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The Effect of Project ProHEART- Promoting Healthy Eating and Activity using Robot-assisted Training- on Healthy Eating Habits and Physical Activity in School-Aged Children

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THE EFFECT OF PROJECT PROHEART- PROMOTING HEALTHY EATING AND ACTIVITY USING ROBOT ASSISTED TRAINING- ON HEALTHY EATING HABITS AND PHYSICAL ACTIVITY IN SCHOOL-AGED CHILDREN

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To: Dean Tomás Guilarte
R. Stempel College of Public Health and Social Work

This dissertation, written by Nadine Mikati, and entitled The Effect of Project ProHEART- Promoting Healthy Eating and Activity using Robot-assisted Training- on Healthy Eating Habits and Physical Activity in School-aged Children, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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DEDICATION

I dedicate this dissertation to my loving family. A special feeling of gratitude to my loving husband, Ali. I couldn’t have done it without your continuous support. My parents, Walid and Majida, have always been there for me for 29 years and counting. Thank you for making me who I am today. I am also very blessed to have two supportive sisters, Mira and Nancy. Thank you all for making all this possible for me and telling me to always follow my dreams! Finally, I want to thank my son who is due to arrive in June. In spite of causing me a lot of morning sickness, you pushed me to finish in time for your arrival. Maybe one day you will read this and be proud of your mommy! I love you all.

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ABSTRACT OF THE DISSERTATION

THE EFFECT OF PROJECT ProHEART- PROMOTING HEALTHY EATING AND ACTIVITY USING ROBOT ASSISTED TRAINING- ON HEALTHY EATING HABITS AND PHYSICAL ACTIVITY IN SCHOOL-AGED CHILDREN

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The objective of this study was to determine the effectiveness of a 6 week afterschool nutrition and physical activity intervention administered by a registered dietitian with the help of a humanoid robot targeting elementary school aged children aged 6-12 years. The study was conducted across four Young Men's Christian's Association (YMCA) sites in Miami-Dade County, Florida (N= 114, Mean age: 8.16 ±1.57 years) using a pretest-posttest quasi-experimental design via randomly assigned intervention (two sites; n=63) and comparison groups (two sites; n=51). The validated Coordinated Approach to Child Health (CATCH) kids club questionnaire and the validated Previous Day Physical Activity Recall (PDPAR) were used to assess nutrition and physical activity knowledge, attitudes/beliefs and behavior change. The Inbody 230 instrument (Biospace, California) was used to calculate body composition and weight. Body Mass Index (BMI) percentiles and associated BMI z-scores for age and gender were calculated based on the Center for Disease Control and Prevention (CDC) growth charts. Data measures were collected at baseline (week 0) and one-week post intervention (week 7). Statistical analysis included independent t-test, paired t-test, chi-squared test, Wilcoxon signed ranks test and logistic regression. Results indicated that nutrition knowledge score significantly increased from 67.43% ±21.03 to 81.31% ±18.47 in the intervention group ($p<0.001$) whereas no significant increase was noted in the comparison group ($p=0.565$). PDPAR also significantly increased in the intervention group ($P<0.001$), however, a significant decrease was shown in the comparison group ($p<0.001$). It was portrayed that children in the intervention group consumed significantly more vegetables ($p=0.043$) and significantly less high fat snacks ($p=0.005$) the previous day than the comparison group post-intervention. Screen time during the week ($p<0.001$) and weekend ($p=0.022$) was significantly less post-intervention in the intervention group when compared to the control. There was no significant change in BMI z-scores pre/post intervention ($p=0.977$). Our findings indicate that this innovative 6-week intervention had promising results with respect to nutrition and physical activity knowledge and behavior change. However, a longer follow-up time would be needed to observe a change in BMI z-scores as well as sustainability of the behavior change.

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ABBREVIATIONS AND ACRONYMS

ASD	Autism Spectrum Disorder
BMI	Body Mass Index
BMIz	Body Mass Index z-score
CATCH	Coordinated Approach to Child Health
CDC	Center for Disease Control and Prevention
FIU	Florida International University
IRB	Institutional Review Board
MET	Metabolic Equivalent
MVPA	Moderate to Vigorous Physical Activity
NHANES	National Health and Nutrition Examination Survey
PDPAR	Previous Day Physical Activity Recall
ProHEART	Promoting Healthy Eating and Activity using Robot-assisted Training
PE	Physical Education
SES	Socioeconomic Status
SPARK	Sports Play and Active Recreation for Kids
U.S	United States
YMCA	Young Men's Christian's Association

CHAPTER I: INTRODUCTION

Prevalence of childhood obesity

Obesity is a major public health concern in the United States (U.S.) that has been associated with an increased incidence of multiple co-morbidities such as cardiovascular disease, type 2 diabetes and cancer (1-5). Therefore, targeting the obesity epidemic earlier in life is crucial. Studies have indicated that childhood obesity has been predictive of adult obesity and it also may increase the risk of obesity-related comorbidities and mortality later in life (6-9).

According to the Center for Disease Control and Prevention (CDC) growth charts, “obesity” in children is defined by a Body Mass Index (BMI) for age and gender, greater than or equal to the 95th percentile whereas “overweight” is defined as having a BMI for age and gender between the 85th and 95th percentile (10). The 2011-2012 National Health and Nutrition Examination Study (NHANES) data (11) portrays that around 16.9% of U.S. children and adolescents aged 2-19 years are obese which remains unchanged from the 2009-2010 data (12). This means 12.5 million girls and boys are classified as obese. Data also shows that the prevalence of overweight and obesity combined in this pediatric population is 31.8% (11). The prevalence of obesity was deemed higher among children aged 6-11 years (17.7%) and adolescents aged 12-19 years (20.5%) than in children aged 2-5 years (8.4%). Additionally, the prevalence of obesity appears to be similar between boys (16.7%) and girls (17.2%) aged 2-19 years (11). It has also been noted that there has been a significant increase in the prevalence of obesity in boys and a non-significant increase among girls from the years 1999-2000 (14% in boys, 13.8% in girls) to the years 2009-2010 (18.6% in boys, 15% in girls) (12).

Data shows that there are race/ethnicity discrepancies in obesity prevalence among youth. The lowest rates of obesity were observed in non-Hispanic Asians (8.6%) compared to non-Hispanic Whites (14.1%, P=0.04), non-Hispanic Blacks (20.2%, P<0.001) and Hispanics (22.4%, P<0.001). Moreover, no significant difference in obesity prevalence was noted between non-Hispanic Blacks and Hispanic youth (P=0.31) (11).

Comorbidities of childhood obesity

Numerous studies have linked childhood obesity to several health related consequences such as type 2 diabetes, metabolic syndrome, high blood pressure, high cholesterol levels, impaired glucose tolerance, non-alcoholic fatty liver disease, asthma and sleep apnea (13-19). It has also been estimated that around 48% of obese children in the U.S. meet the criteria for metabolic syndrome (20). Additionally, there are psychosocial consequences to childhood obesity that have been portrayed in the literature, including low self-esteem, depression, social isolation, discrimination and reduced quality of life (17, 21-24).

Etiology of obesity

Obesity can be caused by a chronic caloric imbalance when a greater amount of calories are consumed than expended daily requirements. However, the etiology of obesity is multifaceted. Other factors that may contribute to obesity include genetics as well as environmental factors such as socioeconomic status (SES), culture, habits and behaviors (17). Polley et al. (25) showed a significant positive association between children and their parents' BMI. Children born to overweight or obese mothers are more prone to become overweight or obese later in life (25). A longitudinal study conducted by Francis et al. (26) illustrated that if a female child has overweight parents, then she will be eight times more likely to become overweight by the age of thirteen. Furthermore, if both parents of a female child are overweight, then that female would experience a greater increase in BMI from 5 to 13 years of age than another female whose parents' are of normal weight (26). Huffman, Kanikireddy and Patel (27) revealed that children originating from single parent households are significantly more overweight than children coming from a two-parent home and that was attributed to having greater familial stress.

Environmental factors such as increased availability of fast food restaurants, higher healthy food prices as well as lack of access to healthy foods such as fruits and vegetables have been positively associated with obesity (28, 29). Lack of physical activity is another factor that may lead to decreased energy expenditure and thus may contribute to the obesity epidemic (17). The 2011 Youth Risk Behavioral Survey showed that about 31% of high school students in the U.S. reported playing with video or computer games for three or more hours per day, during the seven days before the survey (30).

Geographical area of residence has also been linked to rates of obesity. Ohio and Louisiana have shown to have a significantly higher Body Mass Index (BMI) than the national average in males whereas Michigan and Kansas have a significantly higher BMI in females. Colorado, New Mexico and California were noted to have significantly lower BMI than the national average in both males and females (31). Also, low SES in combination with being from a minority racial/ethnic group has been correlated with higher BMI. Living in a low-income neighborhood has also been shown to increase the likelihood of an individual becoming overweight or obese, even after controlling for individual SES (28).

Childhood obesity prevention

One of the solutions to prevent obesity from a public health standpoint would be to emphasize and support positive lifestyle changes with respect to diet and physical activity (32). Teaching children how to eat healthy and promoting physical activity are the main interventions proposed to prevent overweight or obesity (33). Various interventions have been tested for childhood obesity prevention including intervening at the level of the family (home-based), or school setting (34).

Family-based interventions have been shown to be very successful since parents usually provide the conditions for children to select healthy meals and behaviors. However, a lot of parents usually do not understand the need of obesity prevention since they believe that they are healthy and are not willing to change any habits. Also, the biggest limitation in family-based intervention studies is the high dropout rates as well as the small sample size (34- 36).

School-based obesity prevention programs have been portrayed as the most feasible and effective interventions since children are present at school all day. However, few studies have assessed the effect of their intervention on anthropometric indices (37-39). Involving teachers and peers can be a motivating factor that the children enjoy. These interventions usually target a large number of children by implementing nutrition education and physical activity through structured programs. However, these programs are typically short in duration due to lack of time during school hours and competing demands of standardized testing. Furthermore, teachers might lack the knowledge or might not feel equipped to give out nutrition education to children (34, 37, 40, 41).

Afterschool program interventions

School-based obesity prevention interventions have been shown to be the most effective, however, programs delivered in the afterschool hours have shown a greater potential for success since they have more time allocated for that purpose. Nowadays, schools have been focusing their energy on testing scores and have limited time to incorporate other material into the curriculum during school hours. Also, trained professionals such as nutritionists and dietitians are administering the interventions, who are more knowledgeable in obesity prevention than school teachers (42-44).

A review of the literature (43-52) regarding after-school obesity prevention programs shows mixed findings. A 12-week (12 session) after-school program intervention was conducted by Wofford et al. (44) that only enrolled African American children irrespective of weight status (20 boys and 13 girls aged 6-11 years old). Lessons targeted increasing water intake, as well as fruit and vegetable consumption; increasing physical activity and decreasing sweetened beverage intake. Results of this study indicated that children were able to increase health knowledge, decrease the consumption of sugary beverages and increase in overall physical activity time. However, no significant change was observed in BMI percentiles for age or gender (44). On the other hand, Sacher et al. (45) delivered a 9-week (18 sessions) intervention to children (mean age 10 years, mainly girls) but also involved their parents/caregivers in the process. Nutrition education sessions focused on healthy eating tips, reading food labels as well as other lessons to target dietary behaviors. Families were also involved in a guided supermarket tour and provided with healthy recipes. Some sessions also included how to prepare healthy meals and snacks with food sampling as well. Moreover, behaviors sessions targeted behavioral techniques such as stimulus control, goal setting and re-enforcement. Physical activity sessions included exercise techniques that focused on non-competitive group play. No difference in percent body fat was noted. However, children in the intervention group significantly reduced their waist circumference as well as BMI z-scores when compared to the controls. This suggests that involving the parents/caregivers in the process may lead to a favorable outcome (45).

Another intervention study including a parental component was conducted by Choudhry et al. (43). This intervention included 14 weekly sessions targeting African American children (16 boys, 24 girls) aged 5 to 12 years old. The results showed that parental attendance to the sessions was low, however, BMI z-scores for girls decreased significantly, with no significant change for boys. Nevertheless, the prevalence of healthy attitudes significantly increased in both genders (43). Additionally, Topp et al. (46) implemented an afterschool program that targeted African American children aged 5-10 years. This study also included a family component. Thirty-seven sessions were given over a 14-week period. The intervention consisted of three weekly 90-min after school sessions conducted for 14 weeks (Total 37 sessions). Two of the weekly sessions involved track and field activities while the third session consisted of a 45-minute nutrition education module followed by a group physical activity such as soccer, freeze tag, dodge ball, etc. The sessions included videos as well as nutrition activities such as keeping food diaries. Furthermore, children were instructed on food groups, high fat food items to avoid, reading food labels, identifying fruits, vegetables and sources of calcium. Homework was given at times for the child to take home and complete with the parent. Results of this study indicated that there was no significant change in BMI or percent body fat. Yet, there was a trend toward improving their food habits. There was a low completion of nutrition homework rates (46). Therefore, in both aforementioned studies (43, 46), males' BMI z-scores did not significantly change, but only Choudhry et al. (43) was able to show a significant decrease in female BMI z-scores; and in both studies, parental involvement was low (43, 46). Moving on, De Heer et al. (47) conducted a 24-session (12 week) after-school health promotion program on Hispanic elementary school children (mean age 9.2 years). However, no significant changes were observed in BMI in the intervention or control group. Participants experienced slight improvements in aerobic capacity as well as dietary outcomes (not significant). The interesting finding in this study was that non-participants who had classroom contact with program participants experienced health improvements (47).

Improving children's intake of fruits and vegetables is an integral goal of obesity prevention programs (34). A 17-session childhood obesity prevention program conducted by Struempler et al. (48) showed that there were significant increases in fruit and vegetable intake in the intervention group as compared to the control group. Study participants were predominately black, third grade participants. Six nutrition topics were taught: trying new foods, food groups, balanced meals, food nutrients, healthy snacks as well as fruits and vegetables. The intervention constituted traditional lessons followed by a non-traditional re-enforcement session the week after the intervention with iPad applications. The findings also showed that black students reported significantly higher intake (3.45 and 4.94 respectively) of fruits and vegetables, compared with non-black students (3.16 and 4.68 respectively) ($P<0.05$) (47). Iverson, Nigg and Titchenal (49) implemented a nutrition and physical activity intervention in six public schools to children in fourth to sixth grade. The nutrition intervention highlighted fruit and vegetable intake and encouraged positive eating habits. The program also contained a physical activity component, which required all children to actively engage in movement. No significant difference was noted in fruit and vegetable intake ($P=0.78$), physical activity ($P=0.37$) and BMI-for age ($P=0.97$) from baseline to post-intervention. However an "at risk" sub-population was identified that consumed < 5 servings of fruits and vegetables per day, underwent <300 minutes of physical activity per week or had a BMI for age of $\geq 85^{th}$ percentile at baseline. This sub-population had a significant increase in fruit and vegetable intake as well as physical activity ($P\leq 0.01$). However, no changes were observed in BMI for age for the at risk population ($P=0.2$) (49).

Multi-year after-school interventions have been performed as well. Chomitz et al. (50) was able to follow a cohort of children for three years due to a collaborative intervention between the public schools, the public health department as well as the community in order to provide policy support for healthy food choices and lifestyles. Demographics of the sample included: 37% African-American, 37% white, 15% Hispanic and 10% Asian (62% minority population combined). Mean age was 7.7 years old and there were no significant differences between number of males or females. After stratified analysis, the prevalence of obesity decreased significantly by 2.2% ($P < 0.05$), particularly among higher income children and females (50). Another 3-year afterschool project conducted by Dzewaltowski et al. (51) included children with mean age of 9 years. Behavioral goals of this study were to be physically active (at least one hour per day), to eat fruits and vegetables at every meal, to drink less soda and juice, to drink more water and cut back on TV and video games to a maximum of 2 hours per day. However, no data on race or ethnicity were given in this study. Results revealed no change in BMI z-scores in the intervention group. However, a trend was noted in BMI z-scores where change was predominately observed in girls and not boys (51).

Long-term sustainability of an after-school intervention was tested by Freedman and Nickell (52). They conducted an afterschool intervention in a library setting where participants were mainly of minority ethnicities (32% Asian, 29% Hispanic, 2% African American, and 12% white). Program focused on consumption of 5-a day of fruits and vegetables, description of “MyPyramid” as well as consumption of healthy foods, beverages and snacks. Significant changes were obtained post-intervention in milk, vegetable and water intake. However, only increased water intake was sustained for 3-4 months post-intervention (52).

According to the studies reviewed (43-52), multi-media or group childhood obesity prevention programs that include a nutrition and physical activity component were able to increase health knowledge in elementary school aged children. However, different interventions had different effects on BMI and adiposity indices such as percent body fat as well as dietary habits such as fruit and vegetable intake. Conflicting evidence exists regarding the effect of program length, ethnicity, gender and socioeconomic status on the outcomes of the childhood obesity prevention studies. Thus, more research is needed in this area.

The humanoid robot NAO

NAO is a 58-cm tall humanoid robot that can talk, walk, catch small objects, dance and do multiple programmable operations. The robot also has face recognition and can listen to children and respond to certain questions. The robot has been in the market since 2006 and is continuously being updated. This robot is currently being used in over 70 countries worldwide. They are used in schools and incorporated in computer and science classes, from primary school through to university (53).

Humanoid robots and specifically the NAO robot have been used in the literature to help children with Autism Spectrum Disorder (ASD). Robotic technology has been applied to stimulate interest and attention in children suffering from ASD (54-56). Blanson et al. (57) has used the NAO robot in a pilot study along side clinicians to help with health education in children aged 8-12 years suffering from type 1 diabetes mellitus. NAO was used to engage in “small talk” with the children as well as measure diabetes knowledge by quizzing them. The results of this study indicated that children improved health literacy, were interactive with the robot and enjoyed the sessions (57).

Kahn et al. (58) tested the social and moral relationships that children can form with humanoid robots in the presence of a researcher. Participants were ages 9, 12 or 15 years. Results showed that the younger children (9 and 12 year olds) were able to portray the robot as a mental, social and partly moral other and at a greater extent than what the

15-year olds imagined. This study concluded that several children could develop extensive relationships with humanoid robots (58).

Since the results of the aforementioned pilot studies (57, 58) are promising, introducing interactive robots to nutrition education targeting children alongside a dietitian is an area that needs to be explored further. Innovative tools and sessions targeting obesity prevention should be developed for this young population.

This literature review suggests that nutrition education sessions should include videos, games, activities as well as lectures that focus on behaviors. Session topics my include increasing fruit and vegetable consumption, increasing water intake, decreasing soft drinks as well as juice beverages (sweetened beverages), decreasing high fat foods, decreasing sugary foods, increasing fiber intake, increasing calcium intake, learning the food groups, understanding MyPlate, preparing healthy snacks, reading food labels and learning how to choose healthy meals in and outside of home. Physical activity interventions should include group activities such as ball catching, throwing, jump rope, dance and sports (at least one hour per day) that target cardiovascular fitness. Children should also cut back on screen time (TV and video games) to a maximum of 2 hours per day and increase physical activity instead (43-52).

Innovative and novel childhood obesity prevention programs should be developed and tested for effectiveness. Incorporating a humanoid robot into an intervention is one method that could be used in order to help motivate the children, act a as a role model or even grasp their attention throughout the duration of the session.

Specific Aims and Hypotheses

Specific Aim 1

To determine whether a 6 week, 12-session after-school intervention with a registered dietitian and a humanoid robot is effective in improving nutrition knowledge, attitudes and behaviors (comparing post-intervention to baseline).

Hypothesis 1

1a. Mean nutrition knowledge will be significantly greater post-intervention as compared to baseline in the intervention group at the end of a 6 week intervention as measured by the CATCH kids club questionnaire.

1b.The intervention group will have a significantly greater intake of fruits and vegetables post-intervention as compared to baseline at the end of a 6 week intervention as measured by the CATCH kids club questionnaire.

1c.The intervention group will have a significantly less intake of unhealthy snacks post-intervention as compared to baseline at the end of a 6 week intervention as measured by the CATCH kids club questionnaire.

1d. Mean positive change in nutrition attitudes will be significantly greater in the intervention group post-intervention as compared to baseline as measured by the CATCH kids club questionnaire.

Specific Aim 2

To determine whether a 6 week, 12-session after-school intervention with a registered dietitian and a humanoid robot is more effective in improving nutrition knowledge, attitudes and behaviors than the comparison groups (comparing intervention and comparison groups).

Hypothesis 2

2a. Mean nutrition knowledge change will be significantly greater in the intervention group as compared to the comparison group at the end of a 6 week intervention as measured by the CATCH kids club questionnaire.

2b.The intervention group will have a significantly greater intake of fruits and vegetables as compared to the comparison group at the end of a 6 week intervention as measured by the CATCH kids club questionnaire.

2c.The intervention group will have a significantly less intake of unhealthy snacks as compared to the comparison group at the end of a 6 week intervention as measured by the CATCH kids club questionnaire.

2d. Mean positive change in nutrition attitudes and behavior will be significantly greater in the intervention group compared to the comparison group as measured by the CATCH kids club questionnaire.

Specific Aim 3

To determine whether a 6 week, 12-session after-school intervention with a registered dietitian and a humanoid robot is effective in improving physical activity, attitudes and behaviors (comparing post-intervention to baseline).

Hypothesis 3

3a. Screen time (time spent watching TV, playing on the computer or video games) will be significantly less in the intervention group, post-intervention as compared to baseline as measured by the CATCH kids club questionnaire.

3b.The intervention group will have a significantly greater previous day physical activity score. post-intervention as compared to baseline as measured by the Previous Day Physical Activity Recall (PDPAR).

3c. Mean change in physical activity attitudes will be significantly greater in the intervention group, post-intervention as compared to baseline as measured by the CATCH kids club questionnaire.

Specific Aim 4

To determine whether a 6 week, 12-session after-school intervention with a registered dietitian and a humanoid robot is more effective than the comparison groups in improving physical activity knowledge, attitudes and behaviors (comparing intervention and comparison groups).

Hypothesis 4

4a. Screen time (time spent watching TV, playing on the computer or video games) will be significantly less in the intervention group, post-intervention as compared to the comparison group as measured by the CATCH kids club questionnaire.

4b.The intervention group will have a significantly greater previous day physical activity score, post-intervention as compared to the comparison group as measured by the Previous Day Physical Activity Recall (PDPAR).

4c. Mean change in physical activity attitudes will be significantly greater in the intervention group, post-intervention compared to the comparison group as measured by the CATCH kids club questionnaire.

Specific Aim 5

To determine whether a 6 week, 12-session after-school intervention with a registered dietitian and a humanoid robot will maintain BMI z-scores and percent body fat compared to the comparison group and baseline measurement.

Hypothesis 5

5a. Participants will not have significantly different BMI z-scores and percent body fat as compared to baseline at the end of the 6 week intervention (a trend towards significance is expected) as measured via direct measurement.

5b. Participants in the intervention group will not have significantly different BMI z-scores and percent body fat then the comparison group by the end of the 6 week intervention (a trend towards significance is expected) as measured via direct measurement.

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CHAPTER II: THE EFFECT OF PROJECT ProHEART- Promoting Healthy Eating and Activity using Robot-assisted Training- ON NUTRITION KNOWLEDGE AND BEHAVIOR

Introduction

Obesity is a major public health concern in the U.S. that has been associated with an increased incidence of multiple co-morbidities such as cardiovascular disease, type 2 diabetes and cancer (1-5). Therefore, targeting the obesity epidemic earlier in life is crucial. Studies have indicated that childhood obesity has been predictive of adult obesity and it also may increase the risk of obesity-related comorbidities and mortality later in life (6-9).

Research has shown that intervention strategies targeting children before transitioning into adolescence are imperative (10). The children in this age group (6-12 years old) are beginning to gain more independence and hence are forming their own food and physical activity behaviors and attitudes (10). Based on the Cochrane review of childhood obesity prevention programs, successful interventions were especially noted in the 6-12 year old age group (11). However, other systematic reviews (12, 13) found that there is insufficient to moderate evidence supporting the effectiveness of school-based interventions. Therefore, more research is needed to test interventions utilizing innovative designs and approaches.

School-based obesity prevention interventions have been shown to be the most effective since children are present at school all day; however, programs delivered in the after-school hours have shown a greater potential for success (14-16). Moreover, involving peers can be a motivating factor that the children enjoy. School-based interventions usually target a large number of children by implementing nutrition education and physical activity through structured programs. However, these programs are typically short in duration due to lack of time during school hours and competing demands of standardized testing. Furthermore, teachers might lack the knowledge or might not feel equipped to give out nutrition education to children (12, 17). Therefore, after-school based obesity prevention programs delivered via nutritionists/dietitians should be explored further for effectiveness. Ways to improve the current interventions should be developed in order to enhance health-related outcomes in school children. Also, innovative techniques should be incorporated into these programs to get the children more motivated. One novel intervention could be through the incorporation of a humanoid robot as a role model and assistant to the dietitian during the intervention sessions. The literature seems to lack original and effective after-school intervention programs targeting nutrition in elementary children (16-20).

The humanoid robot, NAO, is a 58-cm tall humanoid robot that can talk, walk, catch small objects, dance and do multiple programmable operations. The robot also has face recognition and can listen to children and respond to certain questions. The robot has been in the market since 2006 and is continuously being updated. This robot is currently being used in over 70 countries worldwide. They are used in schools and incorporated in computer and science classes, from primary school through to university (21). Robotic technology, specifically humanoid robots, has been studied and applied to stimulate interest and attention in children suffering from Autism Spectrum Disorder (22-24). However, to our knowledge, there has been no study published that uses a humanoid robot as an assistant to the dietitian in an after-school program targeting childhood obesity prevention. We assume that the robot will motivate the children to be more participative during the after-school program and prompt them to learn more. Our purpose is to provide a fun environment for learning that is different from the regular teacher/classroom, or after-school program experience. Moreover, we are involving a registered dietitian in this study as the nutrition expert instead of the regular classroom teacher who might not be familiar or comfortable giving this material. After examining the results of this study, we may be able to create training sessions and manuals to train school staff/teachers who might be able to give the intervention themselves and thus maintaining sustainability of the program.

Research has illustrated that childhood obesity interventions should target increasing physical activity, decreasing screen time, increasing the intake of fruits and vegetables as well as decreasing sugar-sweetened beverages (16-19). Therefore, an innovative program that targeted these outcomes along with the use of robotic technology was devised. The aim of the present study was to determine whether PROJECT ProHEART- Promoting Healthy Eating and Activity using Robot-assisted Training- is effective in improving nutrition knowledge, attitudes and behaviors at the end of a 6 week intervention. This paper will only examine the nutrition outcomes of this intervention; physical activity related outcomes will be presented elsewhere. We hypothesize that this intervention will lead to an improvement in nutrition knowledge and healthy eating behavior.

Methods

Subject Recruitment

An intervention study using a pretest-posttest quasi-experimental design (intervention and comparison groups) was conducted. A convenience sample was obtained from four locations of the Young Men's Christian's Association (YMCA) that currently offers afterschool programs in Miami-Dade County, Miami, Florida. Currently, the YMCA is the nation's largest not-for-profit community service organization whose mission is to offer programs that build healthy spirit, mind, and body for all. Their impact focuses on youth development, healthy living and social responsibility. There are currently over a hundred afterschool programs offered by the YMCA in Miami-Dade, Broward and Monroe counties combined (25).

The study consisted of two phases: phase one included the screening of individuals; while phase two included the recruitment of individuals who met the inclusion/exclusion criteria. Eligibility criteria included being between the ages of 6 and 12 years, enrolled at one of the four participating YMCA locations in Miami-Dade County, English proficiency and both genders were included in the study. Exclusion criteria were recent surgery that may hinder physical activity, physical or mental disability such as autism, blindness or amputation, diagnosed with cancer or suffering from an untreated chronic disease such as uncontrolled diabetes, heart disease and/or joint problems that would be a barrier to physical activity. Assessments at all sites took place on week prior to the start of the intervention (week 0) and one week post-intervention (week 7). The time span between screening and baseline was one week. The study commenced in March 2015 and was completed in May 2015.

A recruitment flyer explaining the purpose of the study, inclusion/exclusion criteria and the investigators' emails and phone numbers were distributed to all children in the four participating YMCA locations. If interested, parents/guardians were asked to approach the staff on site, or call/email the contact person on the flyer. An in person or over the phone screening to determine child eligibility was conducted. If the child met the inclusion/exclusion criteria, then an appointment was scheduled for informed consent and assent. Informed consent was obtained from one parent/legal guardian as well as child assent was obtained prior to enrollment in the study. Confidentiality measures were taken at all times during the study and participants were notified that any information provided would remain confidential. This study was approved by the Institutional Review Board at Florida International University.

After recruitment, each of the four participating YMCA sites was randomly assigned to one of two groups: intervention or comparison group. The comparison group consisted of children (n=51) from two locations that followed the regular after-school program that the YMCA offers Monday to Friday; no nutrition or physical activity intervention was given. Whereas, the intervention group consisted of children (n=63) enrolled in two other YMCA locations that received nutrition and physical activity education from a registered dietitian and a humanoid robot "NAO" (Aldebran robotics; Paris, France), two days per week for a total of 6 weeks. Thus, in total, 12 intervention sessions were offered and each session was one hour in length. Moreover, participants continued their regular YMCA afterschool program on the other three days of the week.

One hundred and nineteen participants were screened. One hundred and fourteen qualified for the study based on the inclusion/exclusion criteria set and were assessed at baseline: n=63 in the intervention group and n=51 in the comparison group. One participant in the comparison group and 8 participants in the intervention group withdrew after the baseline assessment due to no longer being enrolled at the YMCA. Thus, 105 participants were assessed post-intervention (week 7): n=50 in the comparison group and n=55 in the intervention group. An intent to treat approach was followed, and thus all 114 participants were included in the present study.

Intervention sessions

The intervention sessions targeted nutrition and physical activity education via lectures, games and interactive activities given by the dietitian and NAO. They consisted of 20-25 minutes of discussion, information and interaction about the topic of the week followed by 35-40 minutes of a hands-on activity to meet the learning objectives of that session (i.e. games). Topics that were addressed included: Introduction to food groups, my plate, nutrients and health, 5 a day of fruits and vegetables, portion control, reading food labels, the importance of breakfast, healthy versus unhealthy snacking, increasing physical activity, drinking water versus other sugary beverages, increasing fiber and calcium intake as well as decreasing high fat and sugary foods. Sessions were designed based on the Social Cognitive Theory constructs that focus on the concept that a behavior and knowledge of an individual can be directly related to the observation and replication of other's behavior (26, 27). The use of social cognitive theory in health promotion and nutrition interventions has been supported in the literature (28-33). The registered dietitian and the humanoid robot, NAO, were acting as the role models. Moreover, the participants were given the knowledge and skills required to carry out and repeat a desired behavior through lectures, discussions, activities and handouts. Each session, the children would set a goal to achieve by next session based on the topic at hand. If the subject achieved this goal, they were provided with a positive reinforcement such as a small gift and a "way to go" certificate. After each session, pamphlets summarizing recommendations of that session with examples where provided in order to be given to parents/guardians. Additional resources/ tools were provided to the children to take home such as portion size figures and pedometers. All subjects received a certificate of achievement at the end of the study.

Measures

After screening and consent, participants' parent/guardian was asked to complete the standard socio-demographic questionnaire on site at baseline (week 0). A trained interviewer administered the questionnaire in order to collect the data. Information collected included socio-demographic variables such as child's gender, race/ethnicity, age/birth date, grade level, first language spoken at home as well as annual household income.

The validated CATCH (Coordinated Approach to Child Health) Kids club questionnaire was used at baseline (week 0) and post-intervention (week 7) to assess the impact of the intervention on the children's nutrition knowledge, attitudes and behaviors (34, 35). This 51-item questionnaire took approximately 30 minutes to complete and contained questions on the previous day's eating behaviors, food attitudes and behaviors as well as a nutrition knowledge test.

Statistical analysis

The independent variable of interest is the treatment group. Children in the randomized sites not receiving intervention where considered as the comparison group;

while children in randomized sites receiving the 6 week intervention where considered as the intervention group. Dependent variables being tested were derived from the CATCH kids club questionnaire that included nutrition knowledge score, nutrition attitudes and beliefs as well as nutrition behavior variables such as high fat snacking, fruit/vegetable intake and healthy eating habits.

Baseline differences between intervention and comparison schools were assessed. Descriptive statistics were used for baseline characteristics. Continuous normally distributed data (age) was compared using an independent t-test since age is a continuous, normally distributed variable and we aimed at comparing independent measures between two groups. Categorical data was compared via a chi-squared test; Fisher's exact test was used if cell count was less than 5. Intent to treat analysis was used to include those lost to follow-up post-intervention. A paired t-test was used to determine differences pre- and post- intervention in the nutrition knowledge score (repeated measure, continuous data) within each group while a Wilcoxon signed-rank test was used as a non-parametric statistical test to compare two repeated measurements on categorical data derived from the CATCH kids club questionnaire within a single sample (i.e. between intervention at baseline and intervention post-test; between comparison at baseline and comparison post-test). Logistic regression was used since the dependent variables derived from the CATCH kids' club questionnaire are categorical. The regression analysis predicted the odds of a certain behavior occurring in the intervention group versus the comparison group. Regression analysis was controlled for age, gender, race/ethnicity and baseline measurement where applicable.

Significance was set at $p<0.05$ and all analyses were two sided. Statistical analysis was conducted using SPSS 21.0 (Chicago).

Results

Baseline demographic characteristics

The baseline demographic characteristics are summarized in Table 1. The intervention and comparison groups were significantly different based on ethnicity, P=0.015, in spite of the fact that the majority of the participants in both groups were Hispanic/Latino (35.3% in the comparison group and 58.7% in the intervention group). Also, most of the subjects reported English was their first language spoken at home (92.2% vs. 69.8%, P=0.005 for comparison and intervention groups; respectively). However, there was no significant difference between the groups at baseline with regards to age (Mean: 8.16 ±1.57 years, P=0.091), gender (P=0.061), grade level (P=0.287) or annual household income (P=0.103).

Nutrition knowledge

A paired t-test (data not shown in table) of the nutrition knowledge score (mean percentage correct) indicated that the intervention group had a significant increase of 13.88% post-intervention, P<0.001 (increase from 67.43% to 81.31%). The comparison group had a 1.99% non-significant increase post-intervention, P=0.565 (increase from 60.73% to 62.72%).

Nutrition behavior

Analysis of participants' high fat snacking nutrition behaviors are summarized in Tables 2 and 3. A chi-squared analysis revealed that there was no significant difference in high fat/sugar snacking between the groups at baseline, except in French fries/chips intake where the comparison group had a higher intake (P=0.023). However, post-intervention, the intervention group reported consuming significantly less high fat/sugary snacks such as French fries/chips (P=0.001), sweet rolls, donuts, cookies, brownies, pie or cake (P=0.005) than the comparison group (Table 2). However, when comparing high fat/sugar snacking by treatment group (Table 3), a Wilcoxon signed-ranks test indicated that post-test, neither group had a significant change in high fat/sugar snacking compared to baseline.

Results of fruit and vegetable intake are shown in Table 4. There was no significant difference at baseline between the groups except in 100% fruit juice consumption where the comparison group had significantly more fruit juice intake than the intervention (P=0.006). Post intervention, both groups increased the consumption of 100% fruit juice, but the comparison group had a significantly higher intake in this category (P=0.021). Both groups also increased fruit intake, however, no significant differences were noted between the two groups. On the other hand, vegetable intake in the intervention group increased significantly when compared to the comparison group (P=0.043), which had a decrease in vegetable intake compared to baseline. When comparing fruit and vegetable intake by treatment group (Table 5), results indicate that post-test the intervention group showed a significant increase in vegetable intake (P<0.001) compared to baseline, while no significant change was seen in the comparison group post-test (P=0.105). Also, the intervention and comparison groups depicted a significant increase in consumption of fruit post-test (P<0.001 and P=0.018, respectively) compared to pre-test; however, the intervention group did have a greater increase. No significant differences were noted for 100% juice consumption post-test when analyzed by treatment group.

Table 6 compares the self-reported healthy eating habits of the subjects pre- and post-test. Post intervention, participants in the intervention group reported a significantly greater habit of reading nutrition labels (P=0.027), consuming high fiber cereal (P=0.024), choosing to eat vegetables during dinner (P=0.032), drinking low fat milk instead of whole milk (P<0.001) and choosing to eat cooked vegetables without added butter (P=0.009) than those in the comparison group with no significant differences observed for these categories pre-test. At baseline, the intervention group reported consuming significantly less popcorn with butter versus without (P=0.022), chose a fresh fruit over a candy bar (P=0.033), selected a baked potato over French fries (P=0.005) and preferred a grilled chicken sandwich over a hamburger (P=0.004). Post-intervention these differences further increased (P<0.001) for all of the categories mentioned above. More children in the intervention group reported to consume frozen yogurt over regular ice cream at baseline (P=0.004) and that trend was maintained post-intervention (P=0.009).

The results of a Wilcoxon signed-ranks test intended to compare the reported healthy eating nutrition behaviors by treatment group (post-test versus pre-test) are shown in Table 7. Results illustrate that post-test the intervention group, compared to baseline, showed a significant increase in self-report of reading nutrition labels on food packages (P=0.004), while no significant difference was noted in the comparison group. Also, significantly more children in the intervention group post-test reported consuming the healthier version of items than at baseline. They reported to consume popcorn without butter (P<0.001), low fat/skim milk (P<0.001), fruit for a snack (P=0.005), chicken without the skin (P=0.033), baked potato (P=0.005), vegetables with no added butter (P=0.001) and a grilled chicken sandwich (P=0.001) rather than their calorie-dense counterparts. No significant changes were noted in the comparison group post-test when compared to baseline in the aforementioned categories. Also, a trend towards significance was shown in the intervention group only post-test with regards to reporting eating whole wheat bread (P=0.051) or fruit during lunch (P=0.06) compared to baseline. Children in the comparison (P=0.024) and intervention groups (P=0.007) reported eating significantly more high fiber cereal post-test than at baseline. Moreover, participants reported consuming low fat ice cream or frozen yogurt instead of regular ice cream which was significant post-test in the comparison group (P=0.033) compared to pre-test; however, a trend towards significance was noted in the intervention group (P=0.059). No significant differences were noted in either group post-test with regards to 100% fruit juice consumption or consuming vegetables during dinner.

Nutrition attitudes and beliefs

Changes in nutrition attitudes and beliefs are shown in Table 8. There were no significant differences between the groups at baseline except in the question “the foods that I eat and drink now are healthy”; more subjects in the intervention group at baseline believed that the foods they consumed are healthy (P=0.018). No significant difference was noted post intervention for this category. There was a significant increase in the intervention group and a decrease in the comparison group post-intervention that believed “one should consume 5 a day of fruits and vegetables” (P=0.001). Moreover, children in the intervention group post-test where more likely to order a grilled chicken sandwich at a fast food restaurant instead of ordering a hamburger (P=0.017). All other categories were not significant post-intervention.

Odds ratios

Table 6 shows the odds ratios of various food items that the participants reported choosing post-test in both groups, controlling for ethnicity, age and gender. Results indicated that the odds of selecting popcorn with butter as a snack versus no butter (OR=0.14; P<0.001), choosing whole milk to drink instead of low fat milk (OR=0.14; P<0.002), picking a candy bar as a snack versus a fresh fruit (OR=0.13; P=0.003), eating French fries instead of baked potato (OR=0.16; P=0.001) and choosing a hamburger in place of a grilled sandwich (OR=0.14; P=0.001) were significantly less for subjects in the intervention group compared to the comparison group at post-test. Moreover, participants in the intervention group reported that they were 5.68 times (P=0.006) more likely to have cooked vegetables without butter instead of with butter than subjects in the comparison group post-test. The odds of choosing chicken with or without the skin or choosing frozen yogurt or ice cream were not significantly different between the groups.. Males, in the intervention group, were less likely (OR=0.225; P=0.026) to choose a hamburger over a grilled chicken sandwich than females in the same group. No significant ethnicity differences were noted in the results of this questionnaire. In summary, participants in the intervention group were more likely to eat popcorn without butter, drink low fat milk, have a fresh fruit as a snack, eat baked potato instead of French fries, eat cooked vegetables without butter as well as choose a grilled chicken sandwich as a meal instead of a hamburger.

Attendance

Average participant attendance to the intervention sessions was 64%. Above mentioned variables were analyzed for those that attended 80% or more of the sessions. However, no differences were noted in the aforementioned results and thus were not reported.

Discussion

Our intervention targeted children aged 6 to 12 since it has been shown that as students move from elementary and middle school to high school, their consumption of breakfast, fruits, vegetables, and milk decreases (10). Thus, this pre-adolescent age group is important to intervene in, to help children form healthier eating habits as they progress to adulthood.

A 12-session nutrition intervention with a humanoid robot and a registered dietitian significantly increased nutrition knowledge as well as enhanced overall healthy eating behavior by significantly decreasing high fat/sugary food items, increasing vegetable intake and by improving the majority of healthy food/ snack choices. Overall, the intervention group was making healthier choices than the comparison group by selecting items with less fat and/or added sugar. This study helps address the shortage of published research on childhood obesity specifically among minority populations since our study population was comprised of 55% Hispanics and 22% African Americans.

Our overall results are supported by the literature. Wofford et al. (16), Choudhry et al. (15), Freedman and Nickell (30) as well as Struempler et al. (36) also conducted afterschool nutrition intervention programs targeting healthy eating attitudes that were able to improve overall health knowledge, increase fruit and vegetable intake and decrease sweetened beverage consumption (15, 16, 30, 36).

Nevertheless, the literature also shows conflicting results with regards to after-school interventions where not all interventions lead to significant desirable outcomes. Topp et al. (37) implemented an afterschool nutrition program that found no significant change in food habits. Iverson, Nigg and Titchenal (38) implemented an after school nutrition and physical activity intervention that showed no significant difference in fruit and vegetable intake (P=0.78) from baseline to post-intervention. For this reason, a novel afterschool nutrition program, which we conducted, was needed to address these inconsistencies in data.

Our study has several strengths. First, the study design included a comparison group, which is lacking in most of the after-school programs published (15, 16, 30, 31, 36-39). Second, we were able to randomize sites to comparison or intervention groups. Third, the two groups were very close in sample size (51 in the comparison group and 63 in the intervention group). Fourth, we only lost nine participants post intervention (one in the control and eight in the intervention) due to no longer being enrolled in the YMCA. Fifth, to our knowledge, this is the first study that incorporates a humanoid robot along with a registered dietitian into an after-school nutrition intervention. Humanoid robots and specifically the NAO robot have been used in the literature to help children with Autism Spectrum Disorder (ASD). Robotic technology has been applied to stimulate interest and attention in children suffering from ASD (22-24). Blanson et al. (40) has used the NAO robot in a pilot study to help with health education in children aged 8-12 years suffering from type 1 diabetes mellitus. NAO was used to engage in "small talk" with the children as well as measure diabetes knowledge by quizzing them. The results of this study indicated that children improved health literacy, were interactive with the robot and enjoyed the sessions (40). Introducing interactive robots to healthcare education is an area that needs to be explored further, but the results of this pilot study are promising. Kahn et al. (41) tested the social and moral relationships that children can form with humanoid robots. Participants were ages 9, 12 or 15 years. Results showed that the younger children (9 and 12 year olds) were able to portray the robot as a mental, social and partly moral other and at a greater extent than what the 15-year olds hypothesized. Kahn et al. (41) also concluded that several children could develop extensive relationships with humanoid robots.

Limitations of our study included that we were only able to obtain a convenience sample from the YMCA that might lead to selection bias. Also, there was an imbalance in baseline characteristics for ethnicity with the intervention group having significantly more Hispanics/Latinos and less blacks/African Americans than the comparison group which might have affected the comparability of the results. A longer follow-up time may be needed in order to observe if results were sustainable long-term. Although pamphlets summarizing recommendations were sent after each session to parents/guardians, there was no measure of whether or not they were reading them or complying with recommendations. Additionally, participant attendance to the intervention sessions was low (average: 64%), but it did not seem to affect the results. Furthermore, there is always a bias in reporting when including self-reported questionnaires. Lastly, we did not reach our sample goal of 120 (sample size was 114) for our main hypothesis, which decreased our power to 75%. But, we did achieve a power of 99.9% for our secondary hypothesis (difference between two dependent means, matched pairs).

Finally, our results suggest that project ProHEART was successful in improving nutrition knowledge and promoting healthy nutrition behavior and habits in elementary children aged 6-12. However, a longer follow-up time and including a more hands-on family component are needed to confirm these results.

Table 1. Baseline demographic characteristics by treatment group (N=114)

Characteristic	**Comparison Group**	**Intervention Group**	**P-Value**
	n=51	**n=63**	
Age in years Mean (SD)	8.16 (1.57)	8.69 (1.68)	0.091
Race/Ethnicity Percentage (n)			0.015*
White	27.5 (14)	25.4 (16)	
Black/African American	31.4 (16)	9.5 (6)	
Hispanic/Latino	35.3 (18)	58.7 (37)	
Other	5.8 (3)	6.4 (4)	
Gender Percentage (n)			0.061
Male	66.7 (34)	49.2 (31)	
Female	33.3 (17)	50.8 (32)	
Grade Percentage (n)			0.287
Kindergarten	17.6 (9)	14.3 (9)	
1st grade	31.4 (16)	20.6 (13)	
2nd grade	17.6 (9)	14.3 (9)	
3rd grade	7.9 (4)	17.5 (11)	
4rth grade	19.6 (10)	17.5 (11)	
5th grade	5.9 (3)	15.8 (10)	
First language spoken at home Percentage (n)			0.005*
English	92.2 (47)	69.8 (44)	
Spanish	3.9 (2)	27 (17)	
Other	3.9 (2)	3.2 (2)	
Annual household income Percentage (n)			0.171
<=$50,000	41.2 (21)	28.6 (18)	
> $50,000	58.8 (30)	71.4 (45)	

Continuous variable (age) is presented as mean (SD) and categorical variables as percentage (n). * Represents significant differences. Level of significance is at $P<0.05$.
Abbreviations: SD= Standard Deviation

Table 2. Frequencies of participants' nutrition behaviors: high fat/sugar snacking, at baseline and post-intervention (Dietary Habits)

Nutrition Behavior	Baseline Groups			Post Intervention Groups		
High fat/sugar snacking	**Comparison n= 51 Percentage (n)**	**Intervention n= 63 Percentage (n)**	**P-Value**	**Comparison n=50 Percentage (n)**	**Intervention n=55 Percentage (n)**	**P-Value**
Yesterday, did you eat French fries or chips?			0.023*			0.001*
No	39.2 (20)	61.9 (39)		44.0 (22)	76.4 (42)	
Yes, a little (1-2 times)	35.3 (18)	28.6 (18)		40.0 (20)	21.8 (12)	
Yes, a lot (3 or more times)	25.5 (13)	9.5 (6)		16.0 (8)	1.8 (1)	
Yesterday, did you eat sweet rolls, donuts, cookies, brownies, pies, or cake?			0.217			0.005*
No	39.2 (20)	52.4 (33)		42.0 (21)	58.2 (32)	
Yes, a little (1-2 times)	39.2 (20)	36.5 (23)		36.0 (18)	40.0 (22)	
Yes, a lot (3 or more times)	21.6 (11)	11.1 (7)		22.0 (11)	1.8 (1)	

Chi-squared test was used. Data represented by percentage (n)

* Represents significant differences. Level of significance is at *P*<0.05.

Table 3. Participants' nutrition behaviors for high fat/sugar snacking by treatment group: Post-test versus pre-test (Dietary Habits)

High fat/sugar snacking (posttest vs. pretest)	Comparison (n) n= 50	P-Value	Intervention (n) n=55	P-Value
Yesterday, did you eat French fries or chips?		0.290		0.150
Individuals with negative scores	14		14	
Individuals with positive scores	11		9	
Individuals with ties	25		32	
Yesterday, did you eat sweet rolls, doughnuts, cookies, brownies, pies, or cake?		0.864		0.167
Individuals with negative scores	10		11	
Individuals with positive scores	9		7	
Individuals with ties	31		37	

Wilcoxon signed rank test was used. Data represented by n. A negative score suggests post-test < pre-test value. A positive score suggests post-test > pre-test value. A tie suggest pre-test= post-test value. Level of significance is at *P*<0.05.

Table 4. Frequencies of participants' nutrition behaviors: fruit and vegetable intake at baseline and post-intervention (Dietary Habits)

Nutrition Behavior	Baseline Groups			Post Intervention Groups		
Fruit and Vegetable intake	**Comparison n= 51 Percentage (n)**	**Intervention n= 63 Percentage (n)**	**P-Value**	**Comparison n=50 Percentage (n)**	**Intervention n=55 Percentage (n)**	**P-Value**
Yesterday, did you eat any vegetables?			0.255			0.043*
No	29.4 (15)	39.7 (25)		44.0 (22)	23.6 (13)	
Yes, a little (1-2 times)	47.1 (24)	47.6 (30)		40.0 (20)	43.6 (24)	
Yes, a lot (3 or more times)	23.5 (12)	12.7 (8)		16.0 (8)	32.7 (18)	
Yesterday, did you eat fruit?			0.142			0.224
No	23.5 (12)	36.5 (23)		16.0 (8)	12.7 (7)	
Yes, a little (1-2 times)	47.1 (24)	47.6 (30)		36.0 (18)	52.7 (29)	
Yes, a lot (3 or more times)	29.4 (15)	15.9 (10)		48.0 (24)	34.5 (19)	
Yesterday, did you drink 100% fruit juice?			0.006*			0.021*
No	37.3 (19)	42.9 (27)		18.0 (9)	41.8 (23)	
Yes, a little (1-2 times)	37.3 (19)	52.4 (33)		54.0 (27)	43.6 (24)	
Yes, a lot (3 or more times)	25.4 (13)	4.7 (3)		28.0 (14)	14.6 (8)	

Chi-squared test was used. Data represented by percentage (n) * Represents significant differences. Level of significance is at $P<0.05$.

Table 5. Participants' nutrition behaviors for fruit and vegetable intake by treatment group: Post-test versus pre-test (Dietary Habits)

Fruit and Vegetable intake (posttest vs. pretest)	**Comparison (n) n= 50**	**P-Value**	**Intervention (n) n=55**	**P-Value**
Yesterday, did you eat any vegetables?		0.105		<0.001*
Individuals with negative scores	17		2	
Individuals with positive scores	9		18	
Individuals with ties	24		35	
Yesterday, did you eat fruit?		0.018*		<0.001*
Individuals with negative scores	6		8	
Individuals with positive scores	15		30	
Individuals with ties	29		17	
Yesterday, did you drink 100% fruit juice?		0.171		0.199
Individuals with negative scores	8		13	
Individuals with positive scores	16		18	
Individuals with ties	26		24	

Wilcoxon signed rank test was used. Data represented by n. A negative score suggests post-test < pre-test value. A positive score suggests post-test > pre-test value. A tie suggest pre-test= post-test value.
* Represents significance from baseline. Level of significance is at $P<0.05$.

Table 6. Frequencies of participants' healthy eating behaviors, at baseline and post-intervention (Dietary Habits)

Nutrition Behavior	Baseline Groups			Post Intervention Groups		
Healthy eating	**Comparison n= 51 Percentage (n)**	**Intervention n= 63 Percentage (n)**	**P-Value**	**Comparison n=50 Percentage (n)**	**Intervention n=55 Percentage (n)**	**P-Value**
Do you ever read the nutrition labels on food packages?			0.942			0.027*
Almost always or always	19.6 (10)	22.2 (14)		18.0 (9)	41.8 (23)	
Sometimes	43.1 (22)	41.3 (26)		52.0 (26)	40.0 (22)	
Almost never or never	37.3 (19)	36.5 (23)		30.0 (15)	18.2 (10)	
Do you ever eat high fiber cereal?			0.311			0.024*
Almost always or always	7.8 (4)	11.2 (7)		28.0 (14)	27.3 (15)	
Sometimes	33.4 (17)	44.4 (28)		28.0 (14)	50.9 (28)	
Almost never or never	58.8 (30)	44.4 (28)		44.0 (22)	21.8 (12)	
Do you ever eat whole wheat bread?			0.663			0.731
Almost always or always	23.5 (12)	22.2 (14)		36.0 (18)	41.8 (23)	
Sometimes	41.2 (21)	49.2 (31)		34.0 (17)	34.5 (19)	
Almost never or never	35.3 (18)	28.6 (18)		30.0 (15)	23.7 (13)	
Do you ever drink 100% fruit juice?			0.984			0.426
Almost always or always	47.1 (24)	46.0 (29)		40.0 (20)	52.7 (29)	
Sometimes	33.3 (17)	34.9 (22)		46.0 (23)	36.4 (20)	
Almost never or never	19.6 (10)	19.1 (12)		14.0 (7)	10.9 (6)	

Do you ever eat fruit during lunch?			0.945			0.385
Almost always or always	43.1 (22)	42.8 (27)		42.0 (21)	54.6 (30)	
Sometimes	37.3 (19)	39.7 (25)		38.0 (19)	32.7 (18)	
Almost never or never	19.6 (10)	17.5 (11)		20.0 (10)	12.7 (7)	
Do you ever eat vegetables during dinner?			0.509			0.032*
Almost always or always	37.3 (19)	44.4 (28)		30.0 (15)	54.5 (30)	
Sometimes	27.5 (14)	30.2 (19)		36.0 (18)	27.3 (15)	
Almost never or never	35.2 (18)	25.4 (16)		34.0 (17)	18.2 (10)	
If you were at the movies, which one would you pick as a snack?			0.022 *			<0.001*
Popcorn with butter	72.5 (37)	50.8 (32)		64.0 (32)	18.2 (10)	
Popcorn without butter	27.5 (14)	49.2 (31)		36.0 (18)	81.8 (45)	
Which would you pick to drink?			0.848			<0.001*
Regular whole milk	62.7 (32)	60.3 (38)		60.0 (30)	18.2 (10)	
Low fat or skim milk	37.3 (19)	39.7 (25)		40.0 (20)	81.8 (45)	
Which food would you eat for a snack?			0.033*			<0.001*
Candy bar	49.0 (25)	28.6 (18)		42.0 (21)	9.1 (5)	
Fresh Fruit	51.0 (26)	71.4 (45)		58.0 (29)	90.9 (50)	
Which would you do if you were going to eat a piece of chicken?			0.132			0.062
Leave on the skin	54.9 (28)	39.7 (25)		42.0 (21)	24.1 (13)	
Take off the skin and not eat the skin	45.1 (23)	60.3 (38)		58.0 (29)	75.9 (41)	
Which food would you ask for?			0.004*			0.009*
Frozen yogurt/low fat ice cream	43.1 (22)	71.4 (45)		60.0 (30)	83.6 (46)	
Regular full fat ice cream	56.9 (29)	28.6 (18)		40.0 (20)	16.4 (9)	

Which would you choose to cook if you were going to help make dinner at home?			0.005*			<0.001*
French fries	68.6 (35)	41.3 (26)		60.0 (30)	20.0 (11)	
Baked potato	31.4 (16)	58.7 (37)		40.0 (20)	80.0 (44)	
Which would you do if you were going to eat cooked vegetables?			1.00			0.009*
Eat without butter	64.7 (33)	63.5 (40)		60.0 (30)	83.6 (46)	
Eat after adding butter	35.3 (18)	36.5 (23)		40.0 (20)	16.4 (9)	
Which would you order if you were going to eat at a fast food restaurant?			0.004*			<0.001*
Regular hamburger	74.5 (38)	47.6 (30)		68.0 (34)	20.0 (11)	
Grilled chicken sandwich	25.5 (13)	52.4 (33)		32.0 (16)	80.0 (44)	

Chi-squared test was used. Data represented by percentage (n)

* Represents significant differences. Level of significance is at $P<0.05$.

Table 7. Participants' healthy eating behavior by treatment group: Post-test versus pre-test (Dietary Habits)

Healthy Eating (posttest vs. pretest)	**Comparison (n) n= 50**	**P-Value**	**Intervention (n) n=55**	**P-Value**
Do you ever read the nutrition labels on food packages?		0.601		0.004*
Individuals with negative scores	12		6	
Individuals with positive scores	13		19	
Individuals with ties	25		30	
Do you ever eat high fiber cereal?		0.024*		0.007*
Individuals with negative scores	9		10	
Individuals with positive scores	22		23	
Individuals with ties	19		22	
Do you ever eat whole wheat bread?		0.209		0.051
Individuals with negative scores	11		9	
Individuals with positive scores	22		18	
Individuals with ties	17		28	
Do you ever drink 100% fruit juice?		0.923		0.231
Individuals with negative scores	15		10	
Individuals with positive scores	13		16	
Individuals with ties	22		29	
Do you ever eat fruit during lunch?		0.864		0.06
Individuals with negative scores	10		11	
Individuals with positive scores	9		19	
Individuals with ties	31		25	
Do you ever eat vegetables during dinner?		0.626		0.093

Individuals with negative scores	13		8	
Individuals with positive scores	11		15	
Individuals with ties	26		32	
If you were at the movies, would you choose popcorn without butter as a snack instead of with butter?		0.285		<0.001*
Individuals with negative scores	5		1	
Individuals with positive scores	9		16	
Individuals with ties	36		38	
Would you low fat/skim milk instead of whole milk?		0.637		<0.001*
Individuals with negative scores	8		3	
Individuals with positive scores	10		25	
Individuals with ties	32		27	
Would you eat a fruit for a snack instead of a candy bar?		0.157		0.005*
Individuals with negative scores	2		2	
Individuals with positive scores	6		13	
Individuals with ties	42		40	
Would you eat chicken without the skin?		0.180		0.033*
Individuals with negative scores	7		3	
Individuals with positive scores	13		11	
Individuals with ties	30		40	
Would you ask for a frozen yogurt/low fat ice-cream instead of full fat ice-cream?		0.033*		0.059
Individuals with negative scores	3		5	
Individuals with positive scores	11		13	

Individuals with ties	36		37	
Would you choose to cook a baked potato instead of a French fries if you were going to help make dinner at home?		0.197		0.005*
Individuals with negative scores	5		2	
Individuals with positive scores	10		13	
Individuals with ties	35		40	
Would you eat cooked vegetables without butter instead of adding butter?		0.439		0.001*
Individuals with negative scores	9		1	
Individuals with positive scores	6		13	
Individuals with ties	35		41	
Would you order a grilled chicken sandwich instead of a regular hamburger at a fast food restaurant?		0.405		0.001*
Individuals with negative scores	5		2	
Individuals with positive scores	8		16	
Individuals with ties	37		37	

Wilcoxon signed rank test was used. Data represented by n. A negative score suggests post-test < pre-test value. A positive score suggests post-test > pre-test value. A tie suggest pre-test= post-test value.

* Represents significance from baseline. Level of significance is at *P*<0.0

Table 8. Frequencies of participants' nutrition attitudes and beliefs pre- and post-intervention

Nutrition Attitudes and Beliefs	Baseline Groups			Post Intervention Groups		
	Comparison n= 51 Percentage (n)	Intervention n= 63 Percentage (n)	P-Value	Comparison n=50 Percentage (n)	Intervention n=55 Percentage (n)	P-Value
How many total servings of fruits and vegetables should you eat each day?			0.152			0.001*
At least 2	11.8 (6)	28.6 (18)		26.0 (13)	14.5 (8)	
At least 5	23.5 (12)	23.8 (15)		12.0 (6)	47.3 (26)	
At least 9	35.3 (18)	25.4 (16)		28.0 (14)	25.5 (14)	
I don't know	29.4 (15)	22.2 (14)		34.0 (17)	12.7 (7)	
The foods that I eat and drink now are healthy.			0.018 *			0.663
Yes, all of the time	21.6 (11)	36.5 (23)		36.0 (18)	40.0 (22)	
Yes, sometimes	64.7 (33)	61.9 (39)		54.0 (27)	54.5 (30)	
No	13.7 (7)	1.6 (1)		10.0 (5)	5.5 (3)	
How likely are you to drink low fat or skim milk instead of regular whole milk?			0.321			0.115
Not likely	45.1 (23)	52.4 (33)		44.0 (22)	25.5 (14)	
Likely	29.4 (15)	33.3 (21)		34.0 (17)	40.0 (22)	

Very likely	25.5 (13)	14.3 (9)		11.0 (22)	34.5 (19)	
How likely are you to eat high fiber cereal instead of a donut?			0.197			0.937
Not likely	31.3 (16)	46.0 (29)		34.0 (17)	31.0 (17)	
Likely	47.1 (24)	31.7 (20)		34.0 (17)	34.5 (19)	
Very likely	21.6 (11)	22.3 (14)		32.0 (16)	34.5 (19)	
How likely are you to eat fresh fruit instead of a candy bar?			0.056			0.15
Not likely	37.3 (19)	17.4 (11)		32.0 (16)	16.4 (9)	
Likely	29.4 (15)	41.3 (26)		32.0 (16)	34.5 (19)	
Very likely	33.3 (17)	41.3 (26)		36.0 (18)	49.1 (27)	
How likely are you to take the skin off of chicken (and not eat the skin)?			0.33			0.752
Not likely	54.9 (28)	41.3 (26)		40.0 (20)	36.4 (20)	
Likely	21.6 (11)	25.4 (16)		26.0 (13)	32.7 (18)	
Very likely	23.5 (12)	33.3 (21)		34.0 (17)	30.9 (17)	
How likely are you to ask for frozen yogurt or low fat ice cream instead of full fat ice cream?			0.842			0.436
Not likely	35.3 (18)	30.2 (19)		32.0 (16)	21.8 (12)	
Likely	27.5 (14)	30.2 (19)		26.0 (13)	34.5 (19)	

Very likely	37.2 (19)	39.6 (25)		42.0 (21)	43.7 (24)	
How likely are you to eat a baked potato instead of French fries?			0.066			0.275
Not likely	64.7 (33)	42.9 (27)		36.0 (18)	25.5 (14)	
Likely	19.6 (10)	33.3 (21)		38.0 (19)	34.5 (19)	
Very likely	15.7 (8)	23.8 (15)		26.0 (13)	40.0 (22)	
How likely are you to drink fruit juice instead of a soft drink (a soda pop)?			0.198			0.156
Not likely	41.2 (21)	25.4 (16)		28.0 (14)	18.2 (10)	
Likely	27.5 (14)	36.5 (23)		36.0 (18)	27.3 (15)	
Very likely	31.4 (16)	38.1 (24)		36.0 (18)	54.5 (30)	
How likely are you to order a grilled chicken sandwich at a fast food restaurant instead of ordering a hamburger?			0.092			0.017*
Not likely	54.9 (28)	39.7 (25)		46.0 (23)	20.0 (11)	
Likely	19.6 (10)	38.1 (24)		22.0 (11)	34.5 (19)	
Very likely	25.5 (13)	22.2 (14)		32.0 (16)	45.5 (25)	

Chi-squared test was used. Data represented by percentage (n) * Represents significant differences. Level of significance is at $P<0.05$.

Table 9. Odds ratio comparing nutrition habits in the intervention versus comparison group at post-test

Food item	Odds Ratio	95% CI	P-value
Popcorn with butter versus no butter	0.14	0.05; 0.42	<0.001*
Whole milk versus low fat milk	0.14	0.05; 0.39	<0.002*
Candy bar versus a fresh fruit	0.13	0.034; 0.50	0.003*
Chicken with the skin versus without the skin	0.55	0.21; 1.45	0.228
Frozen yogurt versus regular ice-cream	2.49	0.89; 6.99	0.082
French fries versus baked potato	0.16	0.053; 0.50	0.001*
Cooked vegetables without butter versus with	5.68	1.65; 19.48	0.006*
Hamburger versus a grilled chicken sandwich	0.14	0.043; 0.43	0.001*

Logistic regression was used controlled for ethnicity, age, gender and baseline value.
* Represents a significant difference. Level of significance is at $P<0.05$.
CI: Confidence interval

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CHAPTER III: THE EFFECT OF PROJECT ProHEART- Promoting Healthy Eating and Activity using Robot-assisted Training- ON PHYSICAL ACTIVITY AND SCREEN TIME OUTCOMES

Introduction

Numerous studies have linked childhood obesity to several health related consequences such as type 2 diabetes, metabolic syndrome, high blood pressure, high cholesterol levels, impaired glucose tolerance, non-alcoholic fatty liver disease, asthma and sleep apnea (1-7). Furthermore, there have been psychosocial consequences of childhood obesity that have been portrayed in the literature, which may include low self-esteem, depression, social isolation, discrimination and reduced quality of life (5, 8-10). Studies have indicated that childhood obesity has been predictive of adult obesity as it also may increase the risk of obesity-related comorbidities and mortality later in life (11-14). Research has shown that intervention strategies targeting children before transitioning into adolescence are imperative (15). The children in this age group are beginning to gain more independence and hence are forming their own food and physical activity behaviors and attitudes (15).

One of the solutions to target obesity from a public health standpoint would be to emphasize and support positive lifestyle changes with respect to diet and physical activity (16). Positive eating and physical activity behavior modifications learned through nutrition education and counseling sessions are the main interventions proposed to target overweight and obesity (17).

Physical inactivity and excessive sedentary behavior such as increased screen time are the major determinants of childhood obesity. Therefore, intervention strategies should focus on increasing moderate to vigorous physical activity (MVPA) and decreasing sedentary behavior (18). Physical activity interventions should include group activities (ball catching, throwing, jump ropes), dance and sports (at least one hour per day) that target cardiovascular fitness. Children should also cut back on screen time (TV and video games) to a maximum of 2 hours per day and increase physical activity instead to at least 60 minutes per day, during after-school hours (19-27).

School-based obesity prevention programs have been portrayed as the most feasible and effective interventions since children are present at school all day however, programs delivered in the after-school hours have shown a greater potential for success (20, 26, 28). Moreover, involving teachers and peers can be a motivating factor that the children enjoy. These interventions usually target a large number of children by implementing nutrition education and physical activity through structured programs. However, these programs are typically short in duration (29).

Robotic technology, specifically humanoid robots, has been studied and applied to stimulate interest and attention in children suffering from Autism Spectrum Disorder (30-32). However, to our knowledge, there has been no study published that uses a humanoid robot as an assistant to the dietitian in an after-school program targeting childhood obesity prevention. Studies (33-35) have shown that children spend an average of only 3 minutes (10% of class time) on moderate to vigorous activity during physical education (PE) class during school hours, which is well below the recommendation of 50% of class time. Herrick et al. (36) designed a quasi-experimental controlled study in order to compare fifth grade students in an after-school programs exposed to SPARK (n=48) with controls (n=52) over a period of 5 months. Results showed that by the end of the 5-month period, the SPARK program did not increase moderate to vigorous physical activity (MVPA) in the after-school setting (36).

Therefore, the literature seems to lack research on the effectiveness of the SPARK program and ways to improve SPARK should be developed in order to enhance health-related outcomes in school children. Innovative techniques should be incorporated into these programs to get the children more motivated. One novel intervention could be through the incorporation of a humanoid robot as a role model and assistant to the dietitian during the intervention sessions. NAO is a 58-cm tall humanoid robot that can talk, walk, catch small objects, dance and do multiple programmable operations. The robot also has face recognition and can listen to children and respond to certain questions. The robot has been in the market since 2006 and is continuously being updated. This robot is currently being used in over 70 countries worldwide. They are used in schools and incorporated in computer and science classes, from primary school through to university (37). We assume that the robot will motivate the children to be more active and participative during the after-school program while prompting them to learn more. Our purpose is to provide a fun environment for learning that is different from the regular after-school program experience. Moreover, we are involving a registered dietitian in this study as the nutrition expert instead of the regular classroom teacher who might not be familiar or comfortable giving this material. After examining the results of this study, we may be able to create training sessions and manuals to train school staff/teachers who might be able to give the intervention themselves and thus maintaining sustainability of the program.

The aim of the present study was to determine whether PROJECT ProHEART-Promoting Healthy Eating and Activity using Robot-assisted Training- is effective in improving positive physical activity behavior and decreasing screen time at the end of a 6 week intervention. This paper will only examine the physical activity outcomes of this intervention; nutrition related outcomes and a detailed program design will be presented elsewhere.

Methods

Subject Recruitment

An intervention study using a pretest-posttest quasi-experimental design (intervention and comparison groups) was conducted. A convenience sample was obtained from four locations of the Young Men's Christian's Association (YMCA) that currently offers the Sports, Play and Active Recreation for Kids (SPARK) afterschool program in Miami-Dade County, Miami, Florida. This program aims to improve the health of children and adolescents through afterschool physical education. Currently, the YMCA is the nation's largest not-for-profit community service organization whose mission is to offer programs that build healthy spirit, mind, and body for all. There are currently over a hundred afterschool programs offered by the YMCA in Miami-Dade, Broward and Monroe counties combined (38).

The study consisted of two phases: phase one included the screening of individuals; while phase two included the recruitment of individuals who met the inclusion/exclusion criteria. Eligibility criteria included being between the ages of 6 and 12 years, enrolled at one of the four participating YMCA locations in Miami-Dade

County, English proficiency and both genders were included in the study. Exclusion criteria were recent surgery that may hinder physical activity, physical or mental disability such as autism, blindness or amputation, diagnosed with cancer or suffering from an untreated chronic disease such as uncontrolled diabetes, heart disease and/or joint problems that would be a barrier to physical activity. Assessments at all sites took place on week prior to the start of the intervention (week 0) and one week post-intervention (week 7). The time span between screening and baseline was one week. The study commenced in March 2015 and was completed in May 2015. The time span between screening and baseline was one week. The study commenced in March 2015 and was completed in May 2015.

A recruitment flyer explaining the purpose of the study, inclusion/exclusion criteria and the investigators' emails and phone numbers were distributed to all children in the four participating YMCA locations. If interested, parents/guardians were asked to approach the staff on site, or call/email the contact person on the flyer. An in person or over the phone screening to determine child eligibility was conducted. If the child met the inclusion/exclusion criteria, then an appointment was scheduled for informed consent and assent. Informed consent was obtained from one parent/legal guardian as well as child assent was obtained prior to enrollment in the study. Confidentiality measures were taken at all times during the study and participants were notified that any information provided would remain confidential. This study was approved by the Institutional Review Board at Florida International University.

After recruitment, each of the four participating YMCA sites was randomly assigned to one of two groups: intervention or comparison group. The comparison group consisted of children (n=51) from two locations that followed the regular SPARK after-school program that the YMCA offers Monday to Friday (one hour per day); no intervention was given. Whereas, the intervention group consisted of children (n=63) enrolled in two other YMCA locations that received nutrition and physical activity education from a registered dietitian and a humanoid robot “NAO” (Aldebran robotics; Paris, France), two days per week for a total of 6 weeks in addition to their regular SPARK physical activity afterschool sessions on the other three days of the week. Thus, in total, 12 intervention sessions were offered instead of the SPARK program and each session was one hour in length.

The humanoid robot (NAO) was used as an assistant to the registered dietitian during all intervention lectures and activities with the aim of getting the children more interested in the subject and more interactive during the activities. The robot was programmed in a way in which it participated in the lecture/discussions, asked children questions, danced and performed certain movements. Incorporating NAO, into our intervention was an innovative tool for a childhood obesity prevention program that has not been researched yet.

One hundred and nineteen participants were screened. One hundred and fourteen qualified for the study based on the inclusion/exclusion criteria set and were assessed at baseline: n=63 in the intervention group and n=51 in the comparison group. One participant in the comparison group and 8 participants in the intervention group withdrew after the baseline assessment due to no longer being enrolled at the YMCA. Thus, 105 participants were assessed post-intervention (week 7): n=50 in the comparison group and n=55 in the intervention group. An intent to treat approach was followed, and thus all 114 participants were included in the present study.

Intervention sessions

The intervention sessions targeted nutrition and physical activity education via lectures, games and interactive activities given by the dietitian and NAO. They consisted of 20-25 minutes of discussion, information and interaction about the topic of the week followed by 35-40 minutes of a hands-on activity to meet the learning objectives of that session (i.e. games that target children to perform certain exercise routines, dancing and stretching). After each session, pamphlets summarizing recommendations of that session with examples where provided in order to be given to parents/guardians. Additional resources/ tools were provided to the children to take home such as pedometers and they were encouraged to reach a goal of 10,000 steps a day.

Measures

After screening and consent, participants' parent/guardian was asked to complete the standard socio-demographic questionnaire on site at baseline (week 0). A trained interviewer administered the questionnaire in order to collect the data. Information collected included socio-demographic variables such as child's gender, race/ethnicity, age/birth date, grade level, first language spoken at home as well as annual household income.

The validated CATCH (Coordinated Approach to Child Health) Kids club questionnaire was used at baseline (week 0) and post-intervention (week 7) to assess the impact of the intervention on the children's physical activity and screen time attitudes and behaviors (39, 40). This 51-item questionnaire contains 11 questions pertaining to physical activity habits and screen time. Screen time was defined as time spent using a device such as a computer/laptop, tablet, phone, television, or games console. The questionnaire also contains questions on nutrition knowledge and behavior that will be discussed elsewhere.

The Previous Day Physical Activity Recall (PDPAR) was used to measure physical activity behavior at baseline as well as post-intervention. This self-reported questionnaire is validated for use in school children (41). The PDPAR was shown to be positively correlated with values obtained from a pedometer as well as an accelerometer. It is a subjective technique of estimating physical activity since they rely on responses from the child and is relatively inexpensive when compared to pedometers and accelerometers. The PDPAR uses a time-based recall technique by requesting from the child to recall and record their previous day's physical activity (between 3:00pm and 11:30pm). The time is divided into 17 time blocks, 30 minutes each. Children are asked to specify their activity (35 common activities are listed) and the intensity of the activity (very light, light, moderate, or vigorous) per block of time. The physical activity of the child is then obtained via the metabolic equivalent (MET) level (41).

Statistical analysis

The independent variable of interest is the treatment group. Children in the randomized sites not receiving intervention where considered as the comparison group; while children in randomized sites receiving the 6 week intervention where considered as the intervention group. Dependent variables being tested were derived from the CATCH kids club questionnaire that included physical activity attitudes, physical activity and screen time behavior. The metabolic equivalent (MET) was another dependent variable which was included that was derived from the previous day physical activity recall (PDPAR).

Baseline differences between intervention and comparison schools were assessed. Descriptive statistics were used for baseline characteristics. Continuous normally distributed data (age) was compared using an independent t-test since age is a continuous, normally distributed variable and we aimed at comparing independent measures between two groups. Categorical data was compared via a chi-squared test; Fisher's exact test was used if cell count was less than 5. Intent to treat analysis was used to include those lost to follow-up post-intervention. A paired t-test was used to determine differences pre- and post- intervention in the MET derived from the PDPAR (repeated measure, continuous data) within each group while a Wilcoxon signed-rank test was used as a non-parametric statistical test to compare two repeated measurements on categorical data derived from the CATCH kids club questionnaire within a single sample (i.e. between intervention at baseline and intervention post-test; between comparison at baseline and comparison post-test). Logistic regression was used since the dependent variables derived from the CATCH kids' club questionnaire are categorical. The regression analysis predicted the odds of a certain behavior occurring in the intervention group versus the comparison group. Regression analysis was controlled for age, gender, race/ethnicity and baseline measurement where applicable.

Significance was set at $p<0.05$ and all analyses were two sided. Statistical analysis was conducted using SPSS 21.0 (Chicago).

Results

Baseline demographic characteristics

The baseline demographic characteristics are summarized in Table 1. The intervention and comparison groups were significantly different based on ethnicity, P=0.015, in spite of the fact that the majority of the participants in both groups were Hispanic/Latino (35.3% in the comparison group and 58.7% in the intervention group). Also, most of the subjects reported English was their first language spoken at home (92.2% vs. 69.8%, P=0.005 for comparison and intervention groups; respectively). However, there was no significant difference between the groups at baseline with regards to age (Mean: 8.16 ±1.57 years, P=0.091), gender (P=0.061), grade level (P=0.287) or annual household income (P=0.103).

Physical activity and screen time behavior

A paired t-test of the metabolic equivalent (MET) derived from the previous day physical activity recall (PDPAR) indicated that the intervention group had a significant increase of 9.52 MET post-intervention, P<0.001 (increase from 30.64 to 40.16 MET). Whereas, the comparison group had a significant decrease of 4.08 MET post-test, P<0.001 (decrease from 33.63 to 29.55 MET) (data not shown in table).

Table 2 shows the frequencies of participants' physical activity behaviors and screen time pre- and post-intervention. There was no significant difference at baseline (p=0.37) or post-test (p=1.00) between the groups when asked "Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes". Regarding screen time, there was no significant differences between the groups at baseline. However, post-intervention subjects in the intervention group reported watching significantly less TV (hours) and shows per day during the week ($P<0.001$ and $P=0.03$, respectively) as well as on the weekend ($P=0.022$ and $P=0.026$, respectively) than subjects in the comparison group. Participants in the intervention group also reported playing significantly less video games or using the computer during the week ($P=0.008$) and weekend ($P=0.003$), post intervention when compared to the comparison group.

The results of a Wilcoxon signed-ranks test intended to compare children's physical activity behaviors and screen time by treatment group (post-test versus pre-test) are shown in Table 3. Results show that there was no significance in the intervention group post-test compared to baseline with regards to whether the child participated in sports activities that made the heart beat fast for at least 20 minutes. However, there was a significant increase in that category post-test in the comparison group ($P=0.033$). On the other hand, the number of children post-test in the comparison group significantly increased ($P=0.034$) the number of hours watching TV or videos during the week compared to baseline; while children in the intervention group post-test significantly decreased ($P=0.012$) the number of hours. No significant differences were noted post-test in both groups for hours watched during the weekend, number of shows or time spent on video games or Internet surfing as compared to baseline.

Physical activity attitudes

Table 4 portrays the frequencies of participants' physical activity attitudes pre-and post-intervention. No significant differences were noted at baseline between the groups. Post intervention, the intervention group reported to run or bike 3-5 times a week significantly more than the comparison group ($P=0.049$). A trend towards significance was noted in that the intervention group was more likely to be physically active 3-5 times a week (P=0.052) and was more likely to exercise and keep moving most of the time in the after-school program (P=0.052) than the comparison group, post-intervention. No significant difference was shown between the groups posttest with regards to keeping up a steady pace without stopping for 15-20 minutes when physically active.

Odds ratios

The odds ratio comparing physical activity behavior in the intervention versus the comparison group at post-test controlled for ethnicity, age, gender and baseline value is shown in Table 5. The intervention group were 2.05 times more likely to be physically active 3-5 times a week, 2.56 times more likely to run or bike 3-5 times a week and 1.52 times more likely to keep up a steady pace without stopping for 15-20 minutes when physically active than the comparison group, however, this was not significant (P=0.253, P= 0.099, P= 0.438, respectively). A trend toward significance was noted (P=0.05) in the intervention group that was 5.03 times more likely to exercise and keep moving most of the time in their after-school program. Further analysis demonstrated that African Americans in the intervention group were 13.35 times more likely (P=0.043) to exercise and keep moving for most of the time in the after-school program than Hispanics or Whites. It was also noted that the older children in the intervention group were 1.76 times more likely (P=0.005) to keep up a steady pace without stopping for 15-20 minutes when physically active as compared to the younger children.

Attendance

Average participant attendance to the intervention sessions was 64%. Above mentioned variables were analyzed for those that attended 80% or more of the sessions. However, no differences were noted in the aforementioned results and thus were not reported.

Discussion

Our results show that a 12-session nutrition and physical activity intervention with a humanoid robot and a registered dietitian lead to a significant increase in the previous day physical activity in the after-school hours as well as a significant reduction in hours spent watching TV or videos (weekdays only). However, the intervention group did report watching significantly less TV (hours) and shows as well as playing significantly less video games or using the computer any day of the week, post-test when compared to the comparison group.

We were not able to demonstrate a significant difference in odds ratios with regards to likelihood of physical activity and group status (intervention or comparison); nevertheless, a trend towards significance was noted in that the intervention group was five times more likely to exercise and keep moving most of the time in the after-school program. When stratified by ethnicity, African Americans in the intervention group were shown to be 13.35 times more likely (P=0.043) to exercise and keep moving for most of the time in the after-school program than Hispanics or Whites. However, African Americans only constituted 9.5% of our intervention population. Moreover, older children in the intervention group were 1.76 times more likely (P=0.005) to keep up a steady pace without stopping for 15-20 minutes when physically active than younger children. This can be explained in that older children usually participate in more team-oriented sports such as football, soccer or basketball, which require keeping up a steady pace.

Our overall results are supported by Wofford et al. (26), who also implemented a 12-session afterschool program targeting elementary children and showed a significant increase in overall physical activity time, but no significant change in pedometer steps. However, this study only included African Americans (n=33) and did not have a comparison group (26).

On the other hand, Herrick et al. (36), implemented an afterschool nutrition and physical activity intervention over a period of 5 months, which included SPARK, was unable to show any significance with regards to increasing physical activity in the after-school setting. Hence, a longer follow-up time was needed in our study in order to observe whether these benefits were indeed sustainable. Another difference to note was that Herrick et al. (36) only included fifth graders (mean age of 10.3 years) whereas our population had a mean age of 8.69 years and included all elementary kids that met the inclusion/exclusion criteria. Therefore, the mean age of the population might have affected the results as well.

Iverson, Nigg and Titchenal (42) portray conflicting results in their "Fun 5 program", a nutrition and physical activity after-school intervention which also contained SPARK. No significant difference was noted in physical activity from baseline to post-intervention over the course of the school year. However an "at risk" sub-population was identified that consumed less than 5 servings of fruits and vegetables per day, underwent less than 300 minutes of physical activity per week or had a BMI for age of ≥85th percentile at baseline. This sub-population revealed a significant increase in physical activity post-intervention (42). Our results confirm our previously stated limitations of short study follow-up time. Future studies should implement this study on a larger scale and measure sustainability four to six months post-intervention.

Our study has several strengths. First, the study design included a comparison group, which is lacking in most of the after-school programs published (19-21, 23-26, 42). Second, we were able to randomize sites to comparison or intervention groups. Third, the two groups were very close in sample size (51 in the comparison group and 63 in the intervention group). Fourth, we only lost nine participants post intervention (one in the control and eight in the intervention) due to no longer being enrolled in the YMCA. Fifth, to our knowledge, this is the first study that incorporated a humanoid robot along with a registered dietitian into an after-school nutrition and physical activity intervention.

Limitations of our study included that we were only able to obtain a convenience sample from the YMCA that might lead to selection bias. Also, there was an imbalance in baseline characteristics for ethnicity with the intervention group having significantly more Hispanics/Latinos and less blacks/African Americans than the comparison group which might have affected the comparability of the results. A longer follow-up time may be needed in order to observe if results were sustainable long-term. Additionally, participant attendance to the intervention sessions was low (average: 64%), but it did not seem to affect the results. Furthermore, there is always a bias in reporting when including self-reported questionnaires. Lastly, we did not reach our sample goal of 120 (sample size was 114) for our main hypothesis, which decreased our power to 75%. But, we did achieve a power of 99.9% for our secondary hypothesis (difference between two dependent means, matched pairs).

Finally, the results suggest that project ProHEART was successful in increasing overall previous day physical activity during after-school hours as well as decreasing weekday hours spent watching TV or videos in elementary children aged 6-12. However, a longer follow-up time and a larger sample size are needed to confirm these results.

Table 1. Baseline demographic characteristics by treatment group (N=114)

Characteristic	**Comparison Group**	**Intervention Group**	**P-Value**
	n=51	**n=63**	
Age in years Mean (SD)	8.16 (1.57)	8.69 (1.68)	0.091
Race/Ethnicity Percentage (n)			0.015*
White	27.5 (14)	25.4 (16)	
Black/African American	31.4 (16)	9.5 (6)	
Hispanic/Latino	35.3 (18)	58.7 (37)	
Other	5.8 (3)	6.4 (4)	
Gender Percentage (n)			0.061
Male	66.7 (34)	49.2 (31)	
Female	33.3 (17)	50.8 (32)	
Grade Percentage (n)			0.287
Kindergarten	17.6 (9)	14.3 (9)	
1st grade	31.4 (16)	20.6 (13)	
2nd grade	17.6 (9)	14.3 (9)	
3rd grade	7.9 (4)	17.5 (11)	
4rth grade	19.6 (10)	17.5 (11)	
5th grade	5.9 (3)	15.8 (10)	
First language spoken at home Percentage (n)			0.005*
English	92.2 (47)	69.8 (44)	
Spanish	3.9 (2)	27 (17)	
Other	3.9 (2)	3.2 (2)	
Annual household income Percentage (n)			0.171
<=$50,000	41.2 (21)	28.6 (18)	
> $50,000	58.8 (30)	71.4 (45)	

Continuous variable (age) is presented as mean (SD) and categorical variables as percentage (n). * Represents significant differences. Level of significance is at $P<0.05$.
Abbreviations: SD= Standard Deviation

Table 2. Frequencies of participants' physical activity behaviors and screen time pre- and post-intervention

	Baseline Groups			Post Intervention Groups		
PHYSICAL ACTIVITY BEHAVIOR	**Comparison n= 51 Percentage (n)**	**Intervention n= 63 Percentage (n)**	**P-Value**	**Comparison n=50 Percentage (n)**	**Intervention n=55 Percentage (n)**	**P-Value**
Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes?			0.37			1.00
Yes	72.5 (37)	81.0 (51)		88.0 (44)	89.1 (49)	
No	27.5 (14)	19.0 (12)		12.0 (6)	10.9 (6)	
SCREEN TIME						
During the week, how many hours per day do you usually spend watching TV shows or videos?			0.838			<0.001 *
None or less than 1 hour a day	35.5 (18)	39.7 (25)		22.0 (11)	60.0 (33)	
A little (1-2 hours a day)	31.2 (16)	31.7 (20)		26.0 (13)	25.5 (14)	
A lot (more than 2 hours a day)	33.3 (17)	28.6 (18)		52.0 (26)	14.5 (8)	
During the week, how many TV shows or videos do you usually watch each day?			0.487			0.03 *
None	11.8 (6)	11.1 (7)		8.0 (4)	12.7 (7)	
1-2 shows/videos	35.3 (18)	46.0 (29)		28.0 (14)	49.1 (27)	
3 or more	52.9 (27)	42.9 (27)		64.0 (32)	38.2 (21)	

shows/videos						
During the <u>weekend,</u> how many hours per day do you usually spend watching TV shows or videos?			0.177			0.022*
None or less than 1 hour a day	13.7 (7)	27.0 (17)		26.0 (13)	50.9 (28)	
A little (1-2 hours a day)	31.4 (16)	31.7 (20)		22.0 (11)	20.0 (11)	
A lot (more than 2 hours a day)	54.9 (28)	41.3 (26)		52.0 (26)	29.1 (16)	
During the <u>weekend</u>, how many TV shows or videos do you usually watch each day?			0.137			0.026*
None	3.9 (2)	11.1 (7)		8.0 (4)	7.3 (4)	
1-2 shows/videos	33.3 (17)	42.9 (27)		24.0 (12)	49.1 (27)	
3 or more shows/videos	62.8 (32)	46.0 (29)		68.0 (34)	43.6 (24)	
During the week, how many hours per day do you usually play video games, or use the computer?			0.143			0.008*
None or less than 1 hour a day	43.2 (22)	55.6 (35)		40.0 (20)	67.2 (37)	
A little (1-2 hours a day)	23.5 (12)	27.0 (17)		18.0 (9)	16.4 (9)	
A lot (more than 2 hours a day)	33.3 (17)	17.5 (11)		42.0 (21)	16.4 (9)	
During the <u>weekend</u>, how many hours per day do you usually play video games, or use the computer?			0.086			0.003*
None or less than 1 hour a day	31.4 (16)	44.4 (28)		32.0 (16)	65.5 (36)	
A little (1-2 hours a day)	23.5 (12)	30.2 (19)		28.0 (14)	14.5 (8)	
A lot (more than 2 hours a day)	45.1 (23)	25.4 (16)		40.0 (20)	20.0 (11)	

Chi-squared test was used. Data represented by percentage (n) * Represents significant differences. Level of significance is at *P*<0.05.

Table 3. Participants' physical activity behaviors and screen time by treatment group: Post-test versus pre-test

Physical activity and screen time behavior (posttest vs. pretest)	**Comparison (n) n= 50**	**P-Value**	**Intervention (n) n=55**	**P-Value**
Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes?		0.033*		0.248
Individuals with negative scores	3		4	
Individuals with positive scores	11		8	
Individuals with ties	36		43	
During the week, how many hours per day do you usually spend watching TV shows or videos?		0.034*		0.012*
Individuals with negative scores	11		25	
Individuals with positive scores	18		8	
Individuals with ties	21		22	
During the week, how many TV shows or videos do you usually watch each day?		0.291		0.715
Individuals with negative scores	13		19	
Individuals with positive scores	20		16	
Individuals with ties	17		20	
During the weekend, how many hours per day do you usually spend watching TV shows or videos?		0.381		0.111
Individuals with negative scores	22		28	
Individuals with positive scores	17		15	
Individuals with ties	11		12	
During the weekend, how many TV shows or videos do you usually watch each day?		0.865		0.802
Individuals with negative scores	15		21	
Individuals with positive scores	15		18	
Individuals with ties	20		16	
During the week, how many hours per day do you usually play video games, or use the computer to surf the internet?		0.555		0.333
Individuals with negative scores	13		16	
Individuals with positive scores	16		11	
Individuals with ties	21		28	

During the weekend, how many hours per day do you usually play video games, or use the computer to surf the internet?		0.678		0.176
Individuals with negative scores	18		21	
Individuals with positive scores	15		12	
Individuals with ties	17		22	

Wilcoxon signed rank test was used. Data represented by n. A negative score suggests post-test < pre-test value. A positive score suggests post-test > pre-test value. A tie suggest pre-test= post-test value. * Represents significance from baseline. Level of significance is at $P<0.05$.

Table 4. Frequencies of participants' physical activity attitudes pre- and post-intervention

	Baseline Groups			Post Intervention Groups		
Physical activity attitudes	**Comparison n= 51 Percentage (n)**	**Intervention n= 63 Percentage (n)**	**P-Value**	**Comparison n=50 Percentage (n)**	**Intervention n=55 Percentage (n)**	**P-Value**
How likely are you to be physically active 3-5 times a week?			0.746			0.052
Not likely	21.6 (11)	17.5 (11)		22.0 (11)	10.9 (6)	
Likely	33.3 (17)	39.7 (25)		34.0 (17)	21.8 (12)	
Very likely	45.1 (23)	42.8 (27)		44.0 (22)	67.3 (37)	
How likely you to exercise and keep moving for most of the time in your after school program?			0.055			0.052
Not likely	21.6 (11)	7.9 (5)		16.0 (8)	7.3 (4)	
Likely	25.5 (13)	41.3 (26)		38.0 (19)	23.6 (13)	
Very likely	52.9 (27)	50.8 (32)		46.0 (23)	69.1 (38)	
How likely are you to run or bike 3-5 times a week?			0.79			0.049*
Not likely	25.5 (13)	28.6 (18)		30.0 (15)	10.9 (6)	
Likely	33.3 (17)	36.5 (23)		32.0 (16)	38.2 (21)	
Very likely	41.2 (21)	34.9 (22)		38.0 (19)	50.9 (28)	
How likely are you to keep up a steady pace without stopping for 15-20 minutes when you are physically active?			0.489			0.385
Not likely	35.3 (18)	25.4 (16)		26.0 (13)	18.2 (10)	
Likely	33.3 (17)	41.3 (26)		36.0 (18)	30.9 (17)	
Very likely	31.4 (16)	33.3 (21)		38.0 (19)	50.9 (28)	

Chi-squared test was used. Data represented by percentage (n) * Represents significant differences. Level of significance is at $P<0.05$.

Table 5. Odds ratio comparing physical activity behavior in the intervention versus comparison group at post-test

Behavior	Odds Ratio	95% CI	P-value
Physically active 3-5 times a week	2.05	0.6; 6.99	0.253
Exercise and keep moving most of the time in the after-school program	5.03	0.99; 25.36	0.05
Run or bike 3-5 times a week	2.56	0.84; 7.83	0.099
Keep up a steady pace without stopping for 15-20 mins when physically active	1.52	0.53; 4.42	0.438

Logistic regression was used controlled for ethnicity, age, gender and baseline value.
Level of significance is at $P<0.05$.
CI: Confidence interval

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CHAPTER IV: THE EFFECT OF Project ProHEART -Promoting Healthy Eating and Activity using Robot-assisted Training- ON BODY MASS INDEX Z-SCORES AND BODY COMPOSITION

Introduction

According to the Center for Disease Control and Prevention (CDC) growth charts, "obesity" in children is defined by a Body Mass Index (BMI) for age and gender, greater than or equal to the 95th percentile whereas "overweight" is defined as having a BMI for age and gender between the 85th and 95th percentile (1). The 2011-2012 NHANES data (2) portrays that around 16.9% of U.S. children and adolescents aged 2-19 years are obese which remains unchanged from the 2009-2010 data (3). This means 12.5 million girls and boys are classified as obese. Data also shows that that the prevalence of overweight and obesity combined in this pediatric population is 31.8% (2). The prevalence of obesity was deemed higher among children aged 6-11 years (17.7%) and adolescents aged 12-19 years (20.5%) than in children aged 2-5 years (8.4%). Additionally, the prevalence of obesity appears to be similar between boys (16.7%) and girls (17.2%) aged 2-19 years (2).

Data shows that there are race/ethnicity discrepancies in obesity prevalence among youth. The lowest rates of obesity were observed in non-Hispanic Asians (8.6%) compared to non-Hispanic Whites (14.1%, $P=0.04$), non-Hispanic Blacks (20.2%, $P<0.001$) and Hispanics (22.4%, $P<0.001$). Moreover, no significant difference in obesity prevalence was noted between non-Hispanic Blacks and Hispanic youth ($P=0.31$) (2).

After-school obesity prevention interventions have been shown to be more effective than those offered during school hours since there is more time and flexibility during after-school hours (4, 5). The U.S. Department of Education reported that at least 37.7% of children aged 5 to 14 years take part in some form of after-school activity at least once a week (6). For these afore mentioned reasons, it is a good strategy to implement an obesity prevention programs during after-school hours.

The literature has shown conflicting results with regards to the effect of these programs on Body Mass Index (BMI) percentiles for age/gender as well as adiposity indices such as percent body fat (4, 7-12). Topp et al. (13) implemented an afterschool program that targeted African American children aged 5-10 years. The intervention consisted of three weekly 90-min after school sessions conducted for 14 weeks (Total 37 sessions). Results of this study indicated that there was no significant change in BMI or percent body fat. Yet, there was a trend toward improving their food habits (13). Another after-school health promotion program (12 week, 24 sessions) conducted by De Heer et al. (7) on Hispanic elementary school children (mean age 9.2 years) also showed no significant changes in BMI in the intervention or control group. However, participants did experience slight improvements in aerobic capacity as well as dietary outcomes (not significant) (7). On the other hand, Choudhry et al. (10) included 14 weekly sessions targeting African American children (16 boys, 24 girls) aged 5 to 12 years old. The results showed that parental attendance to the sessions was low, however, BMI z-scores for girls decreased significantly, with no significant change for boys. Nevertheless, the prevalence of healthy attitudes significantly increased in both genders (10).

Moreover, very few studies have included body composition analysis as an outcome to monitor pre and post-intervention (12). Ways to improve the current interventions should be developed in order to enhance health-related outcomes in school children. Also, innovative techniques should be incorporated into these programs to get the children more motivated. One novel intervention could be through the incorporation of a humanoid robot as a role model and assistant to the dietitian during the intervention sessions. Moreover, we are involving a registered dietitian in this study as the nutrition expert instead of the regular classroom teacher who might not be familiar or comfortable giving this material. After examining the results of this study, we may be able to create training sessions and manuals to train school staff/teachers who might be able to give the intervention themselves and thus maintaining sustainability of the program.

NAO is a 58-cm tall humanoid robot that can talk, walk, catch small objects, dance and do multiple programmable operations. The robot also has face recognition and can listen to children and respond to certain questions. The robot has been in the market since 2006 and is continuously being updated. This robot is currently being used in over 70 countries worldwide. They are used in schools and incorporated in computer and science classes, from primary school through to university (14).

The aim of this paper is to present a part of the outcomes of the ProHEART project: Promoting Healthy Eating and Activity using Robot-assisted Training. Outcomes including changes in nutrition and physical activity knowledge, habits and behavior will be discussed elsewhere. This paper discusses changes in body composition and anthropometrics including BMI z-scores, BMI percentiles specific for age/gender as well as body fat percentage pre and post intervention. The purpose of this program is to teach children healthy eating habits and promote physical activity, thus we hypothesize that BMI z-scores should decrease or not significantly change post-intervention compared to baseline in this growing population. Body fat mass and muscle mass are hypothesized to be maintained or to increase due to growth.

Methods

Subject Recruitment

An intervention study using a pretest-posttest quasi-experimental design (intervention and comparison groups) was conducted. A convenience sample was obtained from four locations of the Young Men's Christian's Association (YMCA) that currently offers afterschool programs in Miami-Dade County, Miami, Florida. Currently, the YMCA is the nation's largest not-for-profit community service organization whose impact focuses on youth development, healthy living and social responsibility. There are currently over a hundred afterschool programs offered by the YMCA in Miami-Dade, Broward and Monroe counties combined (15).

The study consisted of two phases: phase one included the screening of individuals; while phase two included the recruitment of individuals who met the inclusion/exclusion criteria. Eligibility criteria included being between the ages of 6 and 12 years, enrolled at one of the four participating YMCA locations in Miami-Dade County, English proficiency and both genders were included in the study. Exclusion criteria were recent surgery that may hinder physical activity, physical or mental disability such as autism, blindness or amputation, diagnosed with cancer or suffering from an untreated chronic disease such as uncontrolled diabetes, heart disease and/or joint problems that would be a barrier to physical activity. Assessments at all sites took place on week prior to the start of the intervention (week 0) and one week post-intervention (week 7). The time span between screening and baseline was one week. The study commenced in March 2015 and was completed in May 2015. The time span between screening and baseline was one week. The study commenced in March 2015 and was completed in May 2015.

A recruitment flyer explaining the purpose of the study, inclusion/exclusion criteria and the investigators' emails and phone numbers were distributed to all children in the four participating YMCA locations. If interested, parents/guardians were asked to approach the staff on site, or call/email the contact person on the flyer. An in person or over the phone screening to determine child eligibility was conducted. If the child met the inclusion/exclusion criteria, then an appointment was scheduled for informed consent and assent. Informed consent was obtained from one parent/legal guardian as well as child assent was obtained prior to enrollment in the study. Confidentiality measures were taken at all times during the study and participants were notified that any information provided would remain confidential. This study was approved by the Institutional Review Board at Florida International University.

After recruitment, each of the four participating YMCA sites was randomly assigned to one of two groups: intervention or comparison group. The comparison group consisted of children (n=51) from two locations that followed the regular after-school program that the YMCA offers Monday to Friday; no intervention was given. Whereas, the intervention group consisted of children (n=63) enrolled in two other YMCA locations that received nutrition and physical activity education from a registered dietitian and a humanoid robot “NAO” (Aldebran robotics; Paris, France), two days per week for a total of 6 weeks. Participants continued their regular YMCA afterschool program on the other three days of the week. Thus, in total, 12 intervention sessions were offered and each session was one hour in length.

The humanoid robot (NAO) was used as an assistant to the registered dietitian during all intervention lectures and activities with the aim of getting the children more interested in the subject and more interactive during the activities. The robot was programmed in a way in which it participated in the lecture/discussions, asked children questions, danced and performed certain movements. Incorporating NAO into the intervention as an innovative tool for obesity prevention in children has not been researched yet.

One hundred and nineteen participants were screened. One hundred and fourteen qualified for the study based on the inclusion/exclusion criteria set and were assessed at baseline: n=63 in the intervention group and n=51 in the comparison group. One participant in the comparison group and 8 participants in the intervention group withdrew after the baseline assessment due to no longer being enrolled at the YMCA. Thus, 105 participants were assessed post-intervention (week 7): n=50 in the comparison group and n=55 in the intervention group. An intent to treat approach was followed, and thus all 114 participants were included in the present study.

Intervention sessions

Intervention sessions targeted nutrition and physical activity education via lectures, games and interactive activities given by the dietitian and NAO. They consisted of 20-25 minutes of discussion, information and interaction about the topic of the week followed by 35-40 minutes of a hands-on activity to meet the learning objectives of that session (i.e. games). After each session, pamphlets summarizing recommendations of that session with examples where provided in order to be given to parents/guardians. We did not include families in the intervention sessions since parents mostly place their children in the after-school program due to the fact that they are unavailable to pick them up right when school ends. Thus, our primary focus of this study was the children.

Measures

After screening and consent, participants' parent/guardian was asked to complete the standard socio-demographic questionnaire on site at baseline (week 0). A trained interviewer administered the questionnaire in order to collect the data. Information collected included socio-demographic variables such as child's gender, race/ethnicity, age/birth date, grade level, first language spoken at home as well as annual household income.

Body weight was measured using the Inbody 230 instrument (Biospace, California). Shoes, socks and heavy clothing such as a jacket were removed prior to measurement. Height was measured to the nearest 0.1 cm using a portable stadiometer Seca 213 (Seca Corp, Maryland). Body Mass Index (BMI) percentiles and associated BMI z-score for age and gender were calculated based on the Center for Disease Control and Prevention (CDC) growth charts since participants were under the age of 20 years (16). BMI for age percentile categories include: Underweight (less than 5th percentile), healthy weight (5th percentile to less than the 85th percentile), overweight (85th to less than the 95th percentile) and Obese (equal or greater than the 95th percentile).

Body composition analysis including percent body fat, fat mass, skeletal muscle mass and total body water of subjects were measured via the bioelectrical impedance analysis technique using Inbody 230 (Biospace, California). This instrument has been validated in the literature and deemed as an accurate, reliable and cost-effective alternative to Dual-energy X-ray absorptiometry (DXA) in the child, adolescent and adult populations (17-21).

Statistical analysis

The independent variable of interest is the treatment group. Children in the randomized sites not receiving intervention where considered as the comparison group; while children in randomized sites receiving the 6 week intervention where considered as the intervention group. Dependent variables being tested were derived from anthropometric and body composition measurements obtained from the children that included weight, height, percent body fat, body fat mass, skeletal muscle mass, total body water, BMI percentile and BMI z-score.

Baseline differences between intervention and comparison schools were assessed. Descriptive statistics were used for baseline characteristics. Continuous normally distributed data and categorical data were compared using an independent t-test and a chi-squared test, respectively. In the latter analyses, Fisher's exact test was used if cell count was less than 5. An independent t-test was used on data that is continuous and normally distributed since we aimed at comparing independent measures between two groups (age, percent body fat, body fat mass, skeletal muscle mass and total body water). Intent to treat analysis was used to include those lost to follow-up post-intervention. A paired t-test was used to determine differences pre- and post- intervention in anthropometric and body composition measurements (weight, percent body fat, body fat mass, skeletal muscle mass, total body water and BMI z-score) within each group. A Wilcoxon signed-rank test was used as a non-parametric statistical test to compare two repeated measurements on anthropometric and body composition data collected (i.e. between intervention at baseline and intervention post-test; between comparison at baseline and comparison post-test).

Significance was set at $p<0.05$ and all analyses were two sided. Statistical analysis was conducted using SPSS 21.0 (Chicago).

Results

Baseline demographic characteristics

The baseline demographic characteristics are summarized in Table 1. The intervention and comparison groups were significantly different based on ethnicity, P=0.015, in spite of the fact that the majority of the participants in both groups were Hispanic/Latino (35.3% in the comparison group and 58.7% in the intervention group). Also, most of the subjects reported English was their first language spoken at home (92.2% vs. 69.8%, P=0.005 for comparison and intervention groups; respectively). However, there was no significant difference between the groups at baseline with regards to age (Mean: 8.16 ±1.57 years, P=0.091), gender (P=0.061), grade level (P=0.287) or annual household income (P=0.103).

BMI z-scores, body composition and weight

Table 2 shows the findings of a paired t-test of body composition outcomes by intervention group at baseline and post-intervention. Results depict that both comparison and intervention groups gained significant weight of 0.48 kg and 0.74 kg, respectively (P<0.001) post-intervention. Also, percent body fat had a significant increase of 2.85% (P<0.001) in the intervention group and a non-significant increase of 0.66% (P=0.199) in the comparison group post-test. Body fat mass significantly increased in both groups, but there was a greater increase in the intervention group (1.06 kg, P<0.001 versus 0.36 kg, P=0.022). There was no significant change in skeletal muscle mass in both groups pre and post intervention. Total body water decreased significantly in the intervention group (-0.24 kg, P=0.046) whereas no significant change was noted in the comparison group. Moreover, BMI z-scores had no significant change pre and post-test in both groups.

When post-intervention data was further stratified by gender and ethnicity in order to show which subgroup contributed to the weight gain the most (data not shown in table), it was noted that girls in the intervention group gained significantly more weight than boys (P<0.001); whereas boys in the comparison group gained significantly more weight than girls (P<0.001). Moreover, the “other” ethnicity in the comparison group that included Asians and Haitians showed the most significant weight gain post-intervention (1.16 kg ±0.31, P=0.022), followed by African Americans/Blacks (0.48 kg ±0.84, P=0.045), Hispanics (0.44 kg ±0.17, P=0.018) and Whites (0.39 kg ±0.49, P=0.012). However in the intervention group, Whites and African Americans/Blacks did not show any significant weight gain post-intervention. In fact, the “other” ethnicity showed the most significant weight gain (1.2 kg ±0.55, P=0.022) followed by Hispanics (0.81 kg ±0.94; P<0.001). No significant differences were noted post-intervention between BMI z-scores and gender or ethnicity.

Distributions of weight and body composition outcomes by intervention condition are shown in Table 3. At baseline, the intervention group had significantly more skeletal muscle mass (P=0.016) and total body water (P=0.017) than the comparison group. All other anthropometric variables including weight were not significant at baseline. Post-intervention data shows no significance between the groups with regards to weight (P=0.08), percent body fat (P=0.088), fat mass (P=0.078), skeletal muscle mass (P=0.139) and total body water (P=0.139).

The results of a Wilcoxon signed-ranks test (Table 4) intended to compare anthropometric and body composition data by treatment group (post-test versus pre-test), showed that in both comparison and intervention groups, children had significantly more weight ($P<0.001$ in both groups), percent body fat ($p=0.045$, $p<0.001$; respectively) and fat mass ($p=0.04$, $p<0.001$; respectively) post-test as compared to baseline. However, no significant difference was noted post-intervention in both groups with regards to BMI z-scores, total body water or skeletal muscle mass when compared to baseline.

BMI for age percentiles

Table 5 shows the distributions of subjects' BMI for age percentiles, pre and post intervention. Results indicate that there was no significant difference between BMI percentile categories at baseline (P=0.522) or post intervention (P=0.853) between the two groups.

Attendance

Average participant attendance to the intervention sessions was 64%. Above mentioned variables were analyzed for those that attended 80% or more of the sessions. However, no differences were noted in the aforementioned results and thus were not reported.

Discussion

Our major finding was that the ProHEART intervention group did not show any significant change in BMI z-scores post-test. As an obesity prevention study, we did not want to see an increase in BMI z-scores and that did not occur. Although we did observe a significant increase in body weight, but that was seen in both the intervention and comparison groups simultaneously, which we can attribute to growth. Unfortunately, we did not measure height post-intervention to ascertain that. However, even though the subjects gained weight (0.74 kg), they did not show any significant changes in BMI z-scores or BMI for age/gender percentiles pre- and post-intervention, which might tell us that maybe this gain in weight, although statistically significant, is not clinically significant.

The literature seems to show conflicting findings with regards to changes in body composition and BMI z-scores following a nutrition and physical activity intervention. After a 12-month intervention, Sacher et al. (12) did show a significant decrease in BMI z-scores, however no change in percent body fat was noted. Wofford et al. (11) (12-week intervention), Dzewaltowski et al. (4) (3-year intervention), Iversen et al. (8) (7-month intervention) and De heer et al. (7) (12-week intervention) outcomes support our results in that there was no change in BMI z-scores post-intervention. Topp et al. (13) (14-week intervention) did not observe any change in BMI z-scores or percent body fat. However, Chomitz et al. (9) (3-year trial) and Choudhry et al. (10) (14-week intervention), did report that BMI z-scores significantly decreased by the end of the intervention. However, both studies did not measure body composition. Choudhry et al. (10) did on the other hand include a parental component, but attendance was very low; only 14 parents attended more than 30% of the sessions. Therefore, it is unclear if intervention length has an effect on BMI z-scores or not. Also, the effect of parental involvement of BMI z-scores and body composition is vague. In our study, flyers were sent out to the parents summarizing recommendations; but we did not measure if the parents were actually reading these flyers. We did not include a more involved family component, as it was hard to get parents to come to a session. Parents mostly work and place their children in the after-school program since they can't pick them up when school ends. Another limitation of our study was that participant attendance to the intervention sessions was low (average: 64%) but did not affect the results.

Our study has several strengths. First, the study design included a comparison group, which is lacking in most of the after-school programs published (7-11, 22, 23). Second, we were able to randomize sites to comparison or intervention groups. Third, the two groups were very close in sample size (51 in the comparison group and 63 in the intervention group). Fourth, we only lost nine participants post intervention (one in the control and eight in the intervention) due to no longer being enrolled in the YMCA. Fifth, to our knowledge, this is the first study that incorporated a humanoid robot along with a registered dietitian into an after-school nutrition and physical activity intervention.

Finally, our results suggest that project ProHEART was effective in maintaining the BMI z-scores of children over a 6 week period. Positive primary outcomes related to improved physical activity, nutrition knowledge and eating habits/ behavior were achieved as a result of this study, but will be discussed elsewhere. Also, the question remains that if a longer follow-up time would have led to better outcomes and if a more hands-on family component is feasible in this community.

Table 1. Baseline demographic characteristics by treatment group (N=114)

Characteristic	**Comparison Group**	**Intervention Group**	**P-Value**
	n=51	**n=63**	
Age in years Mean (SD)	8.16 (1.57)	8.69 (1.68)	0.091
Race/Ethnicity Percentage (n)			0.015*
White	27.5 (14)	25.4 (16)	
Black/African American	31.4 (16)	9.5 (6)	
Hispanic/Latino	35.3 (18)	58.7 (37)	
Other	5.8 (3)	6.4 (4)	
Gender Percentage (n)			0.061
Male	66.7 (34)	49.2 (31)	
Female	33.3 (17)	50.8 (32)	
Grade Percentage (n)			0.287
Kindergarten	17.6 (9)	14.3 (9)	
1st grade	31.4 (16)	20.6 (13)	
2nd grade	17.6 (9)	14.3 (9)	
3rd grade	7.9 (4)	17.5 (11)	
4rth grade	19.6 (10)	17.5 (11)	
5th grade	5.9 (3)	15.8 (10)	
First language spoken at home Percentage (n)			0.005*
English	92.2 (47)	69.8 (44)	
Spanish	3.9 (2)	27 (17)	
Other	3.9 (2)	3.2 (2)	
Annual household income Percentage (n)			0.171
<=$50,000	41.2 (21)	28.6 (18)	
> $50,000	58.8 (30)	71.4 (45)	

Continuous variable (age) is presented as mean (SD) and categorical variables as percentage (n). * Represents significant differences. Level of significance is at $P<0.05$.
Abbreviations: SD= Standard Deviation

Table 2. Paired t-test of outcomes by intervention group (N=105)

	Comparison group (n=50)				Intervention Group (n=55)			
Outcomes	**Post intervention Mean (SD)**	**Baseline Mean (SD)**	**Paired Difference Mean (SD)**	**P-Value**	**Post intervention Mean (SD)**	**Baseline Mean (SD)**	**Paired Difference Mean (SD)**	**P-Value**
Weight (kg)	33.39 (9.39)	32.91 (9.26)	0.48 (0.69)	<0.001*	37.09 (11.79)	36.36 (11.61)	0.74 (0.99)	<0.001*
Percent body fat (%)	30.59 (7.45)	29.93 (8.42)	0.66 (3.58)	0.199	33.0 (6.72)	30.12 (8.26)	2.85 (5.34)	<0.001*
Body fat mass (kg)	10.68 (5.66)	10.32 (5.60)	0.36 (1.06)	0.022*	12.73 (6.12)	11.63 (6.14)	1.06 (1.33)	<0.001*
Skeletal muscle mass (kg)	11.47 (2.74)	11.30 (3.16)	0.17 (1.33)	0.369	12.47 (3.86)	12.70 (3.80)	-0.23 (0.93)	0.074
Total body water (kg)	16.71 (3.39)	16.51 (3.68)	0.19 (1.17)	0.247	17.92 (4.74)	18.15 (4.62)	-0.24 (0.86)	0.046*
Body mass index z-score	-0.13 (0.90)	-0.0114 (0.93)	-0.016 (0.12)	0.356	0.118 (1.08)	0.117 (1.12)	0.001 (0.15)	0.977

Variables are presented as mean (SD). Z-score represented as number of standard deviations the data is above or below a population mean.* Represents significant differences. Level of significance is at $P<0.05$.
Abbreviations: SD= Standard Deviation

Table 3. Distributions of weight and body composition outcomes by intervention condition

	Baseline			Post intervention		
Outcomes	**Comparison Group n=51 Mean (SD)**	**Intervention Group n=63 Mean (SD)**	**P-Value**	**Comparison Group n=50 Mean (SD)**	**Intervention Group n=55 Mean (SD)**	**P-Value**
Weight (kg)	32.76 (9.24)	36.58 (11.31)	0.054	33.39 (9.39)	37.09 (11.79)	0.08
Percent body fat (%)	29.77 (8.41)	29.77 (8.07)	1.00	30.59 (7.45)	32.98 (6.72)	0.088
Body fat mass (kg)	10.23 (5.59)	11.54 (5.91)	0.231	10.68 (5.66)	12.73 (6.12)	0.078
Skeletal muscle mass (kg)	11.27 (3.13)	12.90 (3.83)	0.016*	11.47 (2.74)	12.47 (3.86)	0.139
Total body water (kg)	16.47 (3.66)	18.42 (4.67)	0.017*	16.7 (3.39)	17.92 (4.74)	0.139

Independent t-test was used. Variables are presented as mean (SD). * Represents significant differences. Level of Significance is at $P<0.05$. Abbreviations: SD= Standard Deviation.

Table 4. Participants' anthropometric and body composition measures by treatment group: Post-test versus pre-test

Anthropometric/body composition data (posttest vs. pretest)	Comparison (n) n= 50	P-Value	Intervention (n) n=55	P-Value
Weight (kg)		<0.001*		<0.001*
Individuals with negative scores	10		10	
Individuals with positive scores	38		44	
Individuals with ties	2		1	
Percent Body Fat (%)		0.045*		<0.001*
Individuals with negative scores	14		9	
Individuals with positive scores	36		46	
Individuals with ties	0		0	
Body Fat Mass (Kg)		0.004*		<0.001*
Individuals with negative scores	14		8	
Individuals with positive scores	32		44	
Individuals with ties	4		3	
Skeletal Muscle Mass (kg)		0.089		0.111
Individuals with negative scores	18		30	
Individuals with positive scores	28		20	
Individuals with ties	4		5	
Total Body Water (Kg)		0.083		0.056
Individuals with negative scores	15		29	
Individuals with positive scores	29		19	
Individuals with ties	6		7	
BMI z-score		0.66		0.738
Individuals with negative scores	25		25	
Individuals with positive scores	25		30	
Individuals with ties	0		0	

Wilcoxon signed rank test was used. Data represented by n. A negative score suggests post-test < pre-test value. A positive score suggests post-test > pre-test value. A tie suggest pre-test= post-test value. * Represents significance from baseline. Level of significance is at P<0.05.

Table 5. Distributions of subjects' BMI for age percentiles, pre and post intervention in comparison and intervention groups.

	Baseline Groups			**Post Intervention Groups**		
Category	**Comparison n= 50 Percentage (n)**	**Intervention n= 55 Percentage (n)**	**P-Value**	**Comparison n=50 Percentage (n)**	**Intervention n=55 Percentage (n)**	**P-Value**
BMI for age percentile			**0.522**			**0.853**
Healthy weight (5th to less than 85th percentile)	46.0 (23)	45.5 (25)		44.0 (22)	43.6 (24)	
Overweight (85th to less than 95th percentile)	26.0 (13)	18.1(10)		22.0 (11)	18.2 (10)	
Obese (95th percentile or greater)	28.0 (14)	36.4 (20)		34.0 (17)	38.2 (21)	

Chi-squared test was used. Categorical variables presented as percentage (n). Level of significance is at $P<0.05$. Abbreviations: BMI= Body Mass Index

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CHAPTER V: SUMMARY AND CONCLUSIONS

Discussion of hypotheses

The effect of project ProHEART on nutrition knowledge and behavior

A 12-session nutrition intervention with a humanoid robot and a registered dietitian significantly increased nutrition knowledge as well as enhanced overall healthy eating behavior among children ages 6-12 in an afterschool setting.. Consumption of high fat/sugary food items was significantly decreased, vegetable intake was significantly increased and the majority of healthy food/ snack choices showed significant improvement. This study addressed the shortage of published research on childhood obesity prevention specifically among minority populations since our study population was comprised of 55% Hispanics and 22% African Americans.

Overall, hypotheses 1 a, c, d and 2 a, c, d of this intervention that would lead to an improvement in nutrition knowledge, attitudes and behaviors were supported. However, hypotheses 1b and 2 b were only partially supported since we were only able to see a significantly greater intake of vegetables but not fruits post-intervention.

The effect of project ProHEART on physical activity and screen time outcomes

Our results show that a 12-session nutrition and physical activity intervention conducted with a humanoid robot and by a registered dietitian lead to a significant increase in the previous day physical activity in the after-school hours as well as a significant reduction in screen time during the weekday and weekend.

Overall, hypotheses 3 a, b and 4 a, b were supported in that this intervention is effective in increasing previous day physical activity as well as decreasing screen time.

However, hypotheses 3 c and 4c were partially supported since children reported positive physical activity attitudes such as being physically active 3-5 times a week at baseline and these attitudes did improve post-intervention but not significantly. However, there was a significant improvement in the intervention group compared to the comparison group with regards to biking/running 3-5 times a week.

The effect of project ProHEART on anthropometrics and body composition

The main outcomes BMI z-scores and BMI for age/gender percentiles did not show any significant changes from baseline in both the intervention and comparison groups, which was our goal for the 6-week intervention. We did not see an increase in BMI z-scores that is a crucial outcome in an obesity prevention program. Both groups showed a significant increase in body weight (less than 1 Kg) from baseline, which was attributed to growth. Regarding body composition, our analyses indicated that both groups significantly gained body fat mass, the intervention group had significantly less total body water content whereas there was no change in skeletal muscle mass in either group. These results were partially supported by our hypotheses 5 a, b that stated that children's BMI z-scores and body fat mass will not be significantly different post-test. We did achieve that for the BMI z-scores but we rejected the hypothesis that participants in the intervention group will not have significantly different body fat mass posttest and that was attributed to growth. A trend towards significance was also expected in BMI z-scores, but was not achieved, perhaps due to the short duration of the intervention.

CHAPTER VI: STRENGTHS AND LIMITATIONS

Our study has several strengths. First, the study design included a comparison group, which is lacking in most of the after-school programs published. Second, we were able to randomize sites to comparison or intervention groups. Third, the two groups were very close in sample size (51 in the comparison group and 63 in the intervention group). Fourth, we only lost nine participants post intervention (one in the control and eight in the intervention) due to no longer being enrolled in the YMCA. Fifth, to our knowledge, this is the first study that incorporated a humanoid robot along with a registered dietitian into an after-school nutrition intervention.

Limitations of our study included having only a convenience sample from the YMCA. Also, there was an imbalance in baseline characteristics for ethnicity with the intervention group having significantly more Hispanics/Latinos and less blacks/African Americans than the comparison group. A longer follow-up time may be needed in order to observe if results were sustainable long-term. Although pamphlets summarizing recommendations were sent after each session to parents/guardians, there was no measure of whether or not they were reading them or complying with recommendations. We were unable to include a more involved family component, as it was difficult to get parents to come to a session. Parents mostly worked and placed their children in the after-school program since they can not pick them up when school ends. Additionally, participant attendance at the intervention sessions was low (average: 64%). Furthermore, there is always a bias in reporting when including self-reported questionnaires. Lastly, we did not reach our sample goal of 120 (sample size was 114) for our main hypothesis where we compared the results of the intervention group with the comparison group post-test (difference between two independent means), which decreased our power to 75%. However, we did achieve a power of 99.9% for our secondary hypothesis where we compared the results of each group post-test to its baseline value (difference between two dependent means, matched pairs).

CHAPTER VII: FUTURE RESEARCH

Introducing interactive robots to nutrition education is an area that needs to be explored further, but the results of this study are promising. Our results suggest that the after-school nutrition program led by a dietitian and a humanoid robot targeting elementary children aged 6-12 was successful in improving nutrition knowledge, promoting healthy nutrition behavior and habits, increasing overall physical activity during after-school hours as well as decreasing screen time (time spent on TV, video games and computers). This intervention also showed no significant effect on BMI percentiles or BMI z-scores, as expected. Therefore, future research should aim at targeting more sites for a larger sample size, and longer follow-up time to determine sustainability of these results. Also, including a more hands-on family component will be needed to be addressed as well. An idea would be to send nutrition education videos to the parents and also measure their change in nutrition and physical activity knowledge and behavior. Moreover, we might consider developing a training program and manual to train the after-school staff (train the trainers) to continue this project on an annual basis for sustainability.

Appendix 1: Recruitment flyer

Using a Robot along with a Registered Dietitian to Promote Healthy Eating Habits and Physical Activity in School-aged Children

We would like to invite your child to participate in an after-school program conducted at your local YMCA in collaboration with a Registered Dietitian from Florida International University

Criteria for your child to be eligible to enroll:

- Your child must be 6-12 years old
- You must agree to have your child attend the SPARK (Sports Play Active Recreation for Kids) after-school program offered by your school daily for 6 weeks.
- You must agree to fill out a questionnaire prior to the study commencing.
- You must agree to us taking your child's height and weight as well as analyzing your child's body composition (one week before the study starts and one week after the study ends).

Your child will be given information on nutrition and physical activity. The sessions will also consist of educational games and discussion. This intervention will be incorporated within the current after-school program (SPARK) that is currently available at the school. Your child will also be asked to fill out questionnaires at the beginning and end of the study.

Your child will receive nutrition education from a Registered Dietitian. No money will be given as compensation

If you would like your child to participate or for further information, please call or email

Nadine Mikati: 305-393-9289 or nmika001@fiu.edu

Appendix 2: Screening form

Screening form- script

Parent/Guardian name:________________________

Child name:______________________________________

Child ID number: ________________________________

Please provide telephone number:___________________

We sent a handout last week with your child regarding the 6 week after-school program research study that we will be conducting at your local YMCA aimed to improve your child's nutrition and physical activity knowledge, behaviors and attitudes. It will be offered at the same time and place as the current after-school program your child is enrolled in (SPARK) and will be at no additional cost to you.

Your child still needs to be enrolled in the YMCA's SPARK after-school program in order to participate in this research study.

1. You had indicated that you are interested in enrolling your child in our research study. Would you like your child to participate?
   - ☐ Yes
   - ☐ NO

   If No: Thank you for your time Mr/ Mrs ________
2. Is your child between the ages of 6-12?
   - ☐ Yes
   - ☐ NO

   If No: sorry your child does not qualify for the current study. Nice talking to you Mr/ Mrs __________
3. Has your child undergone recent surgery that may hinder his/her physical activity?
   - ☐ Yes
   - ☐ NO

   If yes: sorry you do not qualify for the current study. Nice talking to you Mr/ Mrs __________

4. Does your child have any physical or mental disability?
   - ☐ Yes
   - ☐ NO

   If yes: sorry you do not qualify for the current study. Nice talking to you Mr/ Mrs

   ____

5. Does your child have cancer or any other chronic medical condition that would be a barrier to physical activity?
   - ☐ Yes
   - ☐ NO

   If yes: sorry you do not qualify for the current study. Nice talking to you Mr/ Mrs ___________

If child meets all the inclusion/exclusion criteria above then move on to consent forms.

If the child does NOT meet the inclusion/exclusion criteria above then, thank them for their time. The child will not be eligible to participate.

Appendix 3: IRB approved Consent/Assent Forms

FIU IRB	1/29/2015
FIU IRB	1/29/2016
FIU IRB Number:	IRB-15-

FIU IRB re-	12/22/201
FIU IRB	12/22/201
FIU IRB Number:	IRB-15-

FLORIDA INTERNATIONAL UNIVERSITY

PARENTAL CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Using a Humanoid Robot along with a Registered Dietitian to Promote Healthy Eating Habits and Physical Activity in School-aged Children

PURPOSE OF THE STUDY

You are being asked to give your permission for your child to be in a research study. The purpose of this study is to determine whether a nutrition and physical activity intervention with a Registered dietitian and a talking robot is more effective than the comparison groups receiving no robot or dietitian intervention.

NUMBER OF STUDY PARTICIPANTS

If you agree to allow your child to participate in this study, he/she will be one of 130 people in this research study.

DURATION OF THE STUDY

Your child's participation will require participation in an afterschool program offered by the YMCA for a period of 6 weeks for the intervention (Mondays through Fridays, 3:30-4:30 pm). Also, participation is also required a week before the study starts and a week after the study ends.

PROCEDURES

If your child participates in this study, we will ask your child to do the following things:

1. Four YMCA after-school program locations will be chosen in Miami-Dade County for this study. Depending on which location your child is in, he/she will be assigned to the comparison group or the intervention group.

2. If your child is enrolled in one of the sites assigned to the comparison group, then he/she will be asked to continue to attend the current afterschool sessions provided by the YMCA called SPARK (Sports Play Active Recreation for Kids). This program consists of various physical activity sessions for kids such as ball throwing and group sports.

3. If your child is enrolled in one of the YMCA sites assigned to the intervention group, then he/she will be asked to attend a new nutrition and physical activity intervention. Your child will attend nutrition and physical activity sessions offered by a Registered Dietitian and a talking robot for 2 days a week. And on the remaining three weekdays, your child will continue the current SPARK afterschool sessions offered

by YMCA. Sessions will include information on adequate nutrition, interactive games and physical activity exercises like dancing, ball throwing and group sports.

4. All programs and activities will take place on YMCA grounds.

5. Data that will be obtained includes: height, weight and body composition analysis that is determined via a machine they step on. This machine is needed to determine body fat percentage. Your child will also be asked to fill out questionnaires that are related to their nutrition and physical activity habits, behaviors and knowledge.

6. Data will be collected before the study starts and on the last week of the study (week 7).

7. The parent or guardian will be asked to fill out one form at the beginning of the study regarding student gender, race/ethnicity, age/birth date and grade level; parental/guardian employment status; annual family income and first language spoken at home.

RISKS AND/OR DISCOMFORTS

The following risks may be associated with your child's participation in this study: Your child may experience minor muscle soreness due to physical activity. This study is considered a minimal risk and participation is voluntary.

BENEFITS

The following benefits may be associated with your child's participation in this study: Your child may experience improvement in nutrition and physical activity knowledge and make better food choices. Weight might also improve.

ALTERNATIVES

Your child may choose to remain in the regular YMCA after-school program that your child is enrolled in and not participate in this intervention. However, any significant new findings developed during the course of the research that may relate to your child's willingness to continue participation will be provided to you.

CONFIDENTIALITY

The records of this study will be kept private and will be protected to the fullest extent provided by law. In any sort of report we might publish, we will not include any information that will make it possible to identify your child as a subject. Research records will be stored securely and only the research team will have access to the records. However, your child's records may be reviewed for audit purposes by authorized University or other agents who will be bound by the same provisions of confidentiality.

COMPENSATION & COSTS
There will be no monetary compensation provided to your child. Your child will not be responsible for any costs to participate in this study. Your child will be receiving nutrition education from a Registered Dietitian.

RIGHT TO DECLINE OR WITHDRAW
Your child's participation in this study is voluntary. Your child is free to participate in the study or withdraw his/her consent at any time during the study. Your child's withdrawal or lack of participation will not affect any benefits to which he/she is otherwise entitled. The investigator reserves the right to remove your child from the study without your consent at such time that they feel it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research study you may contact Dr. Fatma Huffman or Nadine Mikati MS, RD at Florida International University 11200 SW 8th St, AHC-5, Miami, FL 33174, Telephone: 305-348-3788 or 305-393-9289, huffmanf@fiu.edu or nmika001@fiu.edu.

IRB CONTACT INFORMATION
If you would like to talk with someone about your child's rights of being a subject in this research study or about ethical issues with this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT
I have read the information in this consent form and agree to allow my child to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. I understand that I will be given a copy of this form for my records.

_____________________________ _________________
Signature of Parent/Guardian Date

____
Printed Name of Parent/ Guardian

____
Printed Name of Child Participant

_____________________________ _________________
Signature of Person Obtaining Consent Date

Child ID# :__________________________

CHILD ASSENT TO PARTICIPATE IN A RESEARCH STUDY
Using a Humanoid Robot along with a Registered Dietitian to Promote Healthy Eating Habits and Physical Activity in School-aged Children

WHY ARE YOU DOING THIS STUDY?
We would like for you to be in a research study we are doing. A research study is a way to learn information about something. We would like to find out more about afterschool nutrition and physical activity sessions offered by a registered dietitian and talking robot.

HOW MANY OTHERS WILL BE IN THIS STUDY?
If you agree to participate in this study, you will be one of 130 children in this research study.

HOW LONG WILL THE STUDY LAST?
Your participation will require 8 weeks (Mondays through Fridays, 3:30-4:30 pm)

WHAT WILL HAPPEN IN THIS STUDY?
If you participate in this study, we will ask you to do the following things:

1. Attend the afterschool sessions available at your YMCA location (Mondays through Fridays, 3:30-4:30 pm). These sessions will teach you about what good nutrition is. Games and exercise will also be part of the sessions.

2. We will determine your height, weight and how much fat, muscle and water your body contains.

3. You will be asked to fill out forms related to your food and exercise habits and knowledge. This is not a test and will not be graded.

CAN ANYTHING BAD HAPPEN TO ME?
You may experience slight muscle soreness due to exercise.

CAN ANYTHING GOOD HAPPEN TO ME?
The following benefits may be associated with your participation in this study: you may experience improvement in your food and exercise knowledge and have better food choices. Your weight may also improve.

DO I HAVE OTHER CHOICES?
You may choose to remain in the regular YMCA after-school program that you are

enrolled in and not participate in this intervention.

WILL ANYONE KNOW I AM IN THE STUDY?
The records of this study will be kept private and will be protected by the researchers. Research records will be stored securely and only the researcher team will have access to the records.

WILL I BE GIVEN ANYTHING FOR PARTICIPATING?
There will be no money compensation provided to you.
You will not need to pay for anything to participate in this study.

WHAT IF I DO NOT WANT TO DO THIS?
You do not have to be in this study if you don't want to and you can quit the study at any time. If you don't like a question, you don't have to answer it and, if you ask, your answers will not be used in the study. No one will get mad at you if you decide you don't want to participate.

WHO CAN I TALK TO ABOUT THE STUDY?
If you have any questions about the research study you may contact Dr. Fatma Huffman or Nadine Mikati MS, RD at Florida International University 11200 SW 8th St, AHC-5, Miami, FL 33174, Telephone: 305-348-3788 or 305-393-9289, huffmanf@fiu.edu or nmika001@fiu.edu.
If you would like to talk with someone about your rights of being a participant in this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT
This research study has been explained to me and I agree to be in this study.

_________________________________ ________________
Signature of Child Participant Date

____
Printed Name of Child Participant

_______________________________ ________________
Signature of Person Obtaining Consent Date

Child generated ID# :___________________________

Appendix 4: Socio-demographic questionnaire

FLORIDA INTERNATIONAL UNIVERSITY

Child ID Number: _____________

Please provide the following information. All information obtained will be kept confidential.

1. Child Gender:
   - ☐ Boy
   - ☐ Girl

2. Age:
   - ☐ 6 years old
   - ☐ 7 years old
   - ☐ 8 years old
   - ☐ 9 years old
   - ☐ 10 years old
   - ☐ 11 years old
   - ☐ 12 years old

3. Please write your child's exact birth date (Month/Day/year):
   ____

4. Grade level:
   - ☐ Kindergarten
   - ☐ First grade
   - ☐ Second grade
   - ☐ Third grade
   - ☐ Fourth grade
   - ☐ Fifth grade
   - ☐ Sixth grade

5. What is your child's race/ethnicity:
   - ☐ White
   - ☐ Black or African American
   - ☐ Hispanic or Latino
   - ☐ Asian or Pacific Islander
   - ☐ American Indian or Alaskan Native
   - ☐ Other; Please specify: _____________________

6. What is the first language spoken at home:
    - ☐ English
    - ☐ Spanish
    - ☐ Portuguese
    - ☐ French
    - ☐ Creole
    - ☐ Other; Please Specify: ______________________

7. What is your annual household income?
    - ☐ Less than $20,000 per year
    - ☐ Between $20,000 and $50,000 per year
    - ☐ Between $50,000 and $80,000 per year
    - ☐ Between $80,000 and $100,000 per year
    - ☐ Greater than $100,000 per year

8. Please Specify if your child has any known food allergies:

    ____

Thank you!

Appendix 5: CATCH Kids Club Questionnaire

CATCH KIDS CLUB
AFTER-SCHOOL STUDENT QUESTIONNAIRE

The following questions ask about foods and meals you eat, and what you know about nutrition and physical activity. **This is not a test.** We want to learn about what kids your age eat and know about nutrition and about physical activity.

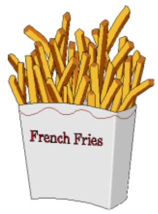
The answers you give will be kept private. No one will ever know what you say unless you tell them. Your name will never be used.

Please be as honest as you can.

STUDENT ID #: ___________

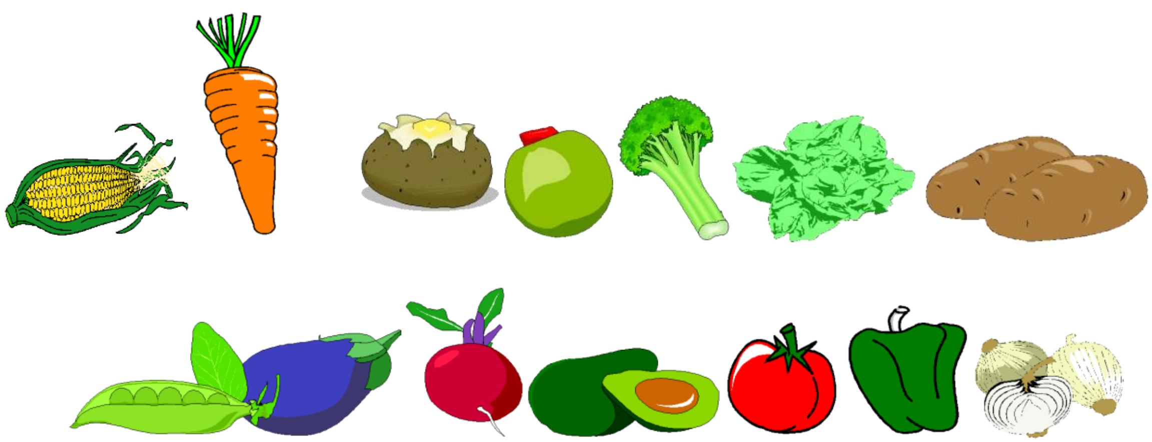
INSTRUCTIONS: Please <u>CIRCLE</u> your answer.

1. Yesterday, did you eat French fries or chips?
Chips are potato chips, tortilla chips, Cheetos, corn chips, or other snack chips.



a. No, I didn't eat any French fries or chips yesterday.
b. Yes, I ate French fries or chips **1 time** yesterday.
c. Yes, I ate French fries or chips **2 times** yesterday.
d. Yes, I ate French fries or chips **3 or more times** yesterday.

2. Yesterday, did you eat any vegetables?
***Vegetables* are salads; boiled, baked and mashed potatoes; and all cooked and uncooked vegetables.**
<u>Do not count</u> French fries or chips.



a. No, I didn't eat any vegetables yesterday.
b. Yes, I ate vegetables **1 time** yesterday.
c. Yes, I ate vegetables **2 times** yesterday.
d. Yes, I ate vegetables **3 or more times** yesterday.

3. **Yesterday, did you eat beans such as pinto beans, black beans, baked beans, kidney beans, refried beans, or pork and beans?** **<u>Do not count</u> green beans.**

a. No, I didn't eat any beans yesterday.
b. Yes, I ate beans **1 time** yesterday.
c. Yes, I ate beans **2 times** yesterday.
d. Yes, I ate beans **3 or more times** yesterday.

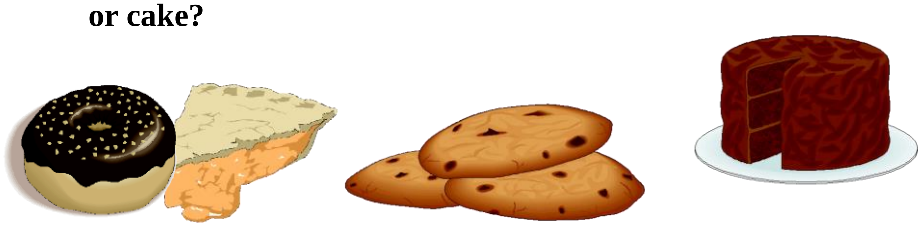
4. **Yesterday, did you eat fruit?** **<u>Do not count</u> fruit juice.**

a. No, I didn't eat any fruit yesterday.
b. Yes, I ate fruit **1 time** yesterday.
c. Yes, I ate fruit **2 times** yesterday.
d. Yes, I ate fruit **3 or more times** yesterday.

5. **Yesterday, did you drink fruit juice?**
<u>Fruit juice</u> is a drink, which is 100% juice, like orange juice, apple juice, or grape juice.
<u>Do not count</u> punch, kool-aid, sports drinks, and other fruit-flavored drinks.

a. No, I didn't drink any fruit juice yesterday.
b. Yes, I drank fruit juice **1 time** yesterday.
c. Yes, I drank fruit juice **2 times** yesterday.
d. Yes, I drank fruit juice **3 or more times** yesterday.

6. **Yesterday, did you eat sweet rolls, doughnuts, cookies, brownies, pies, or cake?**



a. No, I didn't eat any of the foods listed above yesterday.
b. Yes, I ate one of these foods **1 time** yesterday.
c. Yes, I ate one of these foods **2 times** yesterday.
d. Yes, I ate one of these foods **3 or more times** yesterday.

7. Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes. (For example: basketball, jogging, skating, fast dancing, swimming laps, tennis, fast bicycling, or aerobics)?

a. YES
b. NO

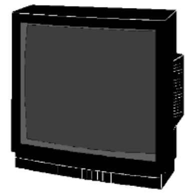
8. During the week, how many hours <u>per day</u> do you <u>usually</u> spend watching TV shows or videos?

a. I don’t watch TV or videos
b. Less than 1 hour a day
c. 1-2 hours a day
d. 3-4 hours a day
e. More than 4 hours a day

9. During the week, how many TV shows or videos do you <u>usually</u> watch each day?

a. I don’t watch TV or videos
b. 1
c. 2
d. 3 or more

10. During the <u>weekend,</u> how many hours <u>per day</u> do you <u>usually</u> spend watching TV shows or videos?

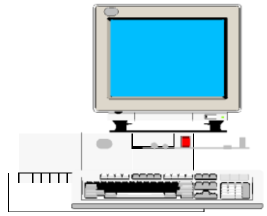


a. I don't watch TV or videos
b. Less than 1 hour a day
c. 1-2 hours a day
d. 3-4 hours a day
e. More than 4 hours a day

11. During the <u>weekend</u>, how many <u>TV shows</u> or videos do you usually watch <u>each day</u>?

a. I don't watch TV or videos
b. 1
c. 2
d. 3 or more

12. During the <u>week</u>, how many hours <u>per day</u> do you <u>usually</u> play video games like Nintendo, Sega, games at the arcade, or use the computer to surf the Internet?



a. I don't play video games or use the computer
b. Less than 1 hour a day
c. 1-2 hours a day
d. 3-4 hours a day
e. More than 4 hours a day

13. During the <u>weekend</u>, how many hours <u>per day</u> do you <u>usually</u> play video games like Nintendo, Sega, games at the arcade, or use the computer to surf the Internet?

a. I don't play video games or use the computer
b. Less than 1 hour a day
c. 1-2 hours a day
d. 3-4 hours a day
e. More than 4 hours a day

14. Do you ever read the nutrition labels on food packages?

a. Almost always or always
b. Sometimes
c. Almost never or never

15. How many total servings of fruits and vegetables should you eat each day.

a. At least 2
b. At least 5
c. At least 9
d. At least 10
e. I don't know

16. The foods that I eat and drink now are healthy.

a. Yes, all of the time
b. Yes, sometimes
c. No

17. Do you ever eat high fiber cereal?

a. Almost always or always
b. Sometimes
c. Almost never or never

18. Do you ever eat whole wheat bread?

a. Almost always or always
b. Sometimes
c. Almost never or never

19. Do you ever drink 100% fruit juice?

a. Almost always or always
b. Sometimes
c. Almost never or never

20. Do you ever eat fruit during lunch?

a. Almost always or always
b. Sometimes
c. Almost never or never

21. Do you ever eat vegetables during dinner?

a. Almost always or always
b. Sometimes
c. Almost never or never

INSTRUCTIONS: Please <u>CIRCLE</u> one of the two foods that you would pick if you had to choose just one.

22. If you were at the movies, which one would you pick as a snack?

a. popcorn <u>with</u> butter

b. popcorn without butter

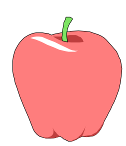
23. Which would you pick to drink?

1%

a. Regular whole milk

b. low fat or skim milk

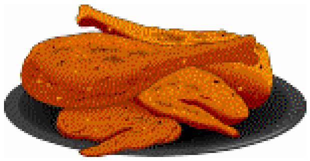
24. Which food would you eat for a snack?

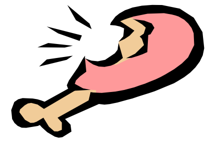


a. candy bar

b. fresh fruit

25. Which would you do if you were going to eat a piece of chicken?





a. leave on the skin

b. take off the skin and not eat the skin

26. Which food would you ask for?

a. frozen yogurt/low fat ice cream

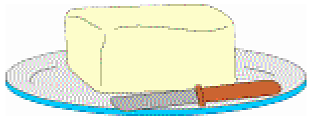
b. Regular full fat ice cream

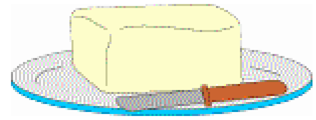
27. Which would you choose to cook if you were going to help make dinner at home?

a. French fries

b. baked potato

28. Which would you do if you were going to eat cooked vegetables?

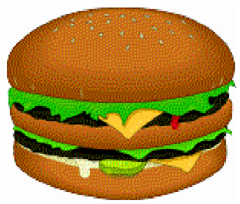




a. Eat <u>without</u> butter

b. Add butter

29. Which would you order if you were going to eat at a fast food restaurant?



a. a regular hamburger

b. a grilled chicken sandwich

INSTRUCTIONS: The questions in this section ask how likely you are to eat some of the foods below. Please answer by circling either NOT LIKELY, LIKELY or VERY LIKELY for each question.

30. How likely are you to drink low fat or skim milk instead of regular whole milk?

a. Not likely
b. Likely
c. Very likely

31. How likely are you to eat high fiber cereal instead of a donut?

a. Not likely
b. Likely
c. Very likely

32. How likely are you to eat fresh fruit instead of a candy bar?

a. Not likely
b. Likely
c. Very likely

33. How likely are you to take the skin off of chicken (and not eat the skin)?

a. Not likely
b. Likely
c. Very likely

34. How likely are you to ask for frozen yogurt or low fat ice cream instead of full fat ice cream?

a. Not likely
b. Likely
c. Very likely

35. How likely are you to eat a baked potato instead of French fries?

a. Not likely
b. Likely
c. Very likely

36. How likely are you to drink fruit juice instead of a soft drink (a soda pop)?

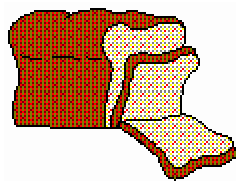
a. Not likely
b. Likely
c. Very likely

37. How likely are you to order a grilled chicken sandwich at a fast food restaurant instead of ordering a hamburger?

a. Not likely
b. Likely
c. Very likely

INSTRUCTIONS: Please CIRCLE ONE of the two foods that you think is better for your health.

38.

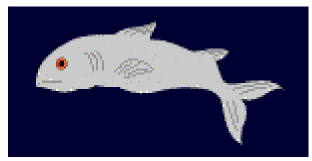


a. whole wheat bread

b. white bread

39.

a. broiled beef



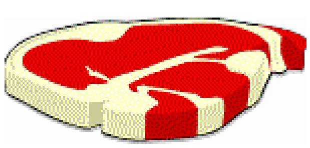
b. broiled fish

40.

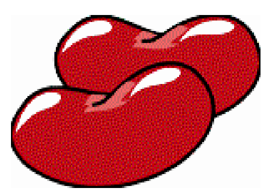
a. cereal

b. eggs and bacon

41.

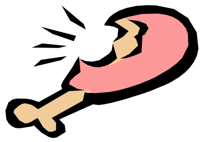


a. beef

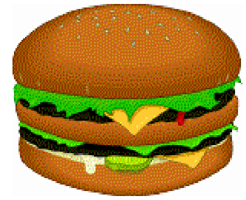


b. beans

42.



a. chicken



b. regular hamburger

43.

a. Regular whole milk

1%

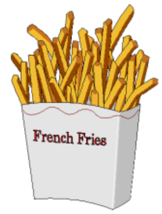
b. low fat or skim milk

44.

a. Frozen yogurt/low fat ice cream

b. Full fat ice cream

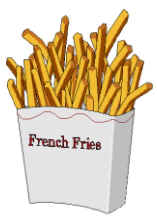
45.



a. green salad

b. French fries

46.



a. French fries

b. baked potato

47.

a. 100% fruit juice

b. fruit punch

INSTRUCTIONS: The questions in this section ask how likely you are to be physically active. Please answer by circling either NOT LIKELY, LIKELY or VERY LIKELY for each question.

48. How likely are you to be physically active 3-5 times a week?

a. Not likely
b. Likely
c. Very likely

49. How likely will you exercise and keep moving for most of the time in your after- school program?

a. Not likely
b. Likely
c. Very likely

50. How likely are you to run or bike 3-5 times a week?

a. Not likely
b. Likely
c. Very likely

51. How likely are you to keep up a steady pace without stopping for 15-20 minutes when you are physically active?

a. Not likely
b. Likely
c. Very likely

Thank you for your help!

Appendix 6: Previous Day Physical Activity Recall (PDPAR) questionnaire

Activities
Scale

On the next page is a scale that records the **main** activities you did yesterday. Please be certain to write on the scale the **day of the week** that "yesterday" was.

1. For each time period write in the **number(s)** of the main activities you actually did in the boxes on the time scale.

2. Then rate how physically **hard** these activities were. Place an "X" on the rating scale to indicate if the activities for each time period were:

- **Very Light** = Slow breathing, little or no movement.




- **Light** = Normal breathing, regular movement.




- **Medium** = Increased breathing, moving quickly for short periods of time.




- **Hard** = Hard breathing, moving quickly for 20 minutes or more.




Please be as accurate as possible but fill out the scale quickly.

Activity Numbers

Eating

1. Meal
2. Snack
3. Cooking

Sleep/Bathing

4. Sleeping
5. Resting
6. Shower/bath

Transportation

7. Ride in car, bus
8. Travel by walking
9. Travel by bike

Work/School

10. Job (list):____
11. Housework/paperwork
12. House chores (list):_______________________________________

Spare Time

13. Watch TV
14. Go to movies/concert
15. Listen to music
16. Talk on the phone
17. Hang around
18. Shopping
19. Play video games
20. Other (list):____

Physical Activities

21. Walk
22. Jog/run
23. Dance (for fun)
24. Aerobic dance
25. Swim (for fun)
26. Swim laps
27. Ride bicycle
28. Lift weights
29. Use skateboard
30. Play organized sport

31. Did individual exercise
32. Did active game outside
33. Other (list):____

Time	**Activity Numbers**	**Very Light**	**Light**	**Medium**	**Hard**
3:00					
3:30					
4:00					
4:30					
5:00					
5:30					
6:00					
6:30					
7:00					
7:30					
8:00					
8:30					
9:00					
9:30					
10:00					
10:30					
11:00					

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Appendix 7: Lesson plan outline in relation to the social cognitive theory

Social Cognitive Theory Construct	**Definition**	**Application in the intervention**
Environmental/reciprocal determinism	Reciprocal interaction between the person, environment and behavior	1. Children took home a pamphlet after each session with a summary of the information learned to give to their parents as a means of educating the parents as well to provide healthy food items at home 2. Children tasted and provided their own input regarding healthy snack options and how to prepare them at home.
Outcome expectations	Anticipated consequences resulting from a person's behavior (may be also related to previous experience/behaviors)	Demonstrated the positive health outcomes of following a nutritious and physically active lifestyle such as drinking milk for stronger bones and teeth
Observational learning/modeling	Learning to perform new behaviors through observation of others as well as the media	1. Children observed NAO (the robot) as well as the registered dietitian to follow exercise routines 2. Children observed healthy recipe preparation by the dietitian and then participate in preparation themselves 3. NAO and the dietitian were acting as role-models

Behavior capability/ facilitation	The ability to perform a behavior through essential knowledge and skills (must learn what to do and how to do it by providing tools & resources)	Children received nutrition and physical activity knowledge during each session via interactive lessons, handouts, activities/games and discussions with the dietitian and the robot
Self-efficacy	Belief or confidence about the ability of a person to successfully perform a desired behavior	1. Children were instructed to choose small achievable positive changes in dietary consumption and/or physical activity. If they were able to accomplish their change, then a "star" was added next to their name on a list posted in the room. The child received a small gift after achieving 4 stars. 2. All participants received a certificate of achievement at the end of the intervention 3. During the activities, when a child answered a question correctly or performs a certain desired behavior then certain motivating phrases will be used such as "good job", "way to go", "excellent work" 4. Children were given “good participation” tickets during the sessions for a raffle drawing at the end of each session (2-3 people won a small gift for behaving well and active participation).
Goal setting	Setting realistic and measureable goals to achieve desired behaviors and outcomes	After each session, the dietitian and children set realistic and measureable goals that they should achieve by the next session. A star was be put on the chart if the child achieves that goal.

Reinforcements	The use of rewards or punishments to modify a behavior	1. All children received stickers, pedometers and bookmarks during this intervention 2. A "prize box" was set for children that are answering questions correctly or winning games

Appendix 8: Lesson plans

Lesson Plan 1: Introduction to Food Groups

Session objectives:

By the end of the session, children will be able to:

1. Understand the different food groups
2. Categorize foods in their respective group

Discussion in class will focus on:

- What the five different food groups are: Grains, Proteins, Dairy, Vegetables and Fruits
- Examples of foods in each category
  - Grains: Bread, cereal, pasta, rice, oatmeal, etc…
  - Proteins: animal (red meat, turkey, chicken, fish, eggs); Plant (beans, peas, soy products, nuts/seeds)
  - Dairy: milk, cheese, yogurt and fortified soymilk
  - Vegetables: carrots, broccoli, lettuce, cucumbers, spinach, cabbage, etc…
  - Fruits: banana, orange, apple, grapes, pineapple, peaches, strawberries, dried fruits (raisins), etc…
- Eating foods from all the food groups is the best way to get the nutrients needed for good health
- The goal for next session: Each child should eat at least one item from each food group the next day. Explain that you will check who achieved this goal by next session. Each time a person achieves a goal a small sticker will be given and a star will be added to a chart. 4 stars = PRIZE

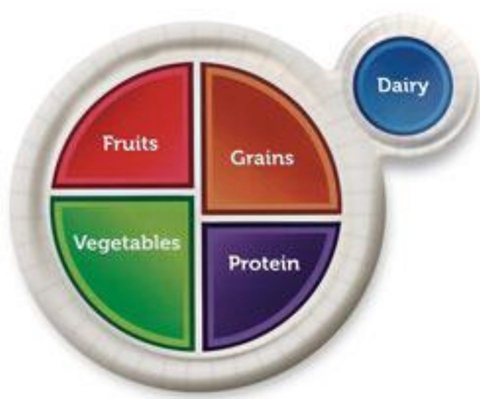
Activity/Game: Food cards

-Participants will be given 2 or 3 food cards each and directed one-by-one to place stick each card onto the proper food group on the cling chart. Harder items will be given to the older kids such as beans.

-The robot will tell the each student if they have placed it correctly or incorrectly. Phrases like “you’re right”, “way to go”, “good job”, and “excellent” will be used for correct answers and “try again” will be used for incorrect answers.

-Will use: Cling kit shown below

Take-home: Paper plates with printed food groups to remember the 5 groups



Lesson Plan 2: Introduction to Myplate

Session objectives:

By the end of the session, children will be able to:

1. Understand what MyPlate is
2. Give examples of meals that meet MyPlate recommendations

Last session recap

Start by seeing who met their goal from last's session. Give stars on the chart to those that did reach their goal

Motivational Stickers & gifts will be given to proactive kids (MYPLATE stickers)

Discussion in class will focus on:

- Make half of your plate fruits and vegetables: Choose red, orange, and dark-green vegetables like tomatoes, sweet potatoes, and broccoli, along with other vegetables for your meals. Add fruit to meals as part of main or side dishes or as dessert.
- Eat whole grains instead of white, refined grains such as: whole wheat bread instead of white bread; brown rice instead of white rice; whole-wheat pasta instead of white pasta.
- Consume fat-free or low-fat (1%) milk instead of whole milk since it has the same nutrients, but less fat.
- Vary your protein choices including both animal and plant choices. Always choose low fat/lean options (example: do not eat the chicken skin)

Activity 1: all participants must set a realistic goal for them to achieve. Answers may vary such as: more activity, trying new foods in different food groups, etc. This will be a class sharing activity. NAO will share his goal as well.

Activity 2: Build a Great Plate

- Each child will receive a Kids MyPlate handout and a pack of Crayola crayons
- They will be instructed to "build a great plate" by drawing items into the space provided
- The robot will tell the each student if they have drew their plate correctly or incorrectly. Phrases like "you're right", "way to go", "good job", and "excellent" will be used for correct answers and "try again" will be used for incorrect answers. The dietitian will further elaborate until the student gets it correct.
- A "choose my plate" sticker will be given to each student upon completion of this activity
- Children age 10-12 will not be asked to draw/color, instead they will be asked to write down 5 dinner meals that include a variety of foods from each group

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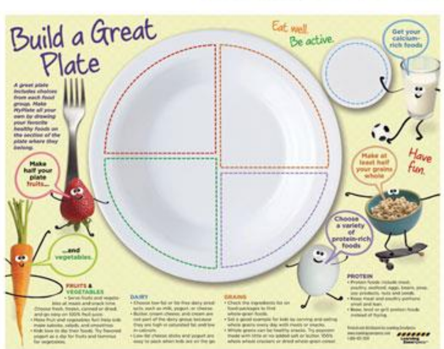
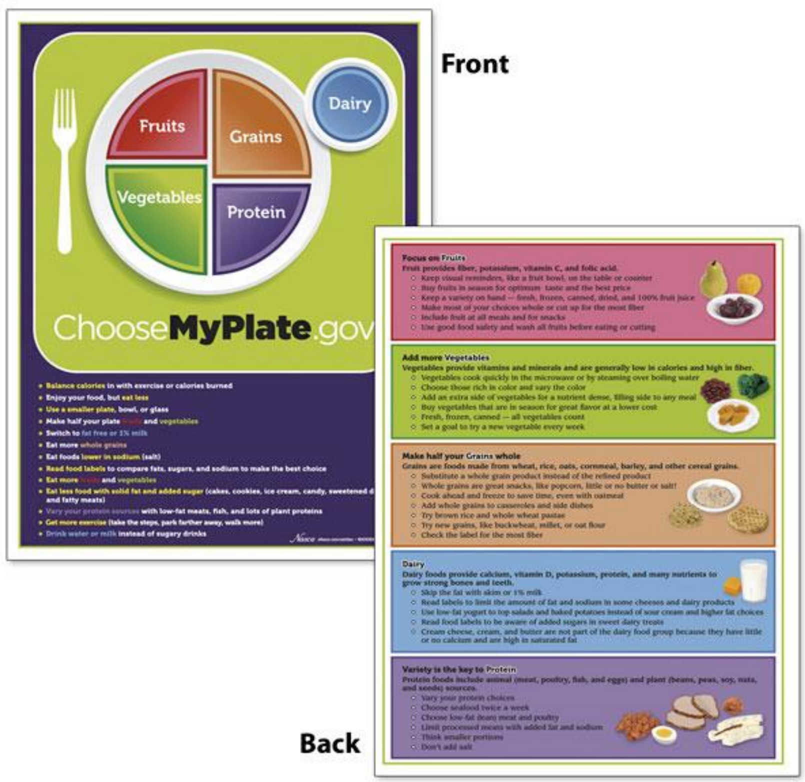


BACK

Handout for kids to take home to parents:

This handout has information about MyPlate as well as tips for each food group that will be helpful for parents



Activity 3: Hulla hoops & jump ropes

- Each child will be given a hulla hoop or jump rope to be active for the remainder of the time. Students may try both activities by switching with each other if time permits.
- Robot will play music and dance while students are being active.

Note: activity may be carried outside if space is tight in the classroom

Lesson Plan 3: Fruits and Vegetables

Session objectives:

By the end of the session, children will:

1. Understand what fruits and vegetables are and why they are important for health
2. Understand what fiber is and that it is present in fruits and vegetables
3. Taste a variety of fruits and vegetables
4. Recognize that 5 servings a day of fruits and vegetables are needed
5. Be encouraged to eat more fruits and vegetables

Class discussion:

- Asking who met last session's goal
- Examples of fruits and vegetables
- Eat 5 a day of fruits and veggies
- Benefits of fruits and vegetables
    - Rich in fiber
    - Fiber is healthy and can help prevent diseases
    - You can find fiber in the **skin** of fruits and vegetables
    - Rich in vitamins & minerals that the body needs to protect us from disease and make us stronger!
    - Eat the Rainbow colors: RED, yellow/orange, Green and blue/purple

Class question: "What do you think it means to be healthy"

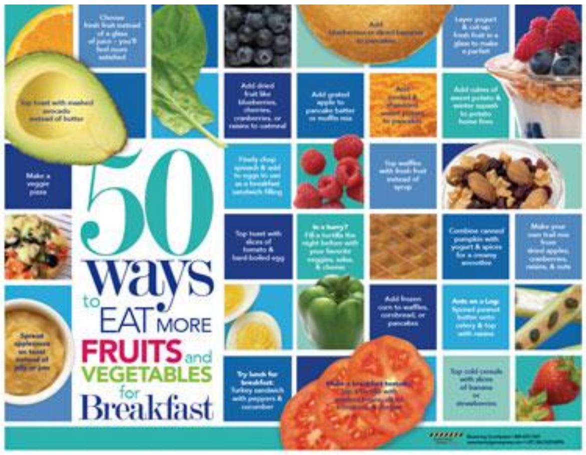
- Go around the class for answers
- To be healthy, we should eat healthy and be physically active everyday

Set goal for next session: Eat 5 a day

Activity: Try simple recipes in class and tasting of fruits and veggies

Give fruits and veggies stickers to those that taste items as a motivator

Take home handout to parents: 50 ways to eat more fruits and veggies handout



Lesson Plan 4: Increasing physical activity

Session objectives:

By the end of the session, children will:

1. Identify tips on how to increase their daily physically active
2. Be encouraged to be physically active for at least 30 to 60 minutes daily

Class discussion:

- Asking who met last session's goal
- What is physical activity? Needed to build strong muscles and bones. Good for the heart. It also helps a person maintain a healthy weight.
- Examples of physical activity
- Running, walking, dancing, sports make a person's heart healthy and strong. A heart pumps oxygen and blood throughout the body.
- How long should a person be active for? 60 minutes daily
- Watching TV/videos, playing with video games, computers and IPads should be decreased in order to increase physical activity.

Activity 1: handout in class

-What can you do to activate your day?

-Draw a picture or write about your favorite way to get active

-Share with classmates

Activity 2: Give each student a pedometer and give instructions how to use it and where to hang it on their clothes. Encourage them to move as much as they can to reach 10,000 steps per day.

Take home pedometers

Set goal for next session: 10,000 steps a day on pedometers given

Activity 3: Fitness Dice

Pair of 4" x 4" dice - one die has fitness and exercise directions and the other has large screen-printed numbers. Exercises include toe touch, arm circles, jumping jacks, leg lifts, and more.

Divide the class into groups, have one person in each group roll the dice and each group should do what the dice says. Go around the class until time is complete.

Lesson Plan 5: Healthy foods versus "sometimes" foods

Session objectives:

By the end of the session, children will:

1. Identify healthy food and snack options and foods that they should eat only sometimes
2. Be able to identify high fat, high sugar food items

Class discussion:

- Asking who met last session's goal
- What are "sometimes" foods? Foods that are high in sugar or solid fat that we should eat only sometimes and in small amounts
- Examples of "sometimes foods" and healthy foods
- Why should we eat "sometimes" food less? These foods can make it harder to keep a healthy weight and have a healthy heart, and too many added sugars can also lead to more cavities.

Activity 1: Traffic light game

-Distribute a green and red traffic light card

- Dietitian will show pictures on the board of different food items. Raise the green light for healthy foods and the red light for "sometimes" foods

- Discussion

-Robot will indicate if everyone has it correct or someone has it wrong

Activity 2 “Eat to Win” flashcards:

Set-up groups to play this card game. Each team will pick a card. Either answer the “know it” question or perform the “do it” task. Each team gets a point for a correct answer. At the end, the team with the most points wins!

Set goal for next session: Minimize “sometimes” food to once or none per day

Take home handout to parents: Sugar shocker foods

Lesson Plan 6: Healthy snacking

Session objectives:

By the end of the session, children will:

1. Identify what a snack is, why and when should they eat a snack
2. Be encouraged to eat healthy snacks

Class discussion:

- Asking who met last session's goal
- What is a snack? A snack is needed to refuel the body
- When should I eat a snack? Only when you are hungry, tired or grouchy. But do not eat snack out of boredom.
- Snack time: mid-morning, afterschool, before bedtime
- Examples of healthy snack options
- **Set goal for next session:** eat 2 healthy snacks the next day

Activity 1: Pencils and papers

- Write your name (first only) vertically down on a sheet of paper and come up with a healthy food item that start with each letter. Share with the class

Let's start with YOYO the robot!

- Y: Yogurt (low fat)
- O: Orange
- Y: Yams
- O: oats

Activity 2: Vote on your own snacks! (Need traffic lights)

What do you eat for snacks or what do your parents give you?

Class votes: Green for healthy/red for "sometimes" snacks

Activity 3: Lets make some healthy fruit shakes!

- Recipe: Low fat yogurt, bananas, 100% orange juice, frozen fruit of choice and blend!!
- Tasting Time!

Take home bookmarks for kids and pamphlets for parents

Inside

Outside

Lesson Plan 7: Portion control

Session objectives:

By the end of the session, children will:

1. Identify what a portion size is and how to measure a portion size
2. Identify different portions needed based on each food group

Class discussion:

- Most people eat and drink more when served larger portions. Choosing smaller portions can help you stay healthy
- Handy portions discussion based on food models and hands
- **Set goal for next session:** Measure different portion sizes of foods you eat at home

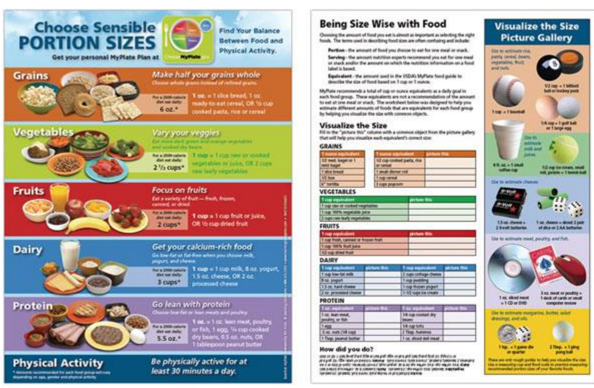
Activity 1: food models

- Divide the class into 3 groups
- Each group must Construct a healthy breakfast, lunch or dinner by placing the food items in a shopping cart
- Winner group gets a prize!!

Activity 2: Beanbags

- Different Beanbags will go around the class while music is playing (kids tossing it to each other).
- When the music stops, whoever has a beanbag in their hand has to name a healthy food item (fruit/vegetable) with that beanbag color.

Take home bookmarks for kids and pamphlets for parents



Lesson Plan 8: Nutrients and Health

Session objectives:

By the end of the session, children will:

1. Understand the importance of eating a variety of foods
2. Identify the 6 nutrients
3. Recognize the benefits of what certain nutrients and foods have on health

Class discussion:

- What is a nutrient? A NUTRIENT is something found in food that your body uses to grow and stay healthy. Different nutrients do different things for our bodies and help us be healthy
- What can a nutrient help us do? Breathe, walk, think, play, dance, do homework…
- How can we get a variety of nutrients? Different foods give us different nutrients. By making healthy choices from all 5-food groups. Eating different types of healthy foods within each food group
- The 6 nutrients: Grains, proteins, fats, vitamins, minerals and water with examples and benefits of each
- Attention: "sometimes" foods contain very little nutrients and we have to limit intake" with examples
- **Set goal for next session:** Eat a variety of healthy nutrients from all 5 food groups

Activity 1: Nutrition ball toss

Kids will throw ball to each other in class and each person should state a benefit of the food that their right hand touches on the ball.

Take home pamphlets for parents: healthy eating from head to toe

Lesson Plan 9: Reading food labels

Session objectives:

By the end of the session, children will:

1. Understand how to read food labels
2. Recognize the percent daily values on food packages

Class discussion:

- Ask if the kids usually eat nutrition labels on packages
- Teach the kids how to read food labels.
    - ➢ Step 1: look at serving size and total calories
    - ➢ Step 2: look at percent daily value
    - ➢ Explain that 20% DV and above means high and 5% or less means low
    - ➢ Decrease intake if fat, sugar, sodium, cholesterol
    - ➢ Increase intake of fiber, protein and vitamins
    - ➢ Explain what sodium and cholesterol are since these haven't been explained before in previous lessons
    - ➢ Step 3: Make a decision: is this a healthy food?

- **Set goal for next session:** Read at least 2 food labels of items you are consuming and decide if healthy or sometimes food!

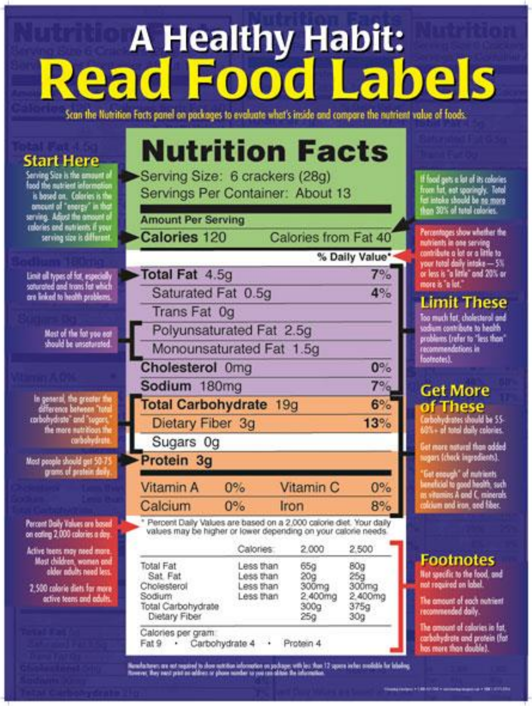
Activity 1: Healthy or sometimes foods?

Kids will observe nutrition facts on the board and will determine if they are healthy or a sometimes food via class discussion

Activity 2: food cards game

Set-up groups to play this card game. Each team will pick a card. Either answer the "know it" question or perform the "do it" task. Each team gets a point for a correct answer. At the end, the team with the most points wins!

Take home pamphlets for parents: How to read food labels



Lesson Plan 10: The importance of water

Session objectives:

By the end of the session, children will:

1. Understand why they should drink water and why is it important
2. Recognize that water should be consumed instead of sugary drinks

Class discussion:

- Benefits of water: survival, body functions, skin
- We need more water when it is hot, or when we do exercise to account for water in urine and water that we sweat
- Water has no calories and no sugar
- Drink water instead of sugary beverages like soda or juice
- Decrease intake of soda and juice nectar

- **Set goal for next session:** drink at least 6 cups of water tomorrow!

Activity: how much sugar is in these items

Kids will observe different items on the desk and try to figure out how much sugar is in each one: water, soda, juice nectar, 100% juice, milk, Gatorade, energy drink

Take home pamphlets for parents: sugar shockers in drinks

Lesson Plan 11: The importance of breakfast

Session objectives:

By the end of the session, children will:

1. Understand why they should have breakfast everyday and why is it important
2. Recognize the types of healthy breakfast items that should be consumed

Class discussion:

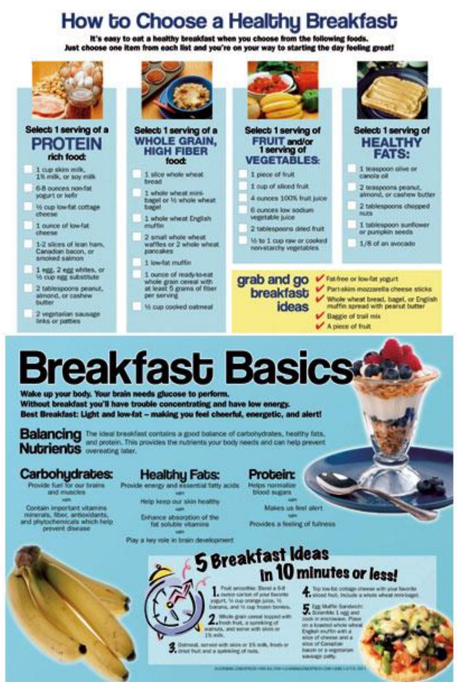
- Breakfast is the most important meal of the day
- Benefits of breakfast: provides energy, helps you stay focused to learn more in school
- Healthy breakfast items you should be eating:
    - Low fat milk, yogurt and cheese for stronger bones and teeth
    - Whole wheat toast, pancakes with sugar free syrup and cereal (whole wheat and not sugary) are needed for the brain, heart and energy
    - Eggs and milk contain protein needed for muscles
    - Fruits and vegetables to keep our digestive system healthy
- **Set goal for next session:** Eat a healthy breakfast that has all 5 food groups

Activity: Favorite breakfast item

Kids will take turns to describe what they had for breakfast and what is their favorite breakfast item. They also have to critique if it was healthy or how they should change it to become healthier.

Each child will receive a breakfast is important sticker after participation and a “wake up to breakfast bookmark”

Take home pamphlets for parents: How to choose a healthy breakfast



Lesson Plan 12: Revision

Session objectives:

1. To recap the main nutrition take home messages given throughout the previous sessions
2. Answer any questions that the children may have

Class discussion:

- Recap
  - Food groups (how many, name them and examples of each)
  - 5 a day of fruits and vegetables
  - At least 60 minutes of physical activity each day (or 10,000 steps)
  - Examples of healthy food items
  - Examples of sometimes food items
  - Where is fiber found and what are its benefits
  - Revise Nutrition labels

Activity 1

A PowerPoint with questions will run and ask the children: "Pick which is a healthier or better option?" 16 questions in total. Answers will be discussed out loud.

Activity 2

Food fun nutrition cards to recap the basics of nutrition and exercise. Students will be divided into 2 teams. Each person will have to answer a question from the cards. The team with the most correct answers wins!

Take home pamphlets for parents: Countdown to your child's health

VITA

NADINE MIKATI

2003-2006	B.S., Nutrition and Dietetics Minor in Biology American University of Beirut, Lebanon
2006- 2009	M.S., Nutrition and Food Science and part-time instructor Recipient of Graduate Professional Scholarship Wayne State University, Detroit, Michigan
2007-2008	Coordinated Program in Dietetics Wayne State University, Detroit, Michigan
2008	Registered Dietitian Commission on Dietetics Registration
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	Recipient of Academy of Nutrition and Dietetics Foundation graduate scholarship, Michigan
2008-2009	Clinical dietitian, Detroit Medical Center Detroit, Michigan
2009	Registered Young Dietitian of the Year award Academy of Nutrition and Dietetics
	Licensed Dietitian, Ministry of Health Beirut, Lebanon
2009-2012	Instructor and Coordinated Program in Dietetics Coordinator, American University of Beirut, Lebanon
2009-2012	Nutrition counseling, private practice Beirut, Lebanon
2011-2012	Monthly contributor in health magazine “Fit’N Style” Beirut, Lebanon
2012-2016	PhD student and Teaching Assistant Florida International University, Miami, Florida

2013	Recipient of Academy of Nutrition and Dietetics Foundation graduate scholarship, Florida
2013-2015	AGILE scholar (Academy of Graduates for Integrative Learning Experiences), Florida International University Miami, FL
2014	Recipient of Florida Academy of Nutrition and Dietetics President's scholarship
2015	Amy Joye Memorial Research Award Academy of Nutrition and Dietetics Foundation
2016	Licensed Dietitian in the state of Florida Recipient of PATH travel Award, Florida International University, Miami, Florida Finalist in graduate student oral competition, American Society for Nutrition, Experimental Biology conference, San Diego, California

PRESENTATIONS AND ABSTRACTS

Mikati N, Church M, Adams B and Jen KL. Dose response to antenatal corticosteroid (AC) exposure in rat offspring. Experimental Biology, San Diego, California, 2008.

Mikati N, Zarini G, Vaccaro J and Huffman F. The Relationship between caffeine consumption and type 2 diabetes markers in three minority ethnicities with or without diabetes. Experimental Biology, Boston, Massachusetts, 2015.

Mikati N, Eltoukhy M and Huffman F. Using a humanoid robot along with a registered dietitian in an after-school setting to promote healthy eating habits and physical activity in school-aged children. Experimental Biology, San Diego, California, 2016.

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