1-1-2021

The Impact Of Ww's Multi-City Fvrx Program On Children

Damaris Lopez Mercado
dlopezmercado1@gmail.com

The Impact of WW's Multi-City FVRx Program on Children

Damaris Lopez Mercado

Year Completed: 2021

Year Degree Awarded: 2021

Master of Public Health

Yale School of Public Health

Primary Advisor: Debbie Humphries, PhD

Secondary Advisor: Kathleen O'Connor-Duffany, PhD

Abstract

Introduction and background: Higher F&V intake are associated with healthier BMI in children, but cost of F&V has been found to be a barrier to access for some families. To mitigate this barrier, Wholesome Wave (WW) implemented a six-month F&V incentive program that included a $25 weekly financial incentive for families to spend on F&V in three U.S. cities. The primary objectives of this paper are to assess whether this program significantly impacted child F&V consumption and child anthropometry from baseline to end-of-program and to assess whether F&V intake and food insecurity and end-of-program are significant predictors of healthy child anthropometry at end-of-program.

Methods: Data for this analysis came from WW's 2017 Multi-City FVRx program and utilized a pre-/post-program design with no control group. Across all three cities, 1,164 children and their families were enrolled in the program. We used a combination of Wilcoxon Sign Rank tests and McNemar-Bowker tests to determine whether there were significant changes in pediatric F&V intake and anthropometry from baseline to end-of-program. We also ran a logistic regression to determine if F&V intake and food insecurity at end-of-program were significant predictors of healthy anthropometry at end-of-program. Analyses conducted on child anthropometry were conducted on all participants with available data and then conducted stratifying by age.

Results: Children enrolled in the program saw significant increases in F&V intake from baseline to end-of-program but did not see significant changes in anthropometry. F&V intake and food insecurity at end-of-program were not significant predictors of healthy anthropometry at end-of program.

Discussion: Our findings suggest that a $25/week F&V incentive for six months is sufficient to significantly increase F&V intake among children. This is consistent with evaluations of other F&V incentive programs. However, changes in intake did not translate to significant anthropometric changes in all participants. There were significant changes in child anthropometry in children under 5, suggesting age might modify the program's impact on anthropometry.

Table of Contents

Introduction

According to the World Health Organization (WHO), approximately 340 million youth have an obese or overweight body mass index (BMI), putting them at risk for poor health outcomes in the future.[1] Poor diet is one of the main drivers behind unhealthy BMI.[2] One way to improve diet is by incorporating more fruits and vegetables (F&V) and less sugary and high-calorie foods and beverages. Higher F&V intake has been found to be associated with healthier BMI in children.[3]

Currently, the U.S. Department of Agriculture (USDA) recommends children under 5 consume ½ to 1 ½ cups of fruit and $^{2}/_{3}$ to 2 cups of vegetables per day. They recommend children over 5 consume anywhere between 1 to 2 ½ cups of fruit and 1 ½ to 4 cups of vegetables per day depending on child sex and age.[4] Yet less than 8 percent of U.S. children are meeting these recommendations. Income level can further exacerbate these findings, with just 7 percent of individuals below or close to the poverty level meeting the recommendations. [5,6] Childhood eating behaviors are easier to change than adult eating behaviors, and eating behaviors developed during childhood are likely carried into adulthood.[7,8] In adults, adequate F&V consumption can be protective against chronic disease, such as Type 2 Diabetes and cardiovascular disease, and mortality.[9-11] Given this, increasing children's F&V intake before they reach adulthood can have major health implications for the population.

F&V accessibility for parents is significantly associated with increased child consumption of F&V.[12] However, food insecurity can negatively impact accessibility. Food insecurity is associated with low socio-economic status[13], and lower socio-economic status (SES) has also been found to be associated with lower F&V intake[14] likely because cost is a major barrier in accessing F&V.[15]

F&V incentive programs have been shown to be successful in mitigating this barrier. F&V incentive programs provide individuals with either food directly or a monetary method to obtain F&V. Incentive programs take many delivery forms, including subsidized food boxes, prepared meal delivery services, garden-based programs, and F&V voucher programs. F&V voucher programs are the most common type of incentive program, where individuals are provided with a voucher that can be redeemed to purchase F&V at specific locations.[16]

Wholesome Wave (WW), a non-profit organization that aims to fight nutrition insecurity, has conducted various F&V incentive programs across the U.S. as part of their Produce Prescription (FVRx) program. Recently, WW obtained data from its 2017 Multi-City FVRx program sponsored by Target. The 2017 Multi-City program provided vouchers to low-income families in three U.S. cities to spend on F&V and collected data on children's attitudes and behaviors towards F&V and on children's anthropometry.

The primary objectives of this paper are to determine whether the WW program significantly increased F&V intake from baseline to end-of-program and to determine whether the program significantly increased the proportion of children with a healthy anthropometry, measured by BMI-for-age Z-scores (BAZ), from baseline to end-of-program. We also used these data to model whether F&V intake and food insecurity at end-of program were significant predictors of healthy BAZ. If these associations exist, we planned to explore whether food insecurity modified the relationship between healthy BAZ and F&V intake.

The conceptual framework guiding the model portion of this analysis is found in Figure 1a. Given the previous research stated above, this framework postulates that food security and F&V intake are critical drivers behind healthy BAZ. The framework also theorizes that there are community, household and sociodemographic characteristics that are associated with food insecurity and F&V intake that are important to include in the model. The framework also acknowledges that there are other determinants of child healthy BAZ. However, these variables were not measured in this study.

We had three main hypotheses. First, we hypothesized that there would be significant increases in F&V intake from baseline to the end of the program. Second, we hypothesized that a significantly higher proportion of children would have healthy anthropometry at the end of the program compared to baseline. Lastly, we hypothesized that F&V intake and food insecurity at end-of-program would be significant predictors of healthy BAZ at the end of the program.

Methods

Specific Research Design and Participants

Data for this analysis came from WW's 2017 Target Multi-City FVRx program and utilized a pre-/post-program design with no control group. WW formed partnerships with school-based clinics and Federally Qualified Health Centers (FQHCs) in Los Angeles, Houston and Miami to recruit low-income families with children with >85 percentile BMI at baseline. Eisner Health served as the clinical site for participants in Los Angeles, Hermann Memorial provided nine clinical sites for participants in Houston, and Jessie Trice Community Health Center provided four clinical sites for participants in Miami. Families had to be food insecure at enrollment based on a 2-question validated screener.[17] Once eligibility was met, enrolled families were referred to their first visit where they received an explanation of the program, had their height and weight measurements taken, and were provided shopping guide materials to explain how to use FVRx vouchers at participating locations. There were 612 participants enrolled in Los Angeles, 291 enrolled in Houston and 261 enrolled in Miami. In all, 1,164 children and their families were enrolled in this program.

Program

The program was comprised of three components: 1) $25 a week in the form of a voucher to spend on F&V 2) clinical visits at which child height and weight data were collected and 3) basic nutrition education provided at clinical visit. Participants visited partnering clinical sites three times through the course of the six-month program.

Participants were given their first voucher at their first clinical visit. Child height and weight measurements were taken at this visit to serve as baseline data. Parents of the children were also asked to fill out a pediatric enrollment screener, a six-question food security screener and a pediatric dietary screener at this visit. Participants and their parents returned for a second visit approximately three months after the baseline visit and for a third visit approximately six months after the baseline visit. Participant height and weight measurements were taken again at each of these visits. Participant parents completed the six-question food security screener, the pediatric dietary screener, and an additional pediatric participant experience questionnaire at the second and third visits as well. Through these multiple screeners, data were collected on child anthropometry, child eating behaviors, family food security, and child attitudes surrounding F&V.

Participants were also provided with basic nutrition education at each visit. The curriculum was guided by the Center for Disease Control (CDC) and the US Department of Agriculture (USDA) 'My Plate' guidelines. Each visit contained a nutrition education component ranging from how to balance a meal and read nutrition labels to cooking demonstrations depending on the city and clinical partner.

Primary outcomes

Our primary outcome for assessing program impact on child F&V intake was change in F&V intake from baseline to end-of-program. Our primary outcome for assessing program impact on child anthropometry was change in BAZ category (from "unhealthy" to "healthy" or vice versa) from baseline to end-of-program. For the modeling portion of the analysis, the main dependent variable was child healthy BAZ at end of program and our main independent variables were level of food insecurity and F&V intake at end-of-program.

Study Indicators

Child anthropometry was measured using BAZ calculated using WHO growth standards.[18-19] BAZ was calculated using child age, sex, height, and weight data collected at each of the three clinical visits throughout the program. Height-for-age z-scores (HAZ) and weight-for-age z-scores (WAZ) were also calculated for all three time-points. BAZ values were used to create an ordinal and categorical healthy BAZ variable for this analysis.

Child F&V intake was measured using the pediatric dietary screener at each clinical visit. Parents of participants were asked to self-report about how many cups of fruit and vegetables their child consumed per day, including 100% pure fruit juice or 100% pure vegetable juice. To facilitate more accurate reporting, parents were given common examples of what a cup of fruit looked like and what a cup of vegetables looked like. Using this data, we categorized children into three consumption groups for a supplemental baseline analysis. The first group are children who ate more F&V at end-of-program compared to baseline. The second group are children who had no change in F&V consumption from baseline to end-of program. Lastly, the third group are children who ate less F&V at end-of-program compared to baseline.

Food insecurity was assessed using the USDA U.S. Household Food Security Survey Module: Six-item Short Form.[20] Answers to these questions were used to derive a food insecurity score. Participants who answered affirmatively to only 1 or fewer items on the form were classified as "low food insecurity", participants who answered affirmatively to 2-4 items on the form were categorized as "high food insecurity", and participants who answered affirmatively to 5-6 items on the form were categorizes as "very high food insecurity".[20]

Statistical Analyses

Reasons for Selection

WW has piloted several FVRx programs throughout the country since 2008. At the time of data selection, WW had data from six different FVRx programs. We chose to use the 2017 Target Multi-City program for this analysis for several reasons. First, the Target Multi-City program was the largest FVRx program WW had piloted at the time, providing us with a larger sample size. Second, this dataset was the only dataset out of the six available that targeted the pediatric population and contained the weight, height, age, and sex data necessary to compute BAZ scores.

Method of Analyses

SAS 9.4 and R 3.6.1 were used for all analyses. Data collection for all three sites at all three times was done in separate Microsoft Excel files and had to be combined for further analysis in SAS. Coding guides were created to ensure variable names and coding were consistent across all data files before they were merged into one master dataset.

Once a master dataset was achieved, the units of height, weight and age variables were converted to accurately calculate HAZ, WAZ, and BAZ. Height data, collected in inches, was converted into centimeters by multiplying each entry by 2.54. Weight data was collected in pounds and converted to kilograms by dividing each entry by 2.205. Age was collected in years and converted to days.

A condensed version of the master dataset, containing converted height, weight, sex and age data, was exported to calculate HAZ, WAZ, and BAZ at all three timepoints in R using the zscorer package.[21] The data was then imported back into SAS and merged with the original and complete master dataset. Any HAZ values less than -6 and greater than 6 and any WAZ values less than -6 and greater than 5 were removed from the data due to biologically implausibility.[22] Additionally, any BAZ values greater than 5 or less than -5 were also removed from the data due to biological implausibility.[22] BAZ was considered "healthy" if it was between -2z and 2z and considered "unhealthy" if >2z. While BAZ < -2z is also considered to be unhealthy, we only had three participants with scores below -2z and removed them from the analyses due to small sample size.

Shapiro-Wilk tests for normality were conducted on F&V consumption and BAZ at all three timepoints. We also ran Shapiro-Wilk tests for normality on all baseline covariates. All tests yielded significant p-values indicating data were non-parametric. Given non-normality and the ordinal and paired nature of F&V intake data, we ran Wilcoxon Sign Rank tests to assess whether F&V intake significantly changed from baseline to end-of-program. Given the paired and categorical nature of the healthy BAZ variable, McNemar-Bowker was used to assess whether the proportion of participants within the healthy BAZ range changed significantly from baseline to end-of-program. We also further categorized BAZ values using WHO age-specific categories and assessed changes from baseline to end-of-program using Wilcoxon Sign Rank.

While these analyses, mentioned above, were conducted looking at healthy BAZ as a categorical or ordinal variable, we also wanted to assess program impact on BAZ as a continuous variable. As a result, we assessed changes in BAZ value from baseline to end-of-program using Wilcoxon Sign Rank. We also compared the differences in BAZ from baseline to end-of-program by age. Participants were divided into three age groups: Under age 5, Ages 5-10, and Over age 10. We chose these age cut-offs as children under 5 have different growth trajectories compared to older children and age 10 is when children may begin going through puberty, which can affect height and weight. Since the data were non-parametric and we had three groups to compare, we used Kruskal Wallis to compare the differences in BAZ value from baseline to end-of-program across the age categories.

We used logistic regression to model whether F&V intake at end-of-program and level of food insecurity at end of program were associated with healthy BAZ at end-of-program. We chose logistic regression since healthy BAZ was coded as a binary variable. We intended to conduct further analyses to determine whether food insecurity modified the hypothesized relationship between intake and healthy BAZ. We performed both adjusted and unadjusted logistic regressions. Covariates for the adjusted version of the model were chosen based on the conceptual framework in Figure 1a and 1b.

Results

Baseline Characteristics of Sample

There were a total of 1,164 children enrolled in this program. Baseline characteristics (calculated for all participants and then stratified by healthy BAZ at end of program) can be found in Table 1. Baseline characteristics stratified by F&V intake were also calculated and can be found in Supplemental Table 1.

All Children

The median age of all children was 9 (range 0 – 19) and the median household size was 5 (range 1 – 12). There were slightly more girls in the sample (50%) than boys (48.1%). Approximately 21.9% of children were Black, African American or Caribbean American, 27.2% were White or Caucasian, 23.9% identified as other or mixed race. The majority (69.9%) reported being of Hispanic or Latino ethnicity. The majority of children’s parents who completed the enrollment form did not have a college degree (81.3%) and approximately 39.4% either worked full time or part time (16.8% and 22.6%, respectively). There were 424 participants whose parents were not employed (36.4%). Using participants’ zip codes, we determined the percentage of households in each child’s zip code living below the poverty line. The median percentage of individuals living below the poverty line in a child’s zip code was 28.2% (Range 6.3% to 51.5%). Based on answers to a six-question food security screener, about half of children came from high or very high food insecure households (42.5% and 8.9% respectively, 51.4% combined). At baseline, the median HAZ was -0.07, the median WAZ was 1.25 and the median BAZ was 1.97 for all children. The median BMI percentile was 96.1. At baseline, 54.9% of all participants were eating at least 1 cups of fruit per day and 42.6% were eating at least 1 cup of vegetables per day. While approximately 53.3% of children were meeting the recommended daily fruit intake for their age and sex at baseline, only 27% were meeting the recommended daily vegetable intake for their age and sex.

Children with Complete BAZ data at End-of-Program

The majority of children (51.3%, N=313) who had BAZ data at the end of the program were above the healthy threshold (BAZ > 2) and were considered to have high and unhealthy BAZ. Median age was slightly lower among the children in the unhealthy BAZ group compared with the children in the healthy BAZ group (p<0.001). Nearly 80% of this sample reported being Hispanic, however, the unhealthy BAZ group had a significantly lower proportion of Hispanic children compared to the healthy BAZ group (76.4% vs. 80.5%, p = 0.025).

Parental employment status was significantly associated with whether a child had a healthy or unhealthy BAZ (p = 0.004). The healthy BAZ group contained a larger proportion of children with at least one parent who worked full time or at least one parent unemployed compared to the unhealthy BAZ group, while the unhealthy BAZ group contained a higher proportion of children with at least one parent working part time or retired. In fact, all the children who had complete BAZ data and had at least one retired parent (N=8) ended up in the unhealthy BAZ group at end-of-program.

There were significant differences between the healthy BAZ and unhealthy BAZ groups in baseline HAZ, WAZ, BAZ, and BMI percentile, but this was to be expected given that we stratified on the BAZ category. There were minor differences among the groups in race, food insecurity, percent living below poverty line, and parent education, but none were statistically significant. Baseline characteristics stratified by BAZ group can be found in Table 1.

Baseline Characteristics Stratified by F&V intake

More than half (54.6%) of children with complete F&V intake data ate more F&V at end-of-program compared to baseline. Like with BAZ group, parental employment status at baseline was also significantly associated with F&V consumption (p<0.001). Participants who ate more F&V at end-of-program had a higher proportion of children with at least one parent working full time compared to participants who experienced no change in F&V intake and children who ate more at baseline. The group who experienced no change in intake had a significantly lower proportion of children with at least one unemployed parent and a significantly higher proportion of children who had at least one parent working part time. In fact, only 8.6% of children with complete F&V intake data who had at least one unemployed parent ended up in the 'no change' group. While the 'no change' group had a higher proportion of children with at least one parent working part time, more than half (52.3%) of children with complete data in this category ended up consuming more F&V at end-of-program. Median household size was also significantly associated with F&V consumption (p = 0.030). Household size was slightly larger among those who ate more F&V at end-of-program compared to those who experienced no change or ate more F&V at baseline.

Lastly, race was significantly associated with F&V consumption (p<0.001). The group who ate more F&V at baseline had a significantly higher proportion of Black, African American or Caribbean American children compared to the other groups. Although, nearly half (48.2%) of all Black, African American or Caribbean American children with complete F&V intake data ate more F&V at end-of-program. There was significantly lower proportion of White or Caucasian children in the 'no change' group compared to the other groups. However, similar to Black, African American or Caribbean American children, more than half (53.4%) of all White or Caucasian children with complete data ended up eating more F&V at end-of-program. Additionally, more than half (56.0%) of mixed race or other race children ate more F&V at end-of-program. There were no statistically significant differences among the consumption groups regarding HAZ, WAZ, or BAZ. Baseline characteristics stratified by F&V intake can be found in Supplemental Table 1.

Program Impact on F&V Consumption

Fruit intake significantly increased from baseline to end of program (p<0.001). There were 736 children who had complete data for fruit intake at baseline and end-of-program. At baseline, approximately 62.8 percent of children with complete fruit intake data consumed at least 1 cup of fruit per day. At end-of-program, 74.9 percent were consuming at least 1 cup of fruit per day. There were 53 children (7.1%) who were not eating any fruit at baseline, which decreased to 6 children (<1.0%) at end-of-program (Table 2).

Like fruit intake, there was a significant increase in vegetable intake from baseline to end of program (p<0.001). There were 701 children who had complete data for vegetable intake at baseline and end-of-program. Approximately 52.4% of children with complete vegetable intake data consumed at least 1 cup of vegetables per day at baseline. At end-of-program, this proportion increased to 64.2%. There were 75 children (10.7%) who were not eating any vegetables at baseline. This decreased to 15 children (2.1%) at end-of-program (Table 2).

Program Impact on BAZ

Overall, there were no significant changes in healthy BAZ category or median BAZ value among all participants. However, in children under age 5, there were significant changes in healthy BAZ category using WHO age-specific categories, but not in the direction we expected.

Out of the 1,164 children enrolled in the program, 590 had complete data for BAZ at baseline and end-of-program. (Twenty children had data for BAZ at end-of-program, but not at baseline). There were slight, but insignificant shifts in the proportion of children who were within healthy BAZ range and who were not. At baseline, 285 children (48.3%) had BAZ below 2, while 305 children (51.7%) had BAZ greater than or equal to 2. At end-of-program the number of children with BAZ below 2 increased slightly to 290 (49.2%) and the number of children with BAZ greater than or equal to 2 decreased slightly to 300 (50.9%). These differences were not statistically significant. These were also no statistically significant differences in median BAZ value from baseline to end-of-program. Results from this analysis can be found in Table 3.

Children under the age of five had an increase in median BAZ, while children older than 5 had a decrease in median BAZ over the time of the program. The median difference in BAZ from baseline to end-of-program for all participants with complete pre/post BAZ was nearly zero at 0.023 standard deviations. However, when stratified by age, children under age 5 had a positive median difference of 0.330 standard deviations, while children between ages 5 - 10 had a negative median difference -0.008 standard deviations and children over 10 had a negative median difference of - 0.017 standard deviations. This variation between age groups was statistically significant ($p<0.001$). Box plots depicting the distribution of the differences in BAZ from baseline to end-of-program by age can be found in Figure 2.

We also looked at differences in anthropometry stratified by WHO age-specific categories (Supplemental Table 2).[23] For children under age 5 at baseline (n = 80), $1 \leq$ BAZ < 2 is considered at risk of becoming overweight, $2 \leq$ BAZ < 3 is considered overweight and BAZ > 3 is considered obese. For children ages 5 – 19 at baseline (n = 510), $1 \leq$ BAZ < 2 is considered overweight and BAZ ≥ 2 is considered obese. For children under age five there was an increase in children who were obese, whereas for older children there was a slight decrease in children who were obese. Additionally, in this age group there was a decrease in children within the normal category and an increase in children in the obese category from baseline to end of program. These differences were statistically significant ($p<0.001$). For the age 5-19 age group, the proportion of children in the normal category increased slightly from baseline to end-of-program, but so did the proportion of children in the overweight category. Proportion of children in the obese category decreased slightly. However, these differences were not statistically significant ($p = 0.071$). Results from this analysis can be found in Supplemental Table 2.

Relationship between BAZ, F&V Intake, and Food Insecurity

We ran three logistic regression models to assess the relationships between F&V intake at end-of-program, food insecurity at end-of-program and healthy BAZ at end-of-program. In the unadjusted model, children who were consuming more cups of vegetables per day at end-of-program had 1.07 times the odds of having a healthy BAZ at the end of the program. The unadjusted model for fruit consumption showed an inverse association between fruit intake and healthy BAZ. Children who were consuming more cups of fruit at end-of-program only had 0.85 times the odds of having a healthy BAZ. This inverse association was also observed for food insecurity, where children with a higher degree of food insecurity at end-of-program had 1.07 times the odds of having a healthy BAZ. This is the opposite of what we hypothesized.

However, none of these relationships were statistically significant and the 95% confidence intervals for all odds ratios contained the possibility for a null finding. Since this data did not support our hypothesis that F&V intake alone was a significant predictor of healthy BAZ, we did not move forward with the analysis to determine whether food insecurity might modify the relationship. Thus, we shifted our thinking from the conceptual framework in Figure 1a to the conceptual framework in Figure 1b. The characteristics influencing F&V intake and food insecurity in the revised framework remained the same, but we removed the hypothesized pathway by which food insecurity modified the relationship between F&V intake and healthy BAZ.

Using this new framework, we ran a model adjusted for child characteristics including sex, age, and height. We also ran a fully-adjusted model containing the child characteristics as well as the community, household and sociodemographic characteristics. While we included parent education and parent employment in the conceptual framework, we chose not to include them in our fully adjusted model as our data only provided information on these variables for one parent, and it was unclear whether the data came from the mother or father. As the unknown education and employment status of the other parent could bias the model, we chose to exclude the variables all together. While the framework theorizes that median household income, food scarcity, and parent height and weight may influence the model, data on these variables was not collected and we excluded them from our model as well.

The direction of these relationships remained consistent in the child characteristic-adjusted model and the fully-adjusted model, with the exception of the relationship between vegetable intake and healthy BAZ. In the unadjusted and child characteristic-adjusted models, we observed a positive association between vegetable intake and healthy BAZ, but in the fully adjusted model we observed an inverse relationship just like we did with fruit intake. However, once again, none of these relationships were statistically significant so we fail to reject the null hypothesis that F&V intake and food insecurity at end-of-program are not associated with healthy BAZ at end-of-program. In the fully adjusted model, only sex and height were found to be significantly associated with healthy BAZ at end-of-program. Odds ratios and p-values for F&V intake and food insecurity in all three models can be found in Table 4. Odds ratios and p-values for all variables in the fully-adjusted model can be found in Table 5.

Discussion

Our findings supported our original hypothesis that the WW program would significantly increase children's F&V intake from baseline to end-of-program but did not support our hypothesis that the program would positively impact children's anthropometry. Therefore, our findings suggest that a $25/week F&V incentive for six months is sufficient to significantly increase F&V intake among children but the changes in intake do not translate to anthropometric changes.

Our findings on F&V intake are consistent with findings from other F&V incentive program evaluations. Other evaluations of F&V incentive programs have observed significant increases in adult and family-level F&V intake.[24-26] For example, a Rhode Island program called Healthy Foods, Healthy Families (HFHF) provided families with $20 bonus bucks at every third farmers market they attended and found significant increases in vegetable intake and significant decreases in soda consumption. Additionally, a Utah program called Double Up Food Bucks provided adult participants on SNAP with $10 of token to spend on F&V at farmers markets. Their evaluation found that the program was successful at significantly increasing total F&V consumption and significantly decreasing food insecurity. Most of the previous research conducted evaluating F&V incentive programs focus on adult or family-level consumption, but none to our knowledge focus solely on child consumption. This makes our evaluation a significant contribution to F&V incentive program evaluation.

There are a few possible alternative reasons that we did not see a significant increase in the proportion of children who had a BAZ value in the healthy range as a result of the program. First, the program only lasted approximately six months, so there may not have been enough time to see significant anthropometric changes in this short time period. Another possible explanation is that the increase in F&V was not large enough to cause changes in anthropometry. For both fruit intake and vegetable intake the largest increase was seen in the 2-3 cup category (92% and 153% increase from baseline to end of program for fruit and vegetable intake, respectively), but perhaps children need to be consuming in the 3+

cup range to see significant anthropometric changes. Third, we must also consider that an increase in F&V will not have positive anthropometric effects if there aren't also decreases in the intake of other, less healthy food items in their diet. This program did not survey parents on other items in the children's diets, so we cannot be confident that increases in F&V is associated with decreases in other food consumption.

Lastly, we must consider that the prevalence of unhealthy and healthy BAZ remained consistent because the incidence of unhealthy BAZ remained equal to the remission of unhealthy BAZ at both time points. Some longitudinal obesity prevention studies have found body weight decreases in overweight children over time and body weight increases in non-overweight children over time.[27,28] While we stratified our analyses by age, we did not stratify analyses based on BAZ category, so there is a possibility that shifts from the unhealthy BAZ category to the healthy BAZ category were attenuated by shifts from the healthy BAZ category to the unhealthy BAZ category.

While there was no significant increase in the proportion of children who had a BAZ in the healthy range from baseline to end-of-program, we did see significant findings when we stratified by age and treated BAZ as a categorical variable rather than binary variable. In children under five years of age, there was a small, but significant decrease in the proportion of children who fell in the normal BAZ category at end-of-program compared to baseline and a small, but significant increase in children who fell into the obese category at end-of-program compared to baseline. This shift is not in the direction we expected and may also be explained by some of the theories posited above. However, when we look at children over age 5, we saw a small increase in the number of children in the normal category and small decreases in the number of children in the overweight and obese category. The findings from the over age 5 analysis are not statistically significant ($p=0.71$) and the differences in BAZ categories from baseline to end-of-program are very small. However, this analysis emphasizes the importance of looking for anthropometric changes within subgroups of children. Children under 5 are in a faster growth period than children over 5 and they may also have different receptivity to F&V compared to the older group, which may explain the difference in the results between the two groups that we observed.

The stratified analysis looking at differences in BAZ as a continuous variable found a nearly-zero difference in median BAZ value from baseline to end-of-program for all participants. However, when stratified by age group, we found a larger, positive median difference of 0.33 standard deviations among children under age 5 and very small negative median differences among children between ages 5-10 and children over age 10. These differences across age groups were statistically significant. This analysis further supports the importance of analyzing pediatric anthropometric changes by age.

Our findings from our logistic regression models suggested an inverse association between fruit intake and healthy BAZ, meaning that the more fruit a child consumed in a day, the lower the odds that child had a healthy BAZ at the end of the program. Previous research has shown that fruit juice consumption can be a major contributor to increased sugar intake and childhood obesity. Fruit juices contain high levels of sugar without the added benefit of fiber, which can cause decreased satiety leading to weight gain and increased adiposity.[29-32]

The lack of a significant association between F&V intake and healthy BAZ is similar to the findings of a 2011 systematic review. The review looked at the relationship of F&V intake with adiposity and found that increased F&V intake contributed to reduced adiposity in overweight or obese adults but did not observe an association among children.[33]

An inverse association was also observed when looking at food insecurity and healthy BAZ, meaning the more food insecure a child was at the end of the program, the higher the odds they had a healthy BAZ at the end of the program. However, none of these associations were statistically significant. This lack of association was more surprising considering previous research had found child BMI percentile was positively associated with personal food insecurity.[34] However, other research has found that when household food security is stratified by adults and children, the children experience food insecurity at a much lower rate than adults,[35] suggesting that children are the last to be impacted by food shortages and food insecurity. This theory may explain the mechanisms behind our findings. Additionally, we must also consider that the factors driving increases in child BMI may be different than the factors driving decreases in child BMI. In other words, although food insecurity may be associated with higher child BMI percentile, this does not mean the food security will be associated with lower child BMI percentile.

Our findings from the logistic regression models may also be due to the fact that this program did not have a large enough sample to adequately power the analysis to detect such small differences in anthropometry. The median difference in BAZ from baseline to end-of-program was essentially zero for all participants, children ages 5-10 and children over age 10, so even if results were statistically significant, they would not have been biologically meaningful. Therefore, while our data and findings do not support our hypothesis that F&V intake and food insecurity are significant predictors of healthy BAZ at end of program, it is still possible that these associations do exist and more research on the impact of F&V incentive programs on child anthropometry should be done to explore this area.

This analysis does have its limitations. This study was not properly powered to detect such small effect sizes in the logistic regression models. Post hoc power calculations conducted through G*Power[36] revealed that we needed a sample size of at least 1,422 to determine whether differences in F&V intake and food insecurity were significant in predicting healthy BAZ at 90 percent power. Despite there being 610 children with BAZ data at end-of-program, only 397 were included in the unadjusted model and the child-characteristic-adjusted model, and only 281 in the fully adjusted model due to missingness among the independent variables. With these current sample sizes, our analysis only achieved 25% power.

Another limitation is that F&V intake and food insecurity were self-reported measures. Food insecurity was measured using a validated screener, but children's F&V intake was self-reported by parents, which may have introduced bias into the analysis. Although parents are usually in charge of children's diets, they may not be aware of every F&V their child eats in a day, especially if the child is in school for a large portion of the day. This can introduce measurement bias into the analysis. Additionally, self-reported diet measures can be susceptible to over reporting F&V intake due to social desirability bias.

Conclusion

WW's 2017 Multi-City FVRx program was successful at significantly increasing F&V intake from baseline to end-of-program, but this did not translate to significant changes in child anthropometry.

F&V intake and food insecurity at end-of-program were not significantly associated with healthy BAZ at end-of-program. However, age and height were significantly associated with healthy BAZ. This makes sense, given that age and height are two of the variables used when calculating BAZ. Since F&V intake alone was not significantly associated with healthy BAZ, this dataset did not support the hypothesis that food insecurity could modify this relationship.

In conclusion, this analysis supports the conclusion that $25 a week F&V incentive is sufficient to increase children's consumption of F&V. However, the health impacts are less clear as the program showed no significant changes in BAZ. In order to accurately assess whether F&V intake and food insecurity are significantly associated with healthy BAZ, WW should consider enrolling considerably more participants into their programs, so even with missing data, well powered models can be run using their data. Additionally, they may also consider using other dietary assessment methods, such as 24-hour recall or food records, combined with an independent method such as checking biomarker levels, to more accurately measure F&V intake changes throughout the program. WW may also consider raising the incentive amount in the future to see if a higher dose of the incentive is successful at positively impacting child anthropometry.

References

1. WHO. Obesity and Overweight. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight [Accessed: 20 March 2021]

2. Sahoo K, Sahoo B, Choudhury AK, Sofi NY, Kumar R, Bhadoria AS. Childhood obesity: causes and consequences. J Family Med Prim Care. 2015;4(2):187-192. doi:10.4103/2249-4863.154628

3. Roseman MG, Yeung WK, Nickelsen J. Examination of weight status and dietary behaviors of middle school students in Kentucky. J Am Diet Assoc. 2007;107(7):1139-1145. doi:10.1016/j.jada.2007.04.015

4. U.S. Department of Agriculture. MyPlate. Washington, DC. [Accessed 20 March, 2021]

5. Lee-Kwan SH, Moore LV, Blanck HM, Harris DM, Galuska D. Disparities in State-Specific Adult Fruit and Vegetable Consumption — United States, 2015. MMWR Morb Mortal Wkly Rep 2017;66:1241–1247. DOI: http://dx.doi.org/10.15585/mmwr.mm6645a1external icon.

6. Lange, S. J., Moore, L. V., Harris, D. M., Merlo, C. L., Lee, S. H., Demissie, Z., & Galuska, D. A. (2021). Percentage of Adolescents Meeting Federal Fruit and Vegetable Intake Recommendations - Youth Risk Behavior Surveillance System, United States, 2017. MMWR. Morbidity and mortality weekly report, 70(3), 69–74. doi.org/10.15585/mmwr.mm7003a1

7. Scaglioni S, Arrizza C, Vecchi F, Tedeschi S. Determinants of children's eating behavior. Am J Clin Nutr. 2011;94(6 Suppl):2006S-2011S. doi:10.3945/ajcn.110.001685

8. American Heart Association. (2020). Healthy eating behaviors in childhood may reduce the risk of adult obesity and heart disease. ScienceDaily. Retrieved April 14, 2021 from www.sciencedaily.com/releases/2020/05/200511092923.htm

9. Aune D, Giovannucci E, Boffetta P, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality-a systematic review and dose-response meta-analysis of prospective studies. Int J Epidemiol. 2017;46(3):1029-1056. doi:10.1093/ije/dyw319

10. Mozaffarian D. Dietary and Policy Priorities for Cardiovascular Disease, Diabetes, and Obesity: A Comprehensive Review. Circulation. 2016;133(2):187-225. doi:10.1161/CIRCULATIONAHA.115.018585

11. Willett WC, Stampfer MJ. Current evidence on healthy eating. Annu Rev Public Health. 2013;34:77-95. doi:10.1146/annurev-publhealth-031811-124646

12. Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de Moor C. Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior. Health Educ Behav. 2003;30(5):615-626. doi:10.1177/1090198103257254

13. Casey PH, Szeto K, Lensing S, Bogle M, Weber J. Children in food-insufficient, low-income families: prevalence, health, and nutrition status. Arch Pediatr Adolesc Med. 2001;155(4):508-514. doi:10.1001/archpedi.155.4.508

14. Rasmussen M, Krølner R, Klepp KI, et al. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. Int J Behav Nutr Phys Act. 2006;3:22. Published 2006 Aug 11. doi:10.1186/1479-5868-3-22

15. Haynes-Maslow L, Parsons SE, Wheeler SB, Leone LA. A qualitative study of perceived barriers to fruit and vegetable consumption among low-income populations, North Carolina, 2011. Prev Chronic Dis. 2013;10:E34. doi:10.5888/pcd10.120206

16. Veldheer S, Scartozzi C, Knehans A, et al. A Systematic Scoping Review of How Healthcare Organizations Are Facilitating Access to Fruits and Vegetables in Their Patient Populations. J Nutr. 2020;150(11):2859-2873. doi:10.1093/jn/nxaa209

17. Hager ER, Quigg AM, Black MM, et al. Development and validity of a 2-item screen to identify families at risk for food insecurity. Pediatrics. 2010;126(1):e26-e32. doi:10.1542/peds.2009-3146

18. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatr Suppl. 2006;450:76-85. doi:10.1111/j.1651-2227.2006.tb02378.x

19. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ. 2007;85(9):660-667. doi:10.2471/blt.07.043497

20. Blumberg SJ, Bialostosky K, Hamilton WL, Briefel RR. The effectiveness of a short form of the Household Food Security Scale. Am J Public Health. 1999;89(8):1231-1234. doi:10.2105/ajph.89.8.1231

21. Guevarra, E. zscorer: Weight-for-age, height-for-age, weight-for-height, BMI-for-age, head circumference-for-age, arm circumference-for-age, subscapular skinfold-for-age and triceps skinfold-for-age z-score calculator. RDocumentation. Accessed https://www.rdocumentation.org/packages/zscorer/versions/0.3.1

22. WHO AnthroPlus for personal computers Manual: Software for assessing growth of the world's children and adolescents. Geneva: WHO, 2009 (http://www.who.int/growthref/tools/en/).

23. de Onis M, Lobstein T. Defining obesity risk status in the general childhood population: which cut-offs should we use?. Int J Pediatr Obes. 2010;5(6):458-460. doi:10.3109/17477161003615583

24. Gans KM, Risica PM, Keita AD, et al. Multilevel approaches to increase fruit and vegetable intake in low-income housing communities: final results of the 'Live Well, Viva Bien' cluster-randomized trial. Int J Behav Nutr Phys Act. 2018;15(1):80. Published 2018 Aug 20. doi:10.1186/s12966-018-0704-2

25. Bowling AB, Moretti M, Ringelheim K, Tran A, Davison K. Healthy Foods, Healthy Families: combining incentives and exposure interventions at urban farmers' markets to improve nutrition among recipients of US federal food assistance. Health Promot Perspect. 2016;6(1):10-16. Published 2016 Mar 31. doi:10.15171/hpp.2016.02

26. Durward CM, Savoie-Roskos M, Atoloye A, et al. Double Up Food Bucks Participation is Associated with Increased Fruit and Vegetable Consumption and Food Security Among Low-Income Adults. J Nutr Educ Behav. 2019;51(3):342-347. doi:10.1016/j.jneb.2018.08.011

27. Williamson DA, Copeland AL, Anton SD, et al. Wise Mind project: a school-based environmental approach for preventing weight gain in children. Obesity (Silver Spring). 2007;15(4):906-917. doi:10.1038/oby.2007.597

28. Foster GD, Sherman S, Borradaile KE, et al. A policy-based school intervention to prevent overweight and obesity. Pediatrics. 2008;121(4):e794-e802. doi:10.1542/peds.2007-1365

29. Kimm SY. The role of dietary fiber in the development and treatment of childhood obesity. Pediatrics. 1995;96(5 Pt 2):1010-1014.

30. O'Neil CE, Zanovec M, Cho SS, Nicklas TA. Whole grain and fiber consumption are associated with lower body weight measures in US adults: National Health and Nutrition Examination Survey 1999-2004. Nutr Res. 2010;30(12):815-822. doi:10.1016/j.nutres.2010.10.013

31. Flood-Obbagy JE, Rolls BJ. The effect of fruit in different forms on energy intake and satiety at a meal. Appetite. 2009;52(2):416-422. doi:10.1016/j.appet.2008.12.001

32. Wojcicki JM, Heyman MB. Reducing childhood obesity by eliminating 100% fruit juice. Am J Public Health. 2012;102(9):1630-1633. doi:10.2105/AJPH.2012.300719

33. Ledoux TA, Hingle MD, Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. Obes Rev. 2011;12(5):e143-e150. doi:10.1111/j.1467-789X.2010.00786.x

34. Kaur J, Lamb MM, Ogden CL. The Association between Food Insecurity and Obesity in Children-The National Health and Nutrition Examination Survey. J Acad Nutr Diet. 2015;115(5):751-758. doi:10.1016/j.jand.2015.01.003

35. Amaro, C.M., Roberts, M.C. An Evaluation of a Dollar-for-Dollar Match Program at Farmers' Markets for Families Using Supplemental Nutrition Assistance Program Benefits. J Child Fam Stud 26, 2790–2796 (2017). https://doi.org/10.1007/s10826-017-0779-4

36. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175-191. doi:10.3758/bf03193146

Figure 1a: Conceptual Framework depicting Food Security Modification

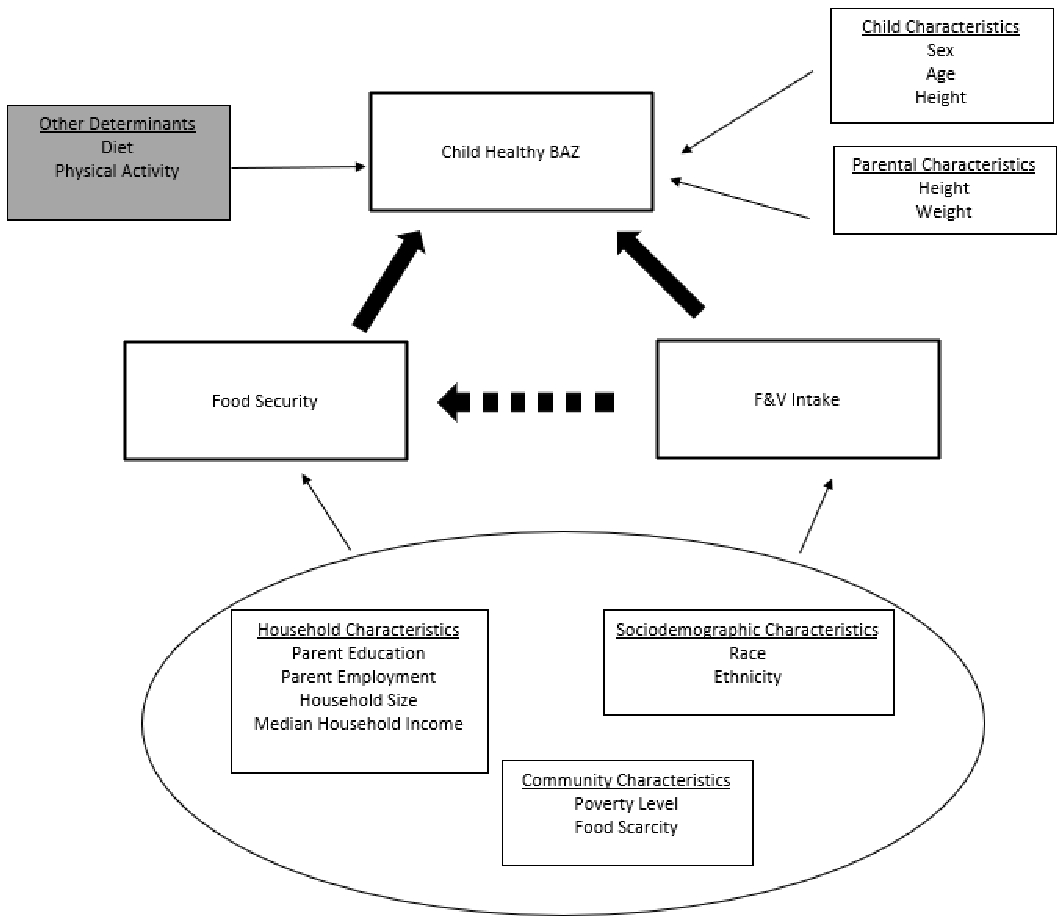

Figure 1b: Conceptual Framework without Food Security Modification

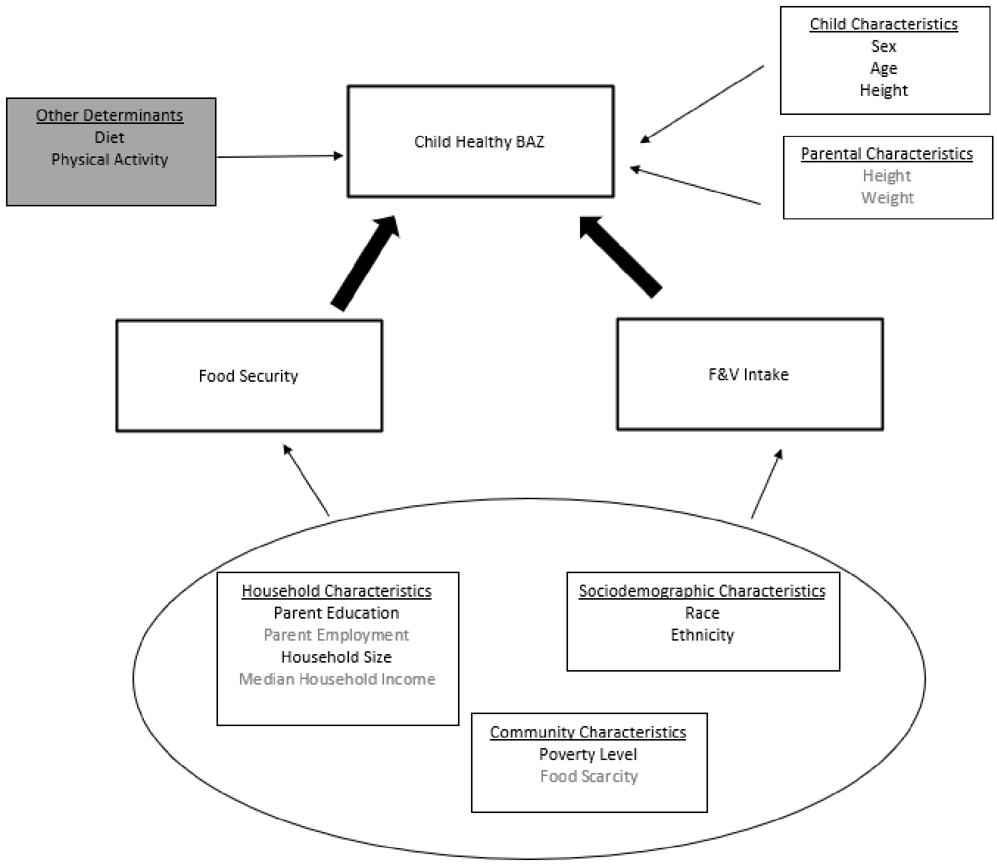

Figure 2: Differences in BAZ from Baseline to End-of-Program

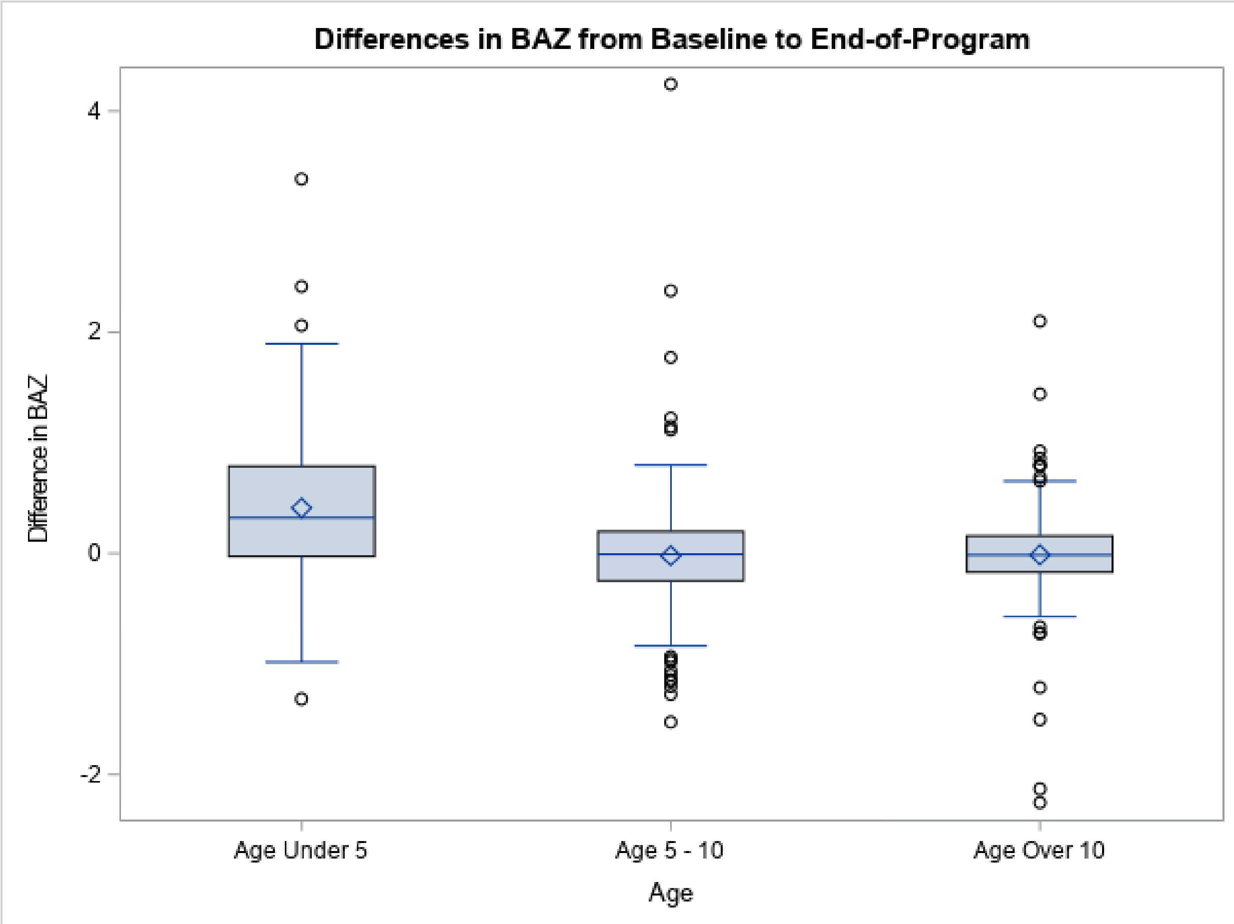

Table 1: Baseline Characteristics Stratified by BMI-for-Age Z-Scores [a]

	All Participants (N=1,164) [b]	Children with Complete BAZ Data at End-of-Program (N=610)	Children with BAZ < 2 at End-of-Program (N = 297) [b]	Children with BAZ >2 at End-of-Program (N = 313) [b]	P-value [c]
Age - *median (IQR)*	9 (7)	10 (6)	10 (7)	9 (5)	< 0.001
Sex - *n (column %)*					0.973
Female	582 (50%)	327 (53.6%)	159 (53.5%)	168 (53.7%)	
Male	560 (48.1%)	283 (46.4%)	138 (46.5%)	145 (46.3%)	
Missing	22 (1.9%)	0 (0%)	0 (0%)	0 (0%)	
Parent Education - *n (column %)*					0.796
Associate's or bachelor's degree and Beyond	131 (11.3%)	66 (10.8%)	33 (11.1%)	33 (10.5%)	
No College Degree	946 (81.3%)	503 (82.5%)	243 (81.8%)	260 (83.1%)	
Missing	87 (7.5%)	41 (6.7%)	21 (7.1%)	20 (6.4%)	
Parent Employment - *n (column %)*					0.004
Employed, working 40 hours a week or more	195 (16.8%)	103 (16.9%)	54 (18.2%)	49 (15.7%)	
Employed, working less than 40 hours a week	263 (22.6%)	130 (21.3%)	51 (17.2%)	79 (25.2%)	
Not Employed	424 (36.4%)	221 (36.2%)	119 (40.1%)	102 (32.6%)	
Retired	11 (1.0%)	8 (1.3%)	0 (0%)	8 (2.6%)	
Unable to Work	28 (2.4%)	6 (1.0%)	4 (1.4%)	2 (0.6%)	
Other	157 (13.5%)	105 (17.2%)	48 (16.2%)	57 (18.2%)	
Missing	86 (7.4%)	37 (6.1%)	21 (7.1%)	16 (5.1%)	
% Households Below Poverty Line in Zip Code - *median (IQR)*	28.2 (13.3)	26.9 (14.0)	28.4 (12.8)	25.1 (14.2)	0.153
Food Inecurity *n (column %)*					0.931
Low or Marginal Food Insecurity	347 (29.8%)	179 (29.3%)	86 (29.0%)	93 (29.7%)	
High Food Insecurity	495 (42.5%)	279 (45.7%)	136 (45.8%)	142 (45.7%)	
Very High Food Insecurity	103 (8.9%)	48 (7.9%)	22 (7.4%)	26 (8.3%)	
Missing	219 (18.8%)		53 (17.9%)	51 (16.3%)	
Household Size - *median (IQR)*	5 (1)	5 (1)	5 (1)	5 (1)	0.632
Race - *n (column %)*					0.554
Black, African American or Caribbean American	255 (21.9%)	84 (13.8%)	37 (12.5%)	47 (15.0%)	

White or Caucasian	317 (27.2%)	193 (31.6%)	92 (31.0%)	101 (32.3%)	
Asian or Pacific Islander	4 (0.3%)	2 (0.3%)	0 (0%)	2 (0.6%)	
American Indian or Native American	9 (0.8%)	2 (0.3%)	0 (0%)	2 (0.6%)	
Other or Mixed Race	278 (23.9%)	168 (27.5%)	81 (27.3%)	87 (27.8%)	
Missing	301 (25.9%)	161 (26.4%)	87 (29.3%)	74 (23.6%)	
Hispanic - *n (column %)*					0.025
Yes	813 (69.9%)	478 (78.4%)	239 (80.5%)	239 (76.4%)	
No	254 (21.8%)	89 (14.6%)	33 (11.1%)	56 (17.9%)	
Missing	97 (8.3%)	43 (7.1%)	25 (8.4%)	18 (5.8%)	
Height-for-Age Z-Score - *median (IQR)*	0.49 (3.32)	0.06 (3.83)	-1.42 (4.01)	1.03 (2.64)	< 0.001
Weight-for-Age Z-Score - *median (IQR)*	1.66 (3.18)	1.88 (3.43)	0.2 (3.32)	2.98 (1.32)	< 0.001
BMI-for-Age Z-Score - *median (IQR)*	1.97 (2.24)	2.05 (2.11)	0.77 (1.64)	2.84 (1.02)	< 0.001
BMI Percentile - *median (IQR)*	96.1 (11.5)	94.8 (12.5)	88.6 (32.9)	98.0 (4.5)	< 0.001
Fruit Intake - *n (column %)*					0.202
None	88 (7.6%)	41 (6.7%)	22 (7.4%)	19 (6.1%)	
½ cup or less	182 (15.6%)	94 (15.4%)	45 (15.2%)	49 (15.7%)	
½ cup to 1 cup	188 (16.2%)	91 (14.9%)	39 (13.1%)	52 (16.6%)	
1 to 2 cups	380 (32.7%)	212 (34.8%)	108 (36.4%)	104 (33.2%)	
2 to 3 cups	98 (8.4%)	60 (9.8%)	33 (11.1%)	27 (8.6%)	
3 to 4 cups	127 (10.9%)	72 (11.8%)	30 (10.1%)	42 (13.4%)	
4+ cups	34 (2.9%)	14 (2.3%)	3 (1.0%)	11 (3.5%)	
Missing	67 (7.8%)	26 (4.3%)	17 (5.7%)	9 (2.9%)	
Vegetable Intake - *n (column %)*					0.770
None	135 (11.6%)	64 (10.5%)	31 (10.4%)	33 (10.5%)	
½ cup or less	236 (20.3%)	115 (18.9%)	55 (18.5%)	60 (19.2%)	
½ cup to 1 cup	197 (16.9%)	99 (16.2%)	54 (18.2%)	45 (14.4%)	
1 to 2 cups	337 (29.0%)	195 (32.0%)	87 (29.3%)	108 (34.5%)	
2 to 3 cups	63 (5.4%)	45 (7.4%)	20 (6.7%)	25 (8.0%)	
3 to 4 cups	80 (6.9%)	40 (6.6%)	19 (6.4%)	21 (6.7%)	
4+ cups	15 (1.3%)	6 (1.0%)	6 (0.7%)	4 (1.3%)	
Missing	101 (8.7%)	46 (7.5%)	29 (9.8%)	17 (5.4%)	

[a] Table values are median (IQR) for continuous variables and n (column %) for categorical variables.

[b] Percentages may not sum to 100% due to rounding.

[c] P-value is for Wilcoxon Rank Sum (continuous variables), Chi-square test (most categorical variables), or Fisher's Exact Test (calculated for Race and Parent Employment)

Table 2: Changes in Fruit and Vegetable Intake from Baseline to End-of-Program [a]

	Baseline [b]	End of Program [b]	P-Value [c]
Fruit (N=736)			< 0.001
None	52 (7.1%)	6 (0.8%)	
½ cup or less	103 (14.0%)	49 (6.7%)	
½ cup to 1 cup	119 (16.2%)	130 (17.7%)	
1 to 2 cups	266 (36.1%)	278 (37.8%)	
2 to 3 cups	84 (11.4%)	161 (21.9%)	
3 to 4 cups	91 (12.4%)	81 (11.0%)	
4+ cups	21 (2.9%)	31 (4.2%)	
Vegetable Intake (N=701)			< 0.001
None	75 (10.7%)	15 (2.1%)	
½ cup or less	128 (18.3%)	82 (11.7%)	
½ cup to 1 cup	130 (18.6%)	154 (22.0%)	
1 to 2 cups	252 (36.0%)	250 (35.7%)	
2 to 3 cups	49 (7.0%)	124 (17.7%)	
3 to 4 cups	59 (8.4%)	57 (8.1%)	
4+ cups	8 (1.1%)	19 (2.7%)	

[a] Values are N (%). N = 736 for participants with complete baseline/end-of-program fruit intake data and N=701 for participants with complete vegetable data

[b] Percentages may not sum to 100% due to rounding.

[c] P-values are for Wilcoxon Sign Rank Test

Table 3: Differences in Anthropometry from Baseline to End-of-Program [a]

	Baseline [b]	**End of Program [b]**	**P-Value [c]**
BAZ			0.466
Healthy (Z < 2)	285 (48.3%)	290 (49.2%)	
Not Healthy (Z >= 2)	305 (51.7%)	300 (50.9%)	
Median BAZ Value	2.05	2.08	0.263

[a] N = 590 people with complete BAZ data at baseline and end of program, meaning 20 people had BAZ data at end of program, but not baseline

[b] Percentages may not sum to 100% due to rounding.

[c] P-value from McNemar-Bowker test for categorical BAZ variable and Wilcoxon Signed Rank for median BAZ variable

Table 4: Associations between F&V intake and Food Security and Child Anthropometry

	Unadjusted		Adjusted for Child Characteristics [a]		Fully Adjusted [b]	
	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Fruit Intake	0.85 (0.68 – 1.04)	0.117	0.85 (0.66 – 1.09)	0.193	0.88 (0.65 - 1.21)	0.435
Vegetable Intake	1.07 (0.89 – 1.29)	0.491	1.11 (0.88 – 1.39)	0.375	0.99 (0.72 – 1.35)	0.938
Food Security	1.07 (0.81 – 1.42)	0.641	1.22 (0.87 – 1.69)	0.246	1.28 (0.84 – 1.96)	0.244

[a] Child characteristic adjusted model adjusted for sex, age, and height
[b] Fully adjusted model adjusted for sex, age, height at end-of-program, community poverty, household size, Hispanic ethnicity, and race

Table 5: Odds Ratios for All Variables in the Fully Adjusted Model

	Odds Ratio (95% CI)	**P-Value**
Fruit Intake	0.88 (0.65 – 1.21)	0.435
Vegetable Intake	0.99 (0.72 – 1.35)	0.938
Food Security	1.28 (0.84 – 1.96)	0.244
Sex		
Female	1.16 (0.64 – 2.12)	0.622
Male	Ref	
Age	1.34 (1.22 – 1.47)	<0.001
Height	0.83 (0.79 – 0.88)	<0.001
Poverty	0.98 (0.95 – 1.02)	0.390
Household Size	1.21 (0.97 – 1.50)	0.098
Hispanic		
Yes	1.05 (0.25 – 4.35)	0.950
No	Ref	
Race		
Black, African American, Caribbean	0.95 (0.21 – 4.26)	0.949
Other or Mixed Race	1.02 (0.53 – 1.97)	0.951
White	Ref.	

Supplemental Table 1: Baseline Characteristics Stratified by F&V intake [a]

	All Participants (N=1,164) [b]	Children with Complete F&V intake data at baseline and End-of-Program (N = 744)	Children who ate less F&V at End-of-Program (N = 256) [b]	No Change (N=82) [b]	Children who ate more F&V at End-of-Program (N=406) [b]	P-value [c]
Age - *median (IQR)*	9 (7)	9 (7)	9 (7)	10 (8)	9 (7)	0.137
Sex - *n (column%)*						0.165
Female	582 (50%)	390 (52.4%)	133 (52.0%)	51 (62.2%)	206 (50.7%)	
Male	560 (48.1%)	353 (47.5%)	122 (47.7%)	31 (37.8%)	200 (49.3%)	
Missing	22 (1.9%)	1 (0.1%)	1 (0.4%)	0 (0%)	0 (0%)	
Parents' Education - *n (column%)*						0.160
Associate's or bachelor's degree and Beyond	131 (11.3%)	80 (10.8%)	20 (7.8%)	9 (11.0%)	51 (12.6%)	
No College Degree	946 (81.3%)	647 (87.0%)	229 (89.5%)	73 (89.0%)	345 (85.0%)	
Missing	87 (7.5%)	17 (2.3%)	7 (2.7%)	0 (0%)	10 (2.5%)	
Parents' Employment - *n (column%)*						<0.001
Employed, working 40 hours a week or more	195 (16.8%)	114 (15.3%)	35 (13.7%)	12 (14.6%)	67 (16.5%)	
Employed, working less than 40 hours a week	263 (22.6%)	174 (23.4%)	56 (21.9%)	27 (32.9%)	91 (22.4%)	
Not Employed	424 (36.4%)	290 (39.0%)	101 (39.5%)	25 (30.5%)	164 (40.4%)	
Retired	11 (1.0%)	9 (1.2%)	1 (0.4%)	2 (2.4%)	6 (1.5%)	
Unable to Work	28 (2.4%)	15 (2.0%)	5 (2.0%)	2 (2.4%)	8 (2.0%)	
Other	157 (13.5%)	126 (16.9%)	51 (19.9%)	13 (15.9%)	62 (15.3%)	
Missing	86 (7.4%)	16 (2.2%)	7 (2.7%)	1 (1.2%)	8 (2.0%)	
% Below Poverty Line - *median (IQR)*	28.2 (13.3)	28.4 (13.8)	28.4 (13.4)	28.8 (12.4)	27.2 (14.2)	0.662
Food Security - *n (column%)*						0.336
High or Marginal Food Security	347 (29.8%)	242 (32.5%)	90 (35.2%)	21 (25.6%)	131 (32.3%)	
Low Food Security	495 (42.5%)	344 (46.2%)	109 (42.6%)	43 (52.4%)	192 (47.3%)	

Very Low Food Security	103 (8.9%)	65 (8.7%)	25 (9.8%)	9 (11.0%)	31 (7.6%)	
Missing	219 (18.8%)	93 (12.5%)	32 (12.5%)	2 (11.0%)	52 (12.8%)	
Household Size - *median (IQR)*	5 (1)	5 (1)	4 (1)	4 (2)	5 (1)	0.030
Race - *n (column%)*						<0.001
Black, African American or Caribbean American	255 (21.9%)	110 (14.8%)	44 (17.2%)	13 (15.9%)	53 (13.1%)	
White or Caucasian	317 (27.2%)	232 (31.2%)	80 (31.3%)	28 (24.2%)	124 (30.5%)	
Asian or Pacific Islander	4 (0.3%)	1 (0.1%)	0 (0%)	0 (0%)	1 (0.3%)	
American Indian or Native American	9 (0.8%)	5 (0.7%)	1 (0.4%)	2 (2.4%)	2 (0.5%)	
Other or Mixed Race	278 (23.9%)	216 (29.0%)	73 (28.5%)	22 (26.8%)	121 (29.8%)	
Missing	301 (25.9%)	180 (24.2%)	58 (22.7%)	17 (20.7%)	105 (25.9%)	
Hispanic - *n (column%)*						0.141
Yes	813 (69.9%)	610 (82.0%)	201 (78.5%)	66 (80.5%)	343 (84.5%)	
No	254 (21.8%)	111 (14.9%)	47 (18.4%)	12 (14.6%)	52 (12.8%)	
Missing	97 (8.3%)	23 (3.1%)	8 (3.1%)	4 (4.9%)	11 (2.7%)	
HAZ - *median (IQR)*	0.49 (3.32)	0.29 (4.35)	0.45 (4.29)	-0.10 (3.82)	0.22 (4.44)	0.311
WAZ - *median (IQR)*	1.66 (3.18)	1.73 (4.19)	1.72 (4.04)	1.31 (4.25)	1.86 (4.87)	0.569
BAZ - *median (IQR)*	1.97 (2.24)	2.01 (2.21)	2.19 (2.09)	1.78 (2.12)	1.90 (2.26)	0.348
BMI Percentile - *median (IQR)*	96.1 (11.5)	96.3 (10.0)	96.7 (9.3)	96.5 (9.5)	95.6 (10.0)	0.837
Fruit Intake - *n (column%)*						<0.001
None	88 (7.6%)	52 (7.0%)	0 (0%)	1 (1.2%)	51 (12.6%)	
½ cup or less	182 (15.6%)	106 (14.3%)	7 (2.7%)	3 (3.7%)	96 (23.7%)	
½ cup to 1 cup	188 (16.2%)	119 (16.0%)	20 (7.8%)	8 (9.8%)	91 (22.4%)	
1 to 2 cups	380 (32.7%)	267 (35.9%)	79 (30.9%)	53 (64.6%)	135 (33.3%)	
2 to 3 cups	98 (8.4%)	84 (11.3%)	61 (23.8%)	6 (7.3%)	17 (4.2%)	
3 to 4 cups	127 (10.9%)	91 (12.2%)	70 (27.3%)	11 (13.4%)	10 (2.5%)	
4+ cups	34 (2.9%)	20 (2.7%)	19 (7.4%)	0 (0%)	1 (0.3%)	
Missing	67 (7.8%)	5 (0.7%)	0 (0%)	0 (0%)	5 (1.2%)	
Vegetable Intake - *n (column%)*						<0.001
None	135 (11.6%)	77 (10.4%)	6 (2.3%)	4 (4.9%)	67 (16.5%)	
½ cup or less	236 (20.3%)	134 (18.0%)	12 (4.7%)	6 (7.3%)	116 (28.6%)	
½ cup to 1 cup	197 (16.9%)	131 (17.6%)	28 (10.9%)	12 (15.9%)	90 (22.2%)	

1 to 2 cups	337 (29.0%)	255 (34.3%)	111 (43.4%)	49 (59.8%)	95 (23.4%)	
2 to 3 cups	63 (5.4%)	50 (6.7%)	34 (13.3%)	6 (7.3%)	10 (2.5%)	
3 to 4 cups	80 (6.9%)	60 (8.1%)	55 (21.5%)	1 (1.12%)	4 (1.0%)	
4+ cups	15 (1.3%)	9 (1.2%)	9 (3.5%)	0 (0%)	0 (0%)	
Missing	101 (8.7%)	28 (3.8%)	0 (0%)	3 (3.7%)	24 (5.9%)	

[a] Table values are median (IQR) for continuous variables and n (column %) for categorical variables.
[b] Percentages may not sum to 100% due to rounding.
[c] P-value is for Kruskal Wallis (continuous variables), Chi-square test (most categorical variables), or Fisher's Exact Test (calculated for Race and Parent Employment)

Supplemental Table 2: Differences in Anthropometry from Baseline to End-of-Program by WHO Age-Specific Categories

	Baseline [b]	**End of Program [b]**	**P-Value [c]**
Children Under Age 5 at Baseline (N=80)			
BAZ			<0.001
Normal (Z < 1.0)	33 (41.3%)	25 (31.3%)	
Risk of Overweight (1 ≤ Z < 2)	9 (11.3%)	12 (15.0%)	
Overweight (2 ≤ Z < 3)	18 (22.5%)	16 (20.0%)	
Obese (Z ≥ 3)	20 (25.0%)	27 (33.8%)	
Children Age 5 – 19 at Baseline (N=510)			
BAZ			0.071
Normal (Z < 1.0)	137 (26.9%)	142 (27.8%)	
Overweight (1 ≤ Z < 2)	106 (20.8%)	111 (21.8%)	
Obese (Z ≥ 2)	267 (52.4%)	257 (50.4%)	

[a] Values are n (column%)
[b] P-value for Wilcoxon Sign Rank