activity intention and behavior significantly more than the web-based intervention (30). The researchers suggested a potential explanation for this difference could be a difference in the way information is processed on paper versus on a screen. Print media may elicit greater attention to and processing of messages than Web media (30). Since school-age children still primarily learn from textbooks and printed materials, learning using computers or mobile technology may not be deemed as credible and could possibly be perceived as a mode used solely for entertainment.

Computer-based interventions, including web-based or multimedia interventions, have been successful in changing dietary behavior in children.

A more direct comparison using a mobile app intervention is difficult due to the very limited research to date investigating the effectiveness of mobile apps to improve dietary quality, especially in children. Nutrition education appears to be an important factor in successful interventions for children. For example, the multimedia intervention, *Squire's Quest!,* which found a significant increase in fruits, vegetables, and 100% juice intake in the intervention group versus the control, used educational activities to affect behavior and was based on Social Cognitive Theory (20).

Another possible explanation for the unsuccessful outcome may be the fact that *LaLa Lunchbox* app does not educate the user but is basically a tool to facilitate the packing of healthier lunches. Since only healthy foods are listed as lunchbox choices in the *LaLa Lunchbox* app, the child is only able to build a healthy lunch. Although the app may imply a nutritional message that all lunches should include a fruit, vegetable, protein, and healthy snack, there are no explicit nutritional messages to inspire participants to make dietary changes. Perhaps the inclusion of nutrition education in *LaLa Lunchbox* would improve lunchtime dietary quality. In addition, many of the children expressed that the app was too limited in its food selections, nutrition education may improve long-term dietary quality even without adhering to the app's choices.

The study demonstrated a need for dietary intervention with lunches brought from home. In both groups overall, only 22% of lunches included a vegetable and more than half included an empty calorie snack. Even with our

homogeneous and well-educated population with high socioeconomic status, the lunches children are bringing from home are not meeting the recommendations for a healthy diet (6).

There were several limitations in this study. The first limitation was that there was a very small sample size, but it was designed as a pilot study to provide a protocol and direction for future research. The sample was restricted due to the requirement that children had to bring a lunch from home for all 6 weeks of the study. Another limitation was that we did not measure consumption of the lunches, so we cannot draw any conclusions on whether or not the app affected what the students actually ate from their lunches. However, previous research has found that the availability and accessibility of foods often predicts consumption (31, 32). Additionally, portion size was not assessed in the observation, so we cannot determine the total amount of calories or nutrients provided in the lunches. Furthermore, while the "What's in Your Lunch?" recording forms proved to be helpful in identifying the ingredients in sandwiches and salads which we would be unable to obtain through only the observation photographs, we could not identify the ingredients in other types of food such as pasta or soup that were contained in enclosed containers. Therefore, it is probable that some food items, especially vegetables within entrées were present but not counted. Lastly, due to the high socioeconomic status and ethnically uniform of the population at Archie R. Cole Middle School, the results of this study cannot be generalized to the population at large.

The nature of the app itself is another issue with promoting generalized use of this intervention. First, the app not applicable to most low-income households whose children receive free/reduced lunches through the NSLP. Second, the collection of food choices in the app assumes access to and availability of a variety of food, which is an unreasonable assumption for many households. Third, choices may be expensive especially “out of season” fruits and vegetables.

One of the strengths of this study was that it was not reliant on self-report, which is susceptible to reporter error and bias. There was a very high (98%) inter-observer reliability. The study was intentionally designed to focus exclusively on the mobile app intervention; therefore, we avoided additional methods that could have influenced behavior change such as nutrition education or incentives. This allowed for results to reflect the impact of the app alone. This strengthens confidence in the finding that the app was not effective. Nevertheless, since most of the children and responding parents enjoyed using it, this study does suggest that mobile health apps hold promise.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This pilot study was one of the first of its kind to examine the efficacy of a stand-alone mobile app that is currently on the market in promoting behavior change. Future research could use the groundwork provided by this study to assess mobile technology. In regards to the specific app *LaLa Lunchbox*,

future studies should examine whether the app, which involves children in the lunch-making process leads to greater consumption because they were included in the decision on what to pack in their lunches. Additionally, further research should investigate the effect of an app along with nutrition education based on educational theories.

Figure 1. Screenshot from LaLa Lunchbox application of "creating a virtual lunchbox"

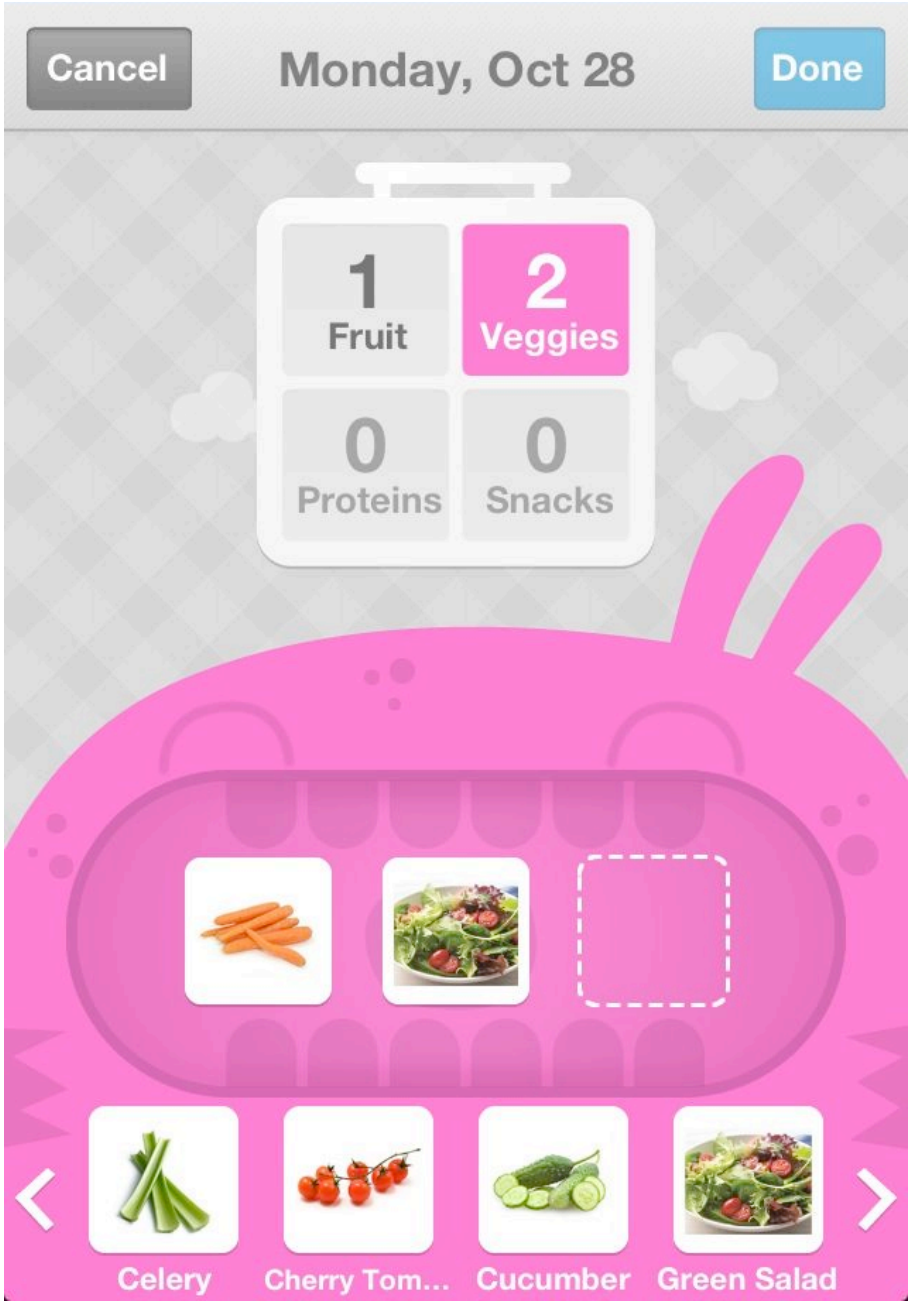

Table 1. Anthropometric and Demographic Data of Study Participants[a]

Characteristics[b]	Experimental (n=12)	Control (n=13)	Overall (n=24)
		Mean ± SD	
Age (years)	11.2 ± .42	11.2 ± .38	11.2 ± .39
BMI (kg/m^2)	17.8 ± 3.5	17.9 ± 2.25	17.9 ± 2.8
		n (%)	
Sex			
Male	4 (36.4%)	1 (7.7%)	5 (20.8%)
Female	7 (63.6%)	12 (92.3%)	5 (79.2%)
Race[c]			
White	7 (70.0%)	11 (84.6%)	18 (72%)
Asian	0 (0.0%)	1 (7.7%)	1 (4%)
Native American	0 (0.0%)	1 (7.7%)	1 (4%)
Did not wish to say	3 (30.0%)	0 (0.0%)	3 (12%)
Parent's Education[c]			
College Graduate	3 (30.0%)	1 (7.7%)	4 (16%)
Some Postcollege Work	0 (0.0%)	1 (7.7%)	1 (4%)
Postgraduate Degree	5 (50.0%)	10 (76.9%)	15 (60%)
Did not wish to say	2 (20.0%)	1 (7.7%)	3 (12%)
BMI Percentile			
<5th	1 (11.1%)	1 (8.3%)	2 (8%)
5-10th	0 (0.0%)	1 (8.3%)	1 (4%)
10-25th	1 (11.1%)	1 (8.3%)	2 (8%)
25-50th	2 (16.7%)	3 (33.3%)	5 (23.8%)
50-75th	0 (0.0%)	5 (41.7%)	5 (20%)
75-85th	2 (22.2%)	1 (8.3%)	3 (12%)
85th-90th	1 (11.1%)	1 (8.3%)	2 (8%)
>95th	1 (11.1%)	0 (0.0%)	1 (4%)

[a]Because of missing values, the total n is not the same for all variables
[b]There were no statistical differences (P>0.05) between groups on any demographic variables using chi-square and independent-samples t-test analyses
[c]Options that were not chosen by the participants are not listed here

Table 2: Comparison of the Lunch Quality Index (LQI)[a] score between the completers in both groups

	Experimental (n=9)	Control (n=10)	Between Group		Time	
	Mean ± SD		F	P value	F	P value
Week 1	2.0 ± 1.22	2.3 ± 1.16	2.24	0.123	2.83	0.047
Week 2	1.44 ± 1.05	2.8 ± 0.92				
Week 3	1.89 ± 1.05	2.2 ± 1.14				
Week 4	2.0 ± 1.00	2.4 ± 0.97				

[a]Lunch Quality Index (LQI) was calculated based on the presence or absence of fruit, vegetable, protein, and/or empty calorie snack

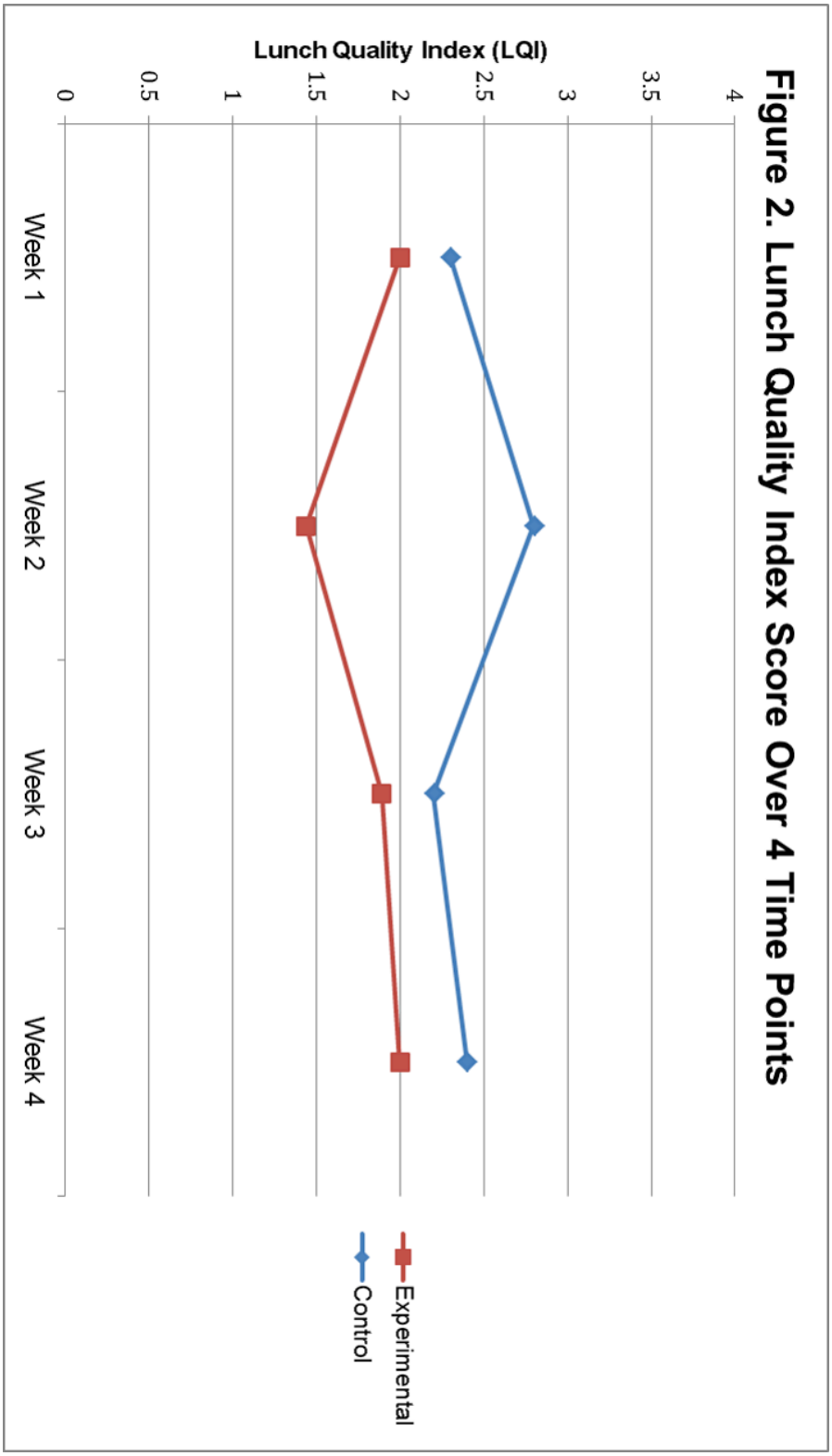
Figure 2. Lunch Quality Index Score Over 4 Time Points
Lunch Quality Index (LQI)
4
3.5
3
2.5
2
1.5
1
0.5
0
Week 1
Week 2
Week 3
Week 4
Experimental
Control

Table 3: Percentage of the Lunch Components in Each Group at different Time Points (including all subjects with data)													
	Week 1			Week 2			Week 3			Week 4			OVERALL
	Experimental	Control	Both	Experimental	Control	Both	Experimental	Control	Both	Experimental	Control	Both	
	n=11	*n=12*	*n=24*	*n=12*	*n=12*	*n=24*	*n=11*	*n=11*	*n=22*	*n=10*	*n=12*	*n=22*	*n=92*
Fruit	54.5%	69.2%	62.5%	58.3%	91.7%	79.2%	63.6%	54.5%	59.1%	60.0%	75.0%	68.2%	67.4%
Vegetable	18.2%	23.1%	20.8%	0.0%	50.0%	25.0%	9.1%	36.4%	22.7%	20.0%	16.7%	18.2%	21.7%
Protein	90.9%	84.6%	87.50%	83.3%	58.3%	79.2%	81.8%	72.7%	77.3%	80.0%	75.0%	77.3%	80.4%
Dairy	27.3%	61.5%	45.8%	25.0%	58.3%	41.7%	36.4%	54.5%	45.5%	40.0%	50.0%	45.5%	44.6%
Lean Meat	27.3%	7.7%	16.7%	25.0%	25.0%	25.0%	18.2%	18.2%	18.2%	20.0%	16.7%	18.2%	19.6%
High-fat Meat	45.5%	23.1%	33.3%	8.3%	16.7%	12.5%	9.1%	9.1%	9.1%	10.0%	0.0%	4.5%	15.2%
Egg	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%	4.5%	0.0%	0.0%	0.0%	1.1%
Peanut Butter	27.3%	23.1%	25.0%	50.0%	0.0%	25.0%	36.4%	9.1%	22.7%	40.0%	25.0%	31.8%	26.1%
Empty Kcal Snack	54.5%	53.8%	54.2%	58.3%	50.0%	54.2%	45.5%	63.6%	54.5%	40.0%	66.7%	45.5%	52.2%
Cookie	18.2%	15.4%	16.7%	16.7%	16.7%	16.7%	9.1%	27.3%	18.2%	30.0%	41.7%	36.4%	21.7%
Candy/Chocolate	0.0%	23.1%	12.5%	50.0%	25.0%	37.5%	0.0%	9.1%	4.5%	20.0%	0.0%	9.1%	16.3%
Cake/Pastries	9.1%	7.7%	8.3%	8.3%	8.3%	8.3%	9.1%	18.2%	13.6%	0.0%	0.0%	0.0%	7.6%
Granola Bar	36.4%	7.7%	20.8%	16.7%	8.3%	12.5%	27.3%	0.0%	13.6%	0.0%	8.3%	27.3%	13.0%
Chips	0.0%	30.8%	16.7%	16.7%	25.0%	20.8%	9.1%	18.2%	13.6%	10.0%	41.7%	4.5%	19.6%

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APPENDIX A – Review of Literature

1. Childhood obesity and chronic disease

Childhood obesity has more than doubled in children and tripled in adolescents in the past 30 years (1). According to the National Health and Nutrition Examination Survey (NHANES), in 1980 approximately 7% of US children (6-11 years) were obese and this prevalence has increased to approximately 17% in 2012 (1). Although the prevalence has remained stable between 2003-2004 and 2011-2012, the rates remain high (1).

As children continue to gain more weight, the proportion of children suffering from severe obesity (BMI ≥ 99th percentile for age/gender) has also risen (2). According to the NHANES for 1999-2004, almost 4% (2.7 million) of U.S. children 2-19 years old were severely obese. When compared to the NHANES II 1976-1980, the prevalence of severe obesity increased by more than 300% since 1976-1980, and by over 70% since NHANES III 1988–1994 (2).

Obese children and adolescents are more likely to be obese as adults, and therefore, are at an increased risk for coronary heart disease, type II diabetes, stroke, many types of cancer, and osteoarthritis in adulthood (3, 4). However, risk factors for coronary heart disease, such as hypertension, dyslipidemia, impaired glucose tolerance, and vascular abnormalities, were once thought to be only experienced by adults, but are now present in many overweight children (5, 6).

A 55-year follow-up study demonstrated that adults who were overweight in adolescence had an increased risk of morbidity and mortality from

cardiovascular diseases, independently of adult weight (7). This suggests that there are permanent metabolic and physical changes that lay the foundation for cardiovascular disease later in life (8). There is evidence that the physical progression of atherosclerosis begins during childhood in severely obese children. An investigation that performed non-invasive ultrasonographic measurements on 48 severely obese children and 27 healthy children discovered that severely obese children showed clear signs of early progression of atherosclerosis through increased likelihood of early endothelial dysfunction and increased stiffness of elastic arteries (8). Therefore, severe childhood obesity not only is a risk factor for later cardiovascular disease, but also is associated with current impairment of vascular function.

2. Diet related etiology

Low nutrient-dense and high energy-dense foods are associated with excess weight gain in children and adults (9, 10). The quality of children's and adolescent's diets (2-18 years old) was assessed using the Healthy Eating Index, estimated from NHANES (2009-2010) (10). They found that children are consuming on average 33% of their total calories (798 kcal/day of 2027 kcal) in the form of empty calories, defined as the sum of solid fat and added sugars (10, 11), considerably exceeding the recommended discretionary calorie allowances for this age group, which range from 8% to 19% of total calories (11). The sources of these empty calories are sugar-sweetened beverages, grain desserts, and pizza (11).

Furthermore, on average, children and adolescents are failing to meet recommendations (10). Scores for greens and beans and whole grains were the farthest from the standards since average consumption was only 14-18% and 16-18% of the recommended amount per day, respectively (10).

3. School lunches

Since children consume more than one-third of their total calories at school, food provided through the NSLP has become an important area of intervention (12). As of March 2012, new standards for the NSLP became effective to align them with the 2010 Dietary Guidelines for Americans (13). School lunches must provide one-third of the daily requirements for energy and macronutrients through a balanced meal that includes all five food groups: fruits, vegetables, grains, meat/meat alternative, and milk (14). The NSLP now considers fruit and vegetables two separate components and children must select either ½ cup of a fruit or vegetable or ¼ cup of a vegetable and ¼ cup of fruit to place on their lunch tray (15). The schools also must serve a greater variety of fruits and vegetables with weekly requirements for dark green, red/orange, beans/peas (legumes), starches, and other vegetables (15). In addition, at least 50% of the grains products served must be whole grain, and only low-fat 1% or skim milk is provided (15).

While the 62% of students in the U.S. that participate in the NSLP are now receiving more nutritious lunches (14), there is no regulation on the quality of lunches brought from home and evidence shows that these packed lunches are failing to meet the recommendations for a healthy diet. Two studies conducted in

the United Kingdom (UK) compared the food and nutrient intakes of primary school children consuming school meals and packed lunches (16). One of the studies visually observed a total of 120 lunches at a single time point, 62 school meals and 58 packed lunches at a single time point (16). The other study examined the diets of 311 children from low-income households using 24-hour recalls (17). The children in both studies were 6-11 years old (16). On average, children that brought a lunch from home consumed more sugar, sodium, saturated fat in their lunches than children who ate a school lunch (16). Children with lunches brought from home had higher daily consumption of white bread, fats and oils, chips and savory snacks, and preserves and sweets, which were likely the sources of the excessive amounts of sodium, fat, and added sugar (17). Therefore, these studies suggests that lunches brought to school from home are less likely to contribute to a healthy diet than school provided lunches (17).

At four Texas middle schools, Cullen et al. assessed school lunch consumption through self-reported lunch food records that were completed immediately following eating. They found that students who ate meals from the NSLP consumed around ½ serving of fruit, ¾ serving of vegetables, 1 serving of milk, and ⅓ serving of whole grains at lunch. Non-NSLP participants reported almost no intake of fruit, vegetables, or milk, and consumed around ¼ serving of whole grains at lunch (18). Middle-school students who had a lunch from the NSLP reported higher intakes of protein, calcium, iron, vitamin A, vitamin C, and fiber compared with those who did not eat NSLP meals. The lunches were then compared to the United States Department of Agriculture and Institute of

Medicine (IOM) guidelines. In general, both NSLP and non-NSLP participants consumed lunches that were significantly different from the guidelines for all nutrients, except the mean amount of calories from fat and saturated fat consumed by the non-NSLP participants, which was meeting the guidelines (18).

Johnston and colleagues conducted a study that also examined the differences in nutritional quality of lunches brought from home compared to lunches provided through the NSLP (19). Researchers directly observed a total of 2107 lunches in lunchrooms on three randomly selected days and coded them for the presence or the absence of specific food items (19). They found that children who received a school lunch included fruit (75.9% vs. 45.3%), vegetables (29.1% vs. 13.2%), and dairy (70.0% vs. 41.8%) with their meal significantly more often than children who brought a packed lunch (19). Furthermore, lunches brought from home were more likely than school lunches to contain foods high in sugar and/or fat (60.0% vs. 17.5%) and a non-100% juice fruit juice drink (47.2% vs. 0.3%) (19).

In another study, Conway et al. assessed 1381 lunches brought from home by middle school children (grades 6-8) through a similar observational technique, but this study also analyzed the sugar content of the lunches (20). Similar to Johnston and colleagues, they found lunches brought from home were low in fruits and vegetables (20). They also found that these bag lunches contained a mean 21.3 grams of sugar, which is above the 12-20 grams per day Since lunches are providing approximately one-third of the total daily kilocalories, according to the American Heart Association, they should contain no more than

4-6.7 grams of sugar, which is much less than the average bag lunch in this study (20).

A cross-sectional study using 24-hour dietary recall data from the 2004-2005 third School Nutrition Dietary Assessment Study found that on average children consume 35% of their daily calories at school (12). The study compared the consumption of National School Lunch Program (NSLP) participants and non-participants (12). Low nutrient, energy-dense foods were classified into five mutually exclusive categories: higher fat baked goods, candy and sweetened gum, dairy-based desserts, french fries and similar potato products, and chips and salty snacks (12). Throughout the day, all children consumed on average 527 kcal from low nutrient, energy-dense foods (12).

The review of the literature shows that school lunches are on average healthier than lunches brought from home. In general, packed lunches contain more sodium, saturated fat, and added sugar than lunches provided by the school (17,18). They also tend to contain less vegetables and whole grains (19,21,22). It is important to address poor quality packed lunches through interventions targeted specifically to induce healthy changes in the types of foods being brought to school for lunch.

4. Previous interventions to improve lunches from home

This section will review intervention studies designed to improve lunches from home.

Lunch is in the Bag is a childcare center-based nutrition education program for parents of preschool-aged children and is aimed at increasing fruits,

vegetables, and whole grains in lunches brought from home (21). Using a quasi-experimental design, six centers were randomly assigned to either an experimental group or comparison group that received no intervention (21). The intervention included parent handouts and behaviorally-based activities for parents and children, in addition to teacher training (21). Following the 5-week intervention, observations of lunches showed a significant increase of fruits and vegetables from 0.41 servings at baseline to 0.65 servings at post and whole grains from 0.54 to 1.06 servings (21).

Another intervention called the “SMART” lunch box was focused on 8-9 year old students in 89 schools in the United Kingdom (UK) (22). This intervention was aimed at improving the contents of packed lunches to better align them with the governmental nutrition standards for school provided lunches (22). Each participating school was randomly assigned to two groups: the full experimental group and the minimal intervention (control) group (22). In the experimental group, parents received supplies for packing a healthy lunch, which included: a lunch bag, a plastic container for a sandwich or alternative entrée, a container for fruit or vegetables, and a water bottle (22). Parents and children in the experimental group also received nutrition education materials and games encouraging families to pack balanced meals that include all five food groups with water to drink (22). In the minimal experimental group, parents received a leaflet with information on improving lunches brought from home (22). Lunches from parents in the experimental group had moderately but significantly greater amounts of fruit and vegetables and dairy foods following the intervention when

compared to the control group (22). The amount of fruits and vegetables combined increased by ⅓ of a serving in the experimental group, but there was no effect on the amount of fat, sugar, and sodium (22).

Tilley and colleagues evaluated a summer camp intervention called the *Healthy Lunchbox Challenge* and found it to be successful in improving both staff and child lunches brought from home (23). The intervention included a parent and staff education program on "Building a Better Lunchbox" and a child and staff incentive program for bringing fruits, vegetables, and water to drink in their lunches (23). Foods and beverages were assessed through direct observation. This large study with 1,977 children found an significant increase in the percentage of children bringing fruits (31% to 42%), vegetables (5% to 16%), and water (47% to 60%) from baseline to post-assessment (23). The percentage of 241 staff members who brought fruits and vegetables significantly increased from 30% to 47% and 9% to 22% respectively (23). There were also observed decreases in low-nutrient-dense foods and beverages such as chips and non-100% juice fruit drinks in both children and staff (23).

In the UK, the 16-day *Food Dudes* program was designed to improve lunchtime consumption in primary school children aged 4-11 (24). The *Food Dudes* program consists of a series of DVD episodes using peer-modeling to promote eating fruit and vegetables (24). This program had previously been successful in improving fruit and vegetable consumption when the fruits and vegetables were provided and offered by the school during lunchtime (25), but it had not been tested on improving lunches brought from home. In both the control

group who did not receive any intervention and the intervention group, consumption of lunches brought from home was measured using before and after photographs (24). The observations took place at baseline measurement, at 3-month follow-up, and after 12 months following the intervention. There was not a significant change in fruits and vegetables consumption in the intervention group at 3 months and a non-significant decrease in fruit and vegetable consumption at 12 months (30 g vs. 30 g vs. 25 g respectively). However, in the control group fruit and vegetable consumption significantly increased at 3 months compared to baseline but the change was not sustained at 12 months (29 g vs. 36 g vs. 30 g respectively) (24). This study found that the *Food Dudes* program was limited in its effect on both short-term and long-term fruit and vegetable consumption.

5. Technology use and health apps

According to a study from Pew Internet & American Life Project, nearly half of American adults own a smartphone (26). Throughout the world, the number of smartphone users just exceeded one billion in the fall of 2012 (27), and a third (34%) of American adults ages 18 and older owned a tablet computer in 2013 (28). The usage of mobile apps is increasing rapidly, and grew at a rate of 115% in the year 2013 (29). Today, the U.S. consumer spends an average of 2 hours and 38 minutes per day on smartphones and tablets (30). Out of that time, 80% (2 hours and 7 minutes) is spent using apps and 20% (31 minutes) is spent on the mobile web (30).

It is not just adults who are making use of this technology. TRU research group conducted a study for the Verizon foundation with 1,000 online surveys to children aged 11-14 years. They found that approximately half (49%) of middle-school children use a smartphone at home and 39% use a smartphone to complete homework assignments (31). Furthermore, more than one in three (36%) use a tablet at home and 31% of middle school students use a tablet to complete homework (31). However, only 18% use a tablet in the classroom (31). Research has found out of students who use tablets in the classroom, two in three (67%) report that using this technology makes them want to learn more, and the majority claim using some form of technology in the classroom makes them feel smart (61%), excited (54%), and happy (52%) (31).

"There's an app for that", the famous Apple advertisement slogan rings true even in regards to the healthcare industry. Health mobile applications (apps) are on the cutting edge of pediatric nutrition practice (32). In 2011, there were more than 40,000 mobile health apps, contributing to the $718 million global industry, according to Research2Guidance, an international market research firm (33). Many consumers are using mobile health apps; however, there is limited research to support the effectiveness of these apps in improving health.

6. Nutrition software for improving health

Although the literature on mobile technology is limited, the literature on mobile interventions is ever growing. However, the research on computer-based software is more comprehensive and previous studies have demonstrated that

computer-based interventions can favorably affect many different health behaviors including dietary quality.

5.1 Multimedia

Web-based and multimedia software provides a platform for reaching large groups of people without expending huge sums of money. Interventions through the internet have produced positive results for many different health outcomes (34). Ezendam et al. evaluated a web-based computer-tailored intervention in 20 schools in the Netherlands (34). The study had a large sample size of 883 adolescents between 12-13 years old (34). The participating schools were randomly assigned to either a control group that received no-intervention or an intervention group that did the 8-lesson internet program (34). They found that this intervention had several significant short-term effects on diet including lower intake of sugar sweetened beverages and snacks and higher intake of fruit and vegetable than the control group at the 4-month follow-up (34). However, there were no effects or unfavorable effects on the measures of physical activity and sedentary behavior (34).

Gold et al. investigated the effectiveness of a structured therapist-led weight loss program called VTrim versus a commercial weight loss website, eDiets.com (35). A sample of 124 overweight or obese adults were randomly assigned to 12-months using VTrim or 12-months using eDiets.com. For the first 6 months, the VTrim website included specific weekly lessons. Weekly meetings were held on-line with the therapist to reinforce the lesson topics. The participants were instructed to reduce their caloric intake by up to 1000

calories/day and were encouraged to gradually increase their energy expenditure. The participants self-reported their weight and dietary intake weekly and the therapist provided weekly feedback. There was also a discussion board to encourage peer-to-peer and group support on VTrim's website. On eDiets.com, participants were given a caloric goal based on a reduction of approximately 1000 calories per day based on their calculated metabolic rate and the website provided tailored meal plans and fitness programs (35). Weight was self-reported weekly and automated feedback messages were received (35). There was an interactive forum where participants could receive online support from both peers and experts (35). This study found that the VTrim group lost significantly more weight at 6 months than the eDiets.com group (6.8 kg vs. 3.3 kg) (35). Although both groups gained some of the weight back by 12 months, the VTrim group maintained significantly higher weight loss compared to the eDiets.com group (5.1 kg vs. 2.6 kg) (35). This study demonstrated that both types of web-based intervention resulted in weight loss, but greater weight loss was achieved with online weight loss program with personalized therapist contact.

In San Francisco, Chen and colleagues assessed the efficacy of a web-based childhood obesity prevention program in Chinese American adolescents aged 12-15 years (36). This study used a randomized control design; researchers assigned the 54 participants to intervention or control groups. Both groups received weekly online session activities for 8 weeks. The intervention group's website was grounded in the Transtheoretical Model-Stages of Change

and the Social Cognitive Theory: each session was personally tailored to the behavioral stage of change of the adolescent (36). Parents in the intervention group received three online lessons within the same 8-week period specific to their child to provide reinforcement and social support at home. The control group accessed a different website that was not personally tailored and just included general health information regarding nutrition, dental care, safety, common dermatology care, and risk-taking behaviors. Parents in the control group received three online sessions of general health information. Although there were no reductions in BMI, significantly more adolescents in the intervention group decreased their waist-to-hip ratio and diastolic blood pressure than the control group. Additionally, the intervention group significantly increased their fruit and vegetable intake and their knowledge related to physical activity and nutrition (36). This study demonstrates that a personally-tailored web-based program that is grounded in educational theory can be effective at not only increasing knowledge but also at improving dietary behaviors and anthropometric variables.

Williamson et al. tested a two year internet-based weight management with overweight African-American girls (9-14 years old) and parent dyads in Baton Rouge, Louisiana (37). The 57 pairs were randomized to one of two treatment websites: one that implemented interactive behavior therapy, referred to as the experimental group and a passive health education control group. Low-cost computers and free internet access were provided to both groups to overcome any disparities in access to the intervention. The experimental group's website

included nutrition education as well as an internet counseling and behavior modification program. The control group's website included only the nutrition education component. Additionally, both groups received four face-to-face counseling sessions during the first 12 weeks. The study found that the girls and parents in the experimental group lost significantly more body weight than the control group at 6 months. Over the next 18 months, the experimental group gained weight back, and by 2 years the weight between the two groups was not significantly different (37). Therefore, this study suggest that an interactive internet-based program may be effective for short-term weight loss but not for long-term weight loss.

A randomized clinical trial evaluated the effect of a website called *Teen Choice: Food & Fitness* on improving nutrition and physical activity in adolescents (38). Participants were recruited via health fairs, flyers at schools, churches, community organizations and newspaper and radio advertisements. After completing the baseline online questionnaire on diet, physical activity, and sedentary behavior, 390 subjects were randomly split into an intervention and a control group. Each group accessed different websites (38). The online program was accessible with a username and password on any computer with Internet access. The experimental group website contained self-regulation and observational learning components of the Social Cognitive Theory, which included role model stories, goal-setting, problem solving, progress tracking, and self-monitoring. The control group website allowed participants to view the nutrition and physical activity knowledge materials, to use the Healthy Eating

Calculator to assess their diet and their physical activity, and to set personal goals for improvement. The post dietary questionnaires demonstrated that more adolescents in the experimental group reported eating three or more serving of vegetables per day in the past week than the control group (18% vs. 5%) (38). Following the intervention, regardless of group, significantly more adolescents reported being physically active at least 60 min/day on all 7 days in the past week and significantly fewer reported watching 3 or more hours of TV per day in the past week (38). This study demonstrates that a web-based intervention is successful at improving fruits and vegetable intake, increasing daily physical activity, and reducing sedentary behavior.

Mauriello et al. evaluated *Health in Motion,* multimedia program targeted at obesity prevention in adolescents developed by Janice Prochaska (39). A sample of 1800 students from high schools in Rhode Island, Massachusetts, New York and Tennessee were randomly assigned to either a intervention or a control group. The students in the treatment group participated in a series of 30-minute sessions at three time points (baseline, 1 month, and 2 months) during school day. In addition, students completed two follow-up assessments at 6 and 12 months. The *Health in Motion* program included audio, video, and animations with tailored feedback to increase physical activity, increase fruit and vegetable intake, and decrease television viewing. The control group did not receive any intervention but also completed assessments at 2, 6, and 12 months (39). The study found that the treatment group reported a greater number of days engaged in at least 60 minutes of physical activity at 2 months (3.38 vs.

2.72) compared to the control group. The treatment group also reported eating more servings of fruits and vegetables at 2 months (3.86 vs. 3.0), 6 months (3.55 vs. 2.73), and 12 months (3.67 vs. 2.97) compared to the control group. The average number of hours viewing television was not significantly different at any time point (39). Interactive multimedia interventions such as *Health in Motion* that deliver tailored feedback demonstrate a potential to initiate behavior change for several energy balance promoting behaviors.

Research on multimedia games to promote health in children appears to be promising. Baranowski et al. from the Baylor College of Medicine assessed the impact of a ten-session, psychoeducational multimedia game *Squire's Quest!* on fruit, juice, and vegetable consumption in 1578 elementary school students (40). Using a software program that simulated a multiple-pass, 24-hour dietary recall, the study found that the *Squire's Quest!* game resulted in a 1.0 serving greater increase of fruit, juice, and vegetable intake in the treatment group compared to the control group (40). This study provides evidence supporting the potential of multimedia games to produce dietary behavior change.

Following a 6-month weight loss trial, Harvey-Berino et al. compared a 12-month weight maintenance program conducted over the internet with a weight maintenance program conducted through minimal and frequent face-to-face contact (41). Overweight adults were recruited through newspaper advertisements and 122 were randomized to one of the three groups. They found the internet program to be less effective than both amounts of face-to-face

contact as the internet group sustained a significantly smaller weight loss at the 1-year follow-up than both in-person groups (-5.7 vs. -10.4 kg) (41). The results of this study suggest that web-based support may not be as effective as any dose of in-person therapist support to facilitate long-term maintenance of weight loss.

To investigate whether web-based interventions are more effective than more traditional methods, Marks and colleagues examined the effect of a web-based physical activity intervention versus a print-based physical activity workbook (42). After recruiting in four middle schools in North Carolina, 359 girls in 6^{th}-8^{th} grades were randomized to either a web-based intervention or a print-based intervention. The print workbook was identical in content to the information on the website. Self-reported physical activity was collected through phone calls at baseline and at 2 weeks. Both groups increased their physical activity intentions, but the print-based intervention was found to increase physical activity intention significantly more than the web-based intervention. Furthermore, the print-based intervention group reported increases in physical activity behavior and there was no change in physical activity behavior with the web-based intervention (42). This study suggests that a print-based workbook is more effective at increasing physical activity intention and behavior than a web-based intervention.

5.2 Mobile communication

Text messaging also has been found to be effective at improving health. Patrick et al. evaluated the effect of a text message-based intervention on weight

loss for overweight adults. Seventy-five overweight adults were randomly assigned to one of two groups (43). The first group only received printed materials about weight control and the second received the intervention, which included personalized text messages sent 2-5 times dairy, printed materials, and brief phone calls from a health counselor every month (43). These personally tailored and interactive text messages were a means for behavioral prompting, support, and self-monitoring. Subjects who received the text-messaging intervention lost significantly more weight (-2.88kg or 3.16% body weight) than the print materials group. Moreover, subjects were highly satisfied, with 22 out of 24 (92%) participants stating that they would recommend the intervention to friends and family (43). This study demonstrates the potential of mobile communication to effective promote weight loss in overweight adults (43).

5.3 Mobile apps

The research base on mobile app-based interventions is considerably lacking compared to other technology-based interventions, and as a result, the effectiveness of app-based interventions is largely unknown.

Turner-McGrievy et al. examined the impact of an intervention using Podcasts, a mobile diet-tracking app, and social networking compared to using the Podcasts alone (44). The sample of 96 overweight or obese adults were randomized to either the Podcast-only group or the Podcast plus enhanced mobile media intervention group (Podcast+Mobile) (44). Both groups received 2 Podcasts per weeks for 3 months and 2 mini-Podcasts per week for weeks 3-6 months (44). The Podcast only group also received a book with amounts of

calories and fat in different foods to help them monitor their dietary intake(44). The Podcast+Mobile group was also instructed to download the diet and physical activity monitoring app, FatSecret's Calorie Counter app, and the social networking app, Twitter, to their mobile smartphone (44). The Twitter app provided a means for further discussion on the topics covered in the Podcasts as well as providing peer-to-peer support. Both groups lost a modest amount of weight at 3 months (Podcast+Mobile= -2.4 kg vs. Podcast only= -2.3 kg) and at 6 months (Podcast+Mobile= -0.2 kg vs. Podcast only= -0.3 kg), but there was no difference between groups (44). There were also no differences between energy intake or energy expenditure between the groups (44). This study shows that the mobile-based interventions can produce a modest, short-term weight loss, but the addition of a diet tracking app and social networking did not have a substantial impact on additional weight loss in overweight adults.

Hebden et al. conducted at a large Australian university measured the effect of a mobile health intervention on weight management among young adults (45). Fifty-one participants were randomized to either an intervention or a control group. Both groups received a printed diet booklet and one session with a registered dietitian (45). In addition, the intervention group received text messages, emails, and had access to smartphone applications and internet forums (45). The four smartphone apps were developed by researchers and each addressed one of the lifestyle behaviors: physical activity and sedentary behavior, intake of fruits and vegetables, energy-dense "takeaway" food, and sugar-sweetened beverages (45). These apps allowed users to record their

behavior (e.g. amount of physical activity performed, servings of fruits and vegetables eaten, etc.). Then they received immediate tailored motivational advice, as well as feedback on the health guidelines for that specific behavior (45). This study found that after 12 weeks, body weight decreased in both the intervention (-1.60 kg) and the control (-1.41 kg groups), but there was no significant difference between the groups (45). This study demonstrates that a mobile health intervention can have short-term positive effects on weight but it is not any more effective than more traditional intervention methods such as face-to-face counseling and print materials.

Another study conducted in Australia by Kirwan et al. investigated the effects of an app currently on the market called *Glucose Buddy* on glycemic control in adults with type 1 diabetes (46). Since poor glycemic control is common, complicated, and dangerous for adult type 1 diabetes patients, researchers aimed to evaluate if mobile technology can help them overcome difficulties to self-management. Participants must have been diagnosed with type 1 diabetes more than 6 months ago. Seventy-two adults were randomized to an intervention group or a control group. Both groups continued their usual care, but the intervention group was instructed to download the *Glucose Buddy* app (46). The *Glucose Buddy* app allows users to manually enter their blood glucose levels, insulin dosages, other medications, dietary intake, and physical activity performed (46). This data can then be displayed on customizable graphs and exported to email (46). A Certified Diabetes Educator (CDE) weekly reviewed all the information participants entered into the *Glucose Buddy* app. Additionally, for

the first 6 months of the study, the participants in the intervention group received at least 1 personalized text message every week from the CDE (46). The primary outcome was HgbA1C concentration, which was measured at baseline, 3, 6, and 9 months. The intervention group had a significantly greater decrease in HbA1c (−1.10) over the 9-month study than the control group which had a non-significant increase (+0.07) (46). No other significant changes were found for the other measures of diet, physical activity, quality of life, or empowerment (46). This study shows that mobile apps can be effective for type 1 diabetes care in adults.

A study conducted for a Master's Thesis from Arizona State University compared adults aged 18-65. Participants were stratified by gender, age, BMI, body weight, and waist circumference. Then, the 57 participants were randomized to either record their daily dietary intake using the *Lose it* iPhone app, using the "notes" function on their smartphones, or using traditional pen and paper methods (47). After the 8-week intervention, both groups lost weight but there were no significant differences in the amount of weight loss between groups. This suggests that self-monitoring of diet and exercise, regardless of method, can result in successful weight loss. There is still a need for more research, but this study demonstrates that smartphone applications have the potential to be an easy, cost-effective way to promote healthy behavior changes.

There is limited research on mobile apps in improving health. A few previous studies on found a positive impact of health apps on adults. Although mobile technology is widely used by school-age children, research has yet to evaluate

the effectiveness of mobile apps in improving the dietary intake of children. Other technology-based interventions demonstrated a favorable effect on dietary quality and studies using mobile apps with adults found them feasible and enjoyable to use, but the results in promoting behavior change are inconclusive. Studies have also shown that lunches brought from home are less healthy than lunches provided at school. However, to our knowledge, there have been no published interventions testing the ability of an app to motivate the parents of a child or the child themselves to increase the nutritional value of lunches brought from home.

APPENDIX B – Lunch Observation Form

What's In Your Lunch?

Please take out your lunch and write down what food items are inside. If you brought a sandwich or salad, use the checklist at the bottom of the page.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. A Sandwich or Salad (circle)

And, check the boxes if your sandwich or salad includes the following:

Bread:

- ☐ Whole Wheat Bread
- ☐ White Bread
- ☐ White Roll
- ☐ Pita Pocket
- ☐ Wheat Pita Pocket
- ☐ Wrap
- ☐ Whole Wheat Wrap
- ☐ Bagel
- ☐ Whole Wheat Bagel
- ☐ Other (write-in):

  _____

  _____

Meats:

- ☐ Turkey
- ☐ Ham
- ☐ Tuna Salad
- ☐ Chicken Salad
- ☐ Egg Salad
- ☐ Chicken Breast
- ☐ Roast Beef
- ☐ Salami
- ☐ Other (write-in):

  _____

  _____

Condiments/Other:

- ☐ Cheese
- ☐ Croutons
- ☐ Nuts (e.g. walnuts, almonds)
- ☐ Hummus
- ☐ Mustard
- ☐ Mayonnaise
- ☐ Ketchup
- ☐ Peanut/Nut Butter
- ☐ Banana
- ☐ Jelly
- ☐ Other (write-in):

  _____

  _____

Veggies:

- ☐ Lettuce
- ☐ Spinach
- ☐ Tomatoes
- ☐ Cucumbers
- ☐ Carrots
- ☐ Bell Peppers
- ☐ Onions
- ☐ Mushrooms
- ☐ Broccoli
- ☐ Corn
- ☐ Olives
- ☐ Avocado
- ☐ Beans (e.g. chickpeas, black beans, white beans)
- ☐ Other (write-in):

  _____

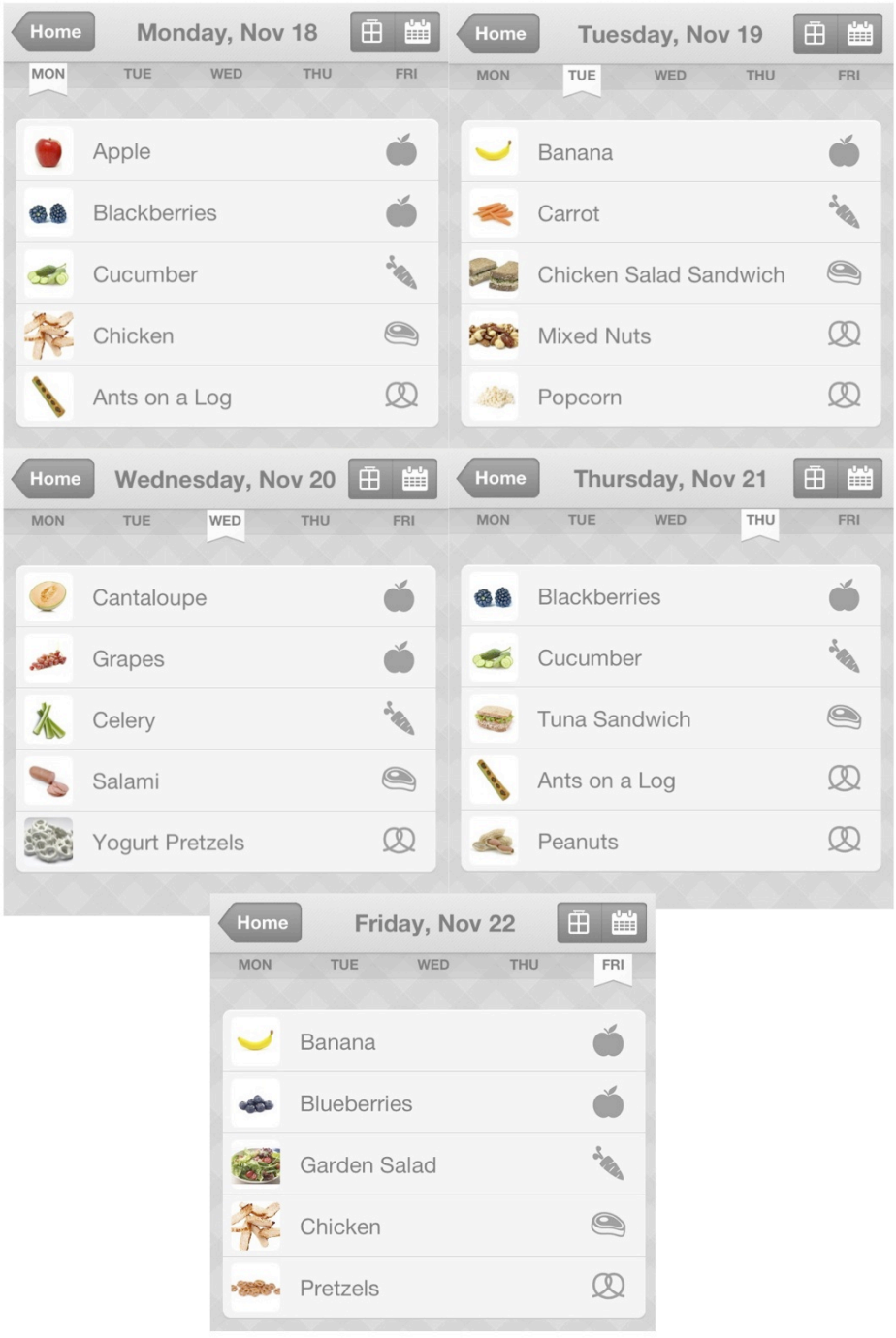
  _____

APPENDIX C – List of Modifications to LaLa Lunchbox App

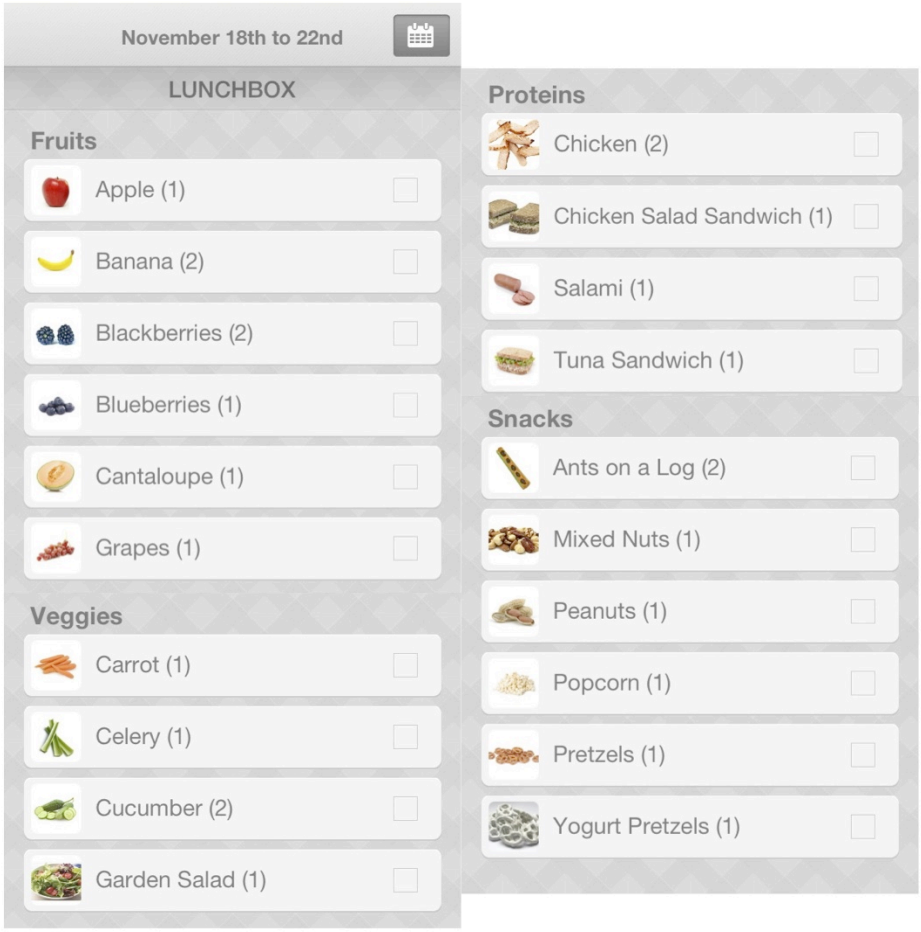
Added to App:	
Protein/Main Dish	• Salad with Chicken • Nut butter • Chicken Breast Strips • Quinoa • Pasta with Meat Sauce • Pasta with Tomato Sauce • Pasta with Chicken • Chicken Salad Sandwich • Soup
Vegetable	• Green salad • Veggie Stir-fry
Fruit	• Fruit Salad
Snack	• Mixed Nuts • Trail mix • Whole Grain Cereal • Dried Fruit
Deleted from App:	
Protein/Main Dish	• Prosciutto & Mozzarella • Mozz & Tomato • Goat Cheese, Apple, & Honey • Smoked Salmon All Apple Gate Naturals products
Snack	• Cookie • All “Peeled Snacks” • Cheese twists

APPENDIX D – Parent Emails Screenshots

LaLa Lunchbox App Screenshot of Lunchbox Choices for One Week

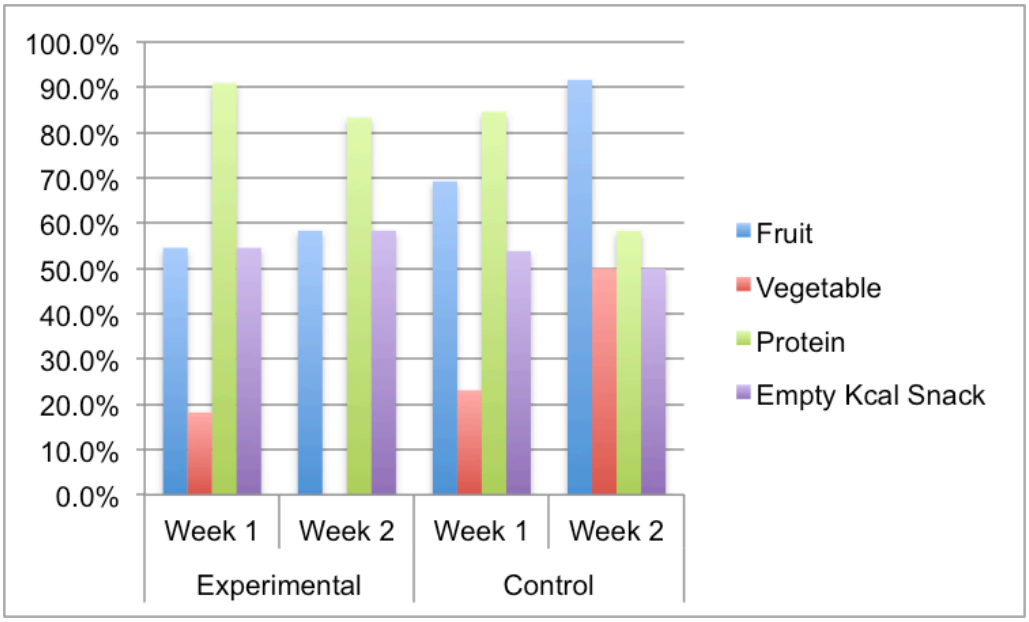


LaLa Lunchbox Screenshot of Grocery List for One Week

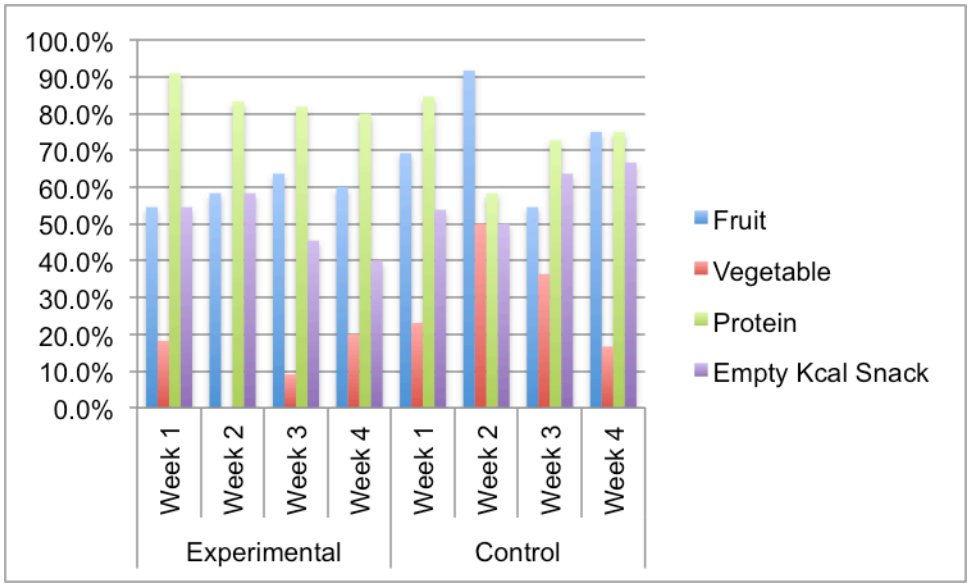


APPENDIX E – Percentage of Food Components Charts

Week 1 and Week 2



All 4 Weeks



APPENDIX F – Post-Evaluation Surveys

Student Evaluation of the LaLa Lunchbox App

Thank you for participating!
Please circle the answer that best represents how you feel about each statement below.

I liked using the iPad app, LaLa Lunchbox.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Unsure/ Don't Know

Why or why not?

_____
_____
_____
_____
_____

My parent/guardian thought the emails they received about my lunchbox choices were helpful.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Unsure/ Don't Know
My parent/guardian tried to buy and pack the foods I chose for my lunchbox.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Unsure/ Don't Know
My parents and/or I would use this app in the future.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Unsure/ Don't Know
My lunches were healthier after using the app than before.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Unsure/ Don't Know

PDF Version of Online Surveymonkey Parent Evaluation Survey

Parent Evaluation of iPad App, LaLa Lunchbox

1.

1. How often did you use the lunchbox choices and grocery lists sent to you through email?

- ◯ Every week
- ◯ 3 times
- ◯ Twice
- ◯ Once
- ◯ Never

2.

2. Why did you not use the lunchbox choices and grocery lists more often?

3.

3. What are some things you liked about the app and the weekly emails?

4.

4. What are some things you disliked about the app and the weekly emails?

5.

Page 1

Parent Evaluation of iPad App, LaLa Lunchbox

5. Would you use the app, LaLa Lunchbox, in the future?

- ◯ Yes, I found it very helpful
- ◯ Maybe
- ◯ No, I don't think I will use the app
- ◯ No, I do not own an iPhone or iPad

Other (please specify)

6.

6. Do you think your child will use the app, LaLa Lunchbox, in the future?

- ◯ Yes, he/she enjoyed using the app
- ◯ Maybe
- ◯ No, I don't think he/she will use the app
- ◯ No, we don't own an iPhone or iPad

Other (please specify)

7.

7. Please let me know in the space provided if you have any ideas or recommendations (including educational material, recipes, another app) that you think might be helpful to other parents in packing healthy lunches for their children

8.

Thank you very much for participating in this study!

APPENDIX G – Parental Consent Forms

Experimental Group

PARENTAL PERMISSION FORM FOR RESEARCH

My name is Christina Pryor and I am a graduate student in nutrition at the University of Rhode Island. Linda Sebelia MS RD is running a research study this fall at Archie R Cole Middle School to learn more about the lunches that 6th graders bring to school every day and to see if the app La La Lunchbox is a useful tool for young people. We are inviting you be a part of this project. The details of the project are written below. You should feel free to ask questions.

Description of the project:
This 6-week long study is being conducted in an effort to evaluate the effectiveness of the smartphone application LaLa Lunchbox. The app allows children to personalize their lunchbox, which is divided into four quadrants: vegetables, fruit, protein, and snacks. Your child is able to choose between four and six items from a variety of pictorial representations for each category. All the foods that are available on the app are minimally processed and are low in fat, sugar, and sodium. The selections are then formatted into a grocery list to make it easier for you to purchase the preferred lunchtime food items. A copy of the grocery list will be sent to you in an email for the following week. Furthermore, you will be provided with your child's username and password which you can use to log into the account if you have a personal iPhone or iPad to view the lunchboxes and the grocery list. Your child will change the password at the end of the study to protect confidentiality.

In order to be eligible for the study your child must bring their own lunch to school for the duration of the 6-week study.

What will be done:
If you allow your child to participate, here is what will happen: Before the start of the first lesson the student will complete a demographic survey to obtain information regarding their age, gender, race/ethnicity, height, weight, and the parent's (your) education level. Your child will then use the app once a week in their homeroom classrooms to plan their lunches for the following week. There will also be four observations of the lunches the children bring to school. During these

observations a photograph will be taken of each lunch next to a number identifying the student of whom it belongs. A photograph will also be taken of any nutrient facts labels on the food products within the lunch. In addition, your child will fill out a form in which they record the contents of their lunch. Once the sixth week is completed, your child will complete another survey to determine if his or her overall dietary intake has been affected.

Risk or discomfort:
There are no risks or discomforts recognized in this research study.
Benefits of this study:
Through this study, your child may gain positive lifelong healthy eating behaviors and skills in using smartphone applications to improve health. Your child will also receive a small gift at the start and end of the study.

Confidentiality:
Your child's part in this study is confidential. Any identifiable information will be stored in secured electronic files and in a locked file cabinet.

Decision to quit at any time:
Since the intervention is being conducted during the homeroom class time, your child is encouraged to participate. However, if your child does not wish to participate, myself, their teacher, and your child will discuss other options available. You also have the right to withdraw your child from participating at any time.

Rights and Complaints:
If you are not satisfied with the way this study is performed, you may discuss your complaints with Linda Sebelia: (401) 874-4024, anonymously, if you choose. In addition, if you have questions about your child's rights as a research participant, you may contact the office of the Vice President for Research, 70 Lower College Road, Suite 2, University of Rhode Island, Kingston, Rhode Island, telephone: (401) 874-4328.

You can contact me, Christina Pryor (URI Graduate Student), at (916) 316-2257 or email me at cepryor4@gmail.com with any questions or concerns about the study.

You have read this Permission Form, you agree to pack a lunch from home for your child for the duration of the 6-week study, and all of your questions have been answered.
If you permit your child to participate in this study, please sign below and have your child return it to his or her homeroom teacher.

_____	_____
Signature of Parent	Signature of Researcher
_____	_____
Typed/printed Name of Parent	Typed/printed name
_____	_____
Date	Date

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_____	_____
Signature of Parent	Signature of Researcher
_____	_____
Typed/printed Name of Parent	Typed/printed Name
_____	_____
Date	Date

THE UNIVERSITY OF RHODE ISLAND SNAP Ed

Please sign both consent forms, keeping one for yourself

Control Group

PARENTAL PERMISSION FORM FOR RESEARCH

My name is Christina Pryor and I am a graduate student in nutrition at the University of Rhode Island. Linda Sebelia MS RD is running a research study this fall at Archie R Cole Middle School to learn more about the lunches that 6th graders bring to school every day and to see if the app LaLa Lunchbox is a useful tool for young people. We are inviting you be a part of this project. The details of the project are written below. You should feel free to ask questions

Description of the project:
This 6-week long study evaluates the nutritional quality of lunches brought from home through direct observation. The observations include taking a photograph of the lunch your child has brought to school which will be evaluated later to determine the nutritional value. There will be a total of 4 observations over the length of the study.

In order to be eligible for the study your child must bring their own lunch to school for the duration of the 6-week study.

What will be done:
If you allow your child to participate, here is what will happen: Before the start of the first lesson the student will complete a demographic survey to obtain information regarding their age, gender, race/ethnicity, height, weight, and the parent's (your) education level. There will also be four observations of the lunches your child brings to school. During these observations a photograph will be taken of each lunch next to a number identifying the student of whom it belongs. A photograph will also be taken of any nutrient facts labels on the food products within the lunch. In addition, your child will fill out a form in which they record the contents of their lunch. Once the sixth week is completed, your child will complete another survey to determine if his or her overall dietary intake has been affected.

Risk or discomfort:
There are no risks or discomforts recognized in this research study.
Benefits of this study:
Your child will receive a small gift at the start and end of the study. Also, through this study, we will be able to assess the nutritional quality of lunches brought to school by 6th graders. This information will be compared with an experimental group that is taking part in an iPad nutrition app intervention with the goal of improving nutritional quality of lunches. Your child will have the opportunity to use this app once the 6-week study is over.

Confidentiality:
Your child's part in this study is confidential. Any identifiable information will be stored in secured electronic files and in a locked file cabinet.

Decision to quit at any time:
Since the intervention is being conducted during homeroom class time, your child is encouraged to participate. However, if your child does not wish to participate, myself, their teacher, and your child will discuss other options available. You also have the right to withdraw your child from participating at any time.

Rights and Complaints:
If you are not satisfied with the way this study is performed, you may discuss your complaints with Linda Sebelia: (401) 874-4024, anonymously, if you choose. In addition, if you have questions about your child's rights as a research participant, you may contact the office of the Vice President for Research, 70 Lower College Road, Suite 2, University of Rhode Island, Kingston, Rhode Island, telephone: (401) 874-4328.

You can contact me, Christina Pryor (URI Graduate Student), at (916) 316-2257 or email me at cepryor4@gmail.com with any questions or concerns about the study.

You have read this Permission Form, you agree to pack a lunch from home for your child for the duration of the 6-week study, and all of your questions have been answered.
If you permit your child to participate in this study, please sign below and have your child return it to his or her homeroom teacher.

_____	_____
Signature of Parent	Signature of Researcher
_____	_____
Typed/printed Name of Parent	Typed/printed Name
_____	_____
Date	Date

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_____	_____
Signature of Parent	Signature of Researcher
_____	_____
Typed/printed Name of Parent	Typed/printed Name
_____	_____
Date	Date

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Please sign both consent forms, keeping one for yourself

APPENDIX H – Child Assent Forms

Experimental Group

CHILD ASSENT FORM FOR RESEARCH

My name is Christina Pryor and I am a graduate student in nutrition at the University of Rhode Island. Linda Sebelia MS RD is running a research study this fall at Archie R Cole Middle School to learn more about the lunches that 6th graders bring to school every day and to discover if the app LaLa Lunchbox is a useful tool for young people. We are inviting you be a part of this project. The details of the project are written below. You should feel free to ask questions.

What will be done:

You and your parent or guardian will fill out forms, including a demographic survey. After you bring back this form and the permission form from your parent or guardian with your signatures, you will start a 6-week program playing with an iPad app called LaLa Lunchbox for about a half an hour once a week in your homeroom. This app lets you pick food you would want your parents or guardian to put in your lunchbox for the next week. We will also be taking some pictures of the lunches you bring to school. At the end of the program you will fill out the food frequency questionnaire again.

Risks or discomfort:

This study has no known risks or discomfort.

Benefits of this study:

You may start choosing healthier food to have in your lunches and end up eating better and feeling better. You will receive a small gift at the start and end of the study.

Confidentiality:

No one else will know if you were in the study and no one will find out what answers you gave. We will store all the information about you in a locked file cabinet.

Decision to quit at any time:

You may want to talk this over with your parents or guardian before you decide. The decision to be part of this study is up to you. You can still be part of the program even if you are not part of the study. We will also ask your parents to give their permission for you to take part in this study, but even if your parents say "yes", you can still decide not to do this. If you do decide to participate, you can always drop out of the study at any time. Just let your teacher know or ask one of your parents to call us.

Feel free to ask questions. If you have a question later that you didn't think of now, you can ask your homeroom teacher. If you have questions you or parents may call us at (916) 316-2257 or call the person in charge of the study, Linda Sebelia at (401) 874-4024.

Signing your name at the bottom of this form means that you have read or listened to what it says and you understand it. Signing this form also means that you agree to participate in this study and your questions have been answered. You and your parents will be given a copy of this form after you have signed it.

_____	_____
Signature of participant	Signature of Researcher
_____	_____
Typed/printed Name	Typed/printed Name
_____	_____
Date	Date

Control Group

CHILD ASSENT FORM FOR RESEARCH

My name is Christina Pryor and I am a graduate student in nutrition at the University of Rhode Island. Linda Sebelia MS RD is running a research study this fall at Archie R Cole Middle School to learn more about the lunches that 6th graders bring to school every day, and we are inviting you be a part of this project. The details of the project are written below. You should feel free to ask questions.

What will be done:

You and your parent or guardian will fill out forms, including a demographic survey. After you bring back this form and the permission form from your parent or guardian with your signatures, we will take some pictures of the lunches you bring to school. After 6-weeks, you will fill out the food frequency questionnaire again.

Risks or discomfort:

This study has no known risks or discomfort.

Benefits of this study:

You will receive a small gift at the start and end of the study, and you will be helping us determine what 6th graders are bringing to school in their lunches so we can figure out if a specific nutrition program is effective or not.

Confidentiality:

No one else will know if you were in the study and no one will find out what answers you gave. We will store all the information about you in a locked file cabinet.

Decision to quit at any time:

You may want to talk this over with your parents or guardian before you decide. The decision to be part of this study is up to you. You can still be part of the program even if you are not part of the study. We will also ask your parents to give their permission for you to take part in this study, but even if your parents say "yes", you can still decide not to do this. If you do decide to participate, you can always drop out of the study at any time. Just let your teacher know or ask your parents to call us.

Feel free to ask questions. If you have a question later that you didn't think of now, you can ask your homeroom teacher. If you have questions you or parents may call us at (916) 316-2257 or call the person in charge of the study, Linda Sebelia at (401) 874-4024.

Signing your name at the bottom of this form means that you have read or listened to what it says and you understand it. Signing this form also means that you agree to participate in this study and your questions have been answered. You and your parents will be given a copy of this form after you have signed it.

_____	_____
Signature of Participant	Signature of Researcher
_____	_____
Typed/printed Name	Typed/printed Name
_____	_____
Date	Date

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