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**Serving Fruits and Vegetables in Kid-Friendly Shapes Increased Fruit and Vegetable
Consumption in Preschool Children Aged 2-5 Years**

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Abstract

Background. With childhood obesity rising, and taste preferences being influenced at an early age, it's more important now than ever to encourage children to eat right.

Objective. To find whether shaping fruits and vegetables (F&Vs) into kid-friendly designs would increase consumption in preschool aged children.

Design. The four week long observational study took place at Loma Linda Children Academy in two stages during their normal lunch time hour. Baseline data was recorded during the first two weeks, and a month later intervention data was collected during the last two weeks. The menus served remained exactly the same except for the shapes of the F&Vs were cut into one of our eight kid-friendly designs during intervention weeks.

Participants. A convenience sample of healthy preschool aged children (both male and female) between ages 2 and 5 were served hot lunch from the food service provider of the school, serving approximately 30 students per day, Monday through Thursday. Children with allergies were excluded from the study.

Main outcome measures. Daily measurements were pooled by age group (2-3, 3-4, 4-5) and gender, which generated approximately 6 data points daily to be used for statistical comparisons. This translates into a sample size of 46 during baseline weeks and 45 for intervention weeks, for a total of 91 data points. Data was analyzed looking at F&V consumed/total F&V served and reported as a percentage.

Statistical analysis performed. Results were calculated using an independent T-test and 3-way ANOVA comparison between variables.

Results. Overall, displaying F&Vs into kid-friendly shapes increased the preschoolers' intake regardless of age and gender by 10.8% when compared to unshaped F&Vs ($p = .02$).

Conclusion. The results of this study may be helpful to parents and caregivers dealing with picky eaters and may be applied to school food service programs to increase F&Vs selections, displace empty calories, and ultimately produce overall benefits to the young, yet aging population.

Introduction

Early childhood is a pivotal period for influencing feeding behavior in a positive way. It is critical to create healthy eating patterns in children that will last for a lifetime.¹ During the last decades, various environmental factors negatively affected young children's food choices resulting in significantly growing rates of obesity worldwide.² The World Health Organization reports that there are over 42 million obese children under the age of 5.³ Even more alarming, in the United States, one in five school-aged children (aged 6-19) has obesity.^{3,4} Obesity is defined as accumulation of excess fat in the body posing considerable physical and mental challenges; lowering self esteem and self confidence, and increasing the risk for developing chronic diseases.⁵ One consequence of increased adiposity is type 2 diabetes, a chronic condition that was previously rare in children but has increased dramatically in recent years.^{5,6} It is accentuated by the increased consumption of sugar containing foods and beverages, with children experiencing high blood glucose levels, insulin resistance, and insulin insufficiency from a young age.⁶ Moreover, lack of physical activity, both at home and in schools, is adding to the health damaging effect, supporting rapidly growing obesity rates and consequently chronic diseases.⁷ Previous studies have concluded that these conditions develop and carry on through adolescence and adulthood^{4,8}, taking an extensive toll on individual's health and finances, making them a financial burden for society as a whole.⁹ The increased prevalence of obese children in the United States has brought attention to the public health issue of inadequate nutrition in preschool aged children, especially in childcare centers.^{1,3} In today's busy society, younger children spend a significant amount of time in pre-schools and daycares, rather than at home during mealtimes.¹⁰ For this reason, peer influence and adequate food intake in school settings must be taken into consideration with regards to framing eating behaviors and food

choices.¹¹ Modeling has been shown to be an effective tool for encouraging eating behaviors in young children.^{8,12-15} Parental influences still exist, but society is seeing an increased role of peer-influence in dietary choices, consequently affecting their health status.^{8,12-15} At a young age, children may easily be influenced either in a negative or a positive direction.¹⁶

Numerous studies suggest preschool age taste preferences, food choices, and even obesity carries on through adolescence and adulthood.^{4,8} A promising opportunity in the battle against obesity and associated diseases has been to target diet patterns of preschool age children, in efforts to cause a ripple effect into future dietary decisions. Several behavioral factors shape the development of food acceptance, including food selection and food preferences.¹ Fruits and vegetables (F&Vs) have been defined by the USDA as vital food groups.¹⁷ They have a distinct role in providing vitamins, minerals, phytonutrients and dietary fiber required for optimal and long-term health maintenance in all children.^{18,19} According to CDC, a proper diet, including an adequate amount of F&Vs is crucial for intellectual development, bone growth, avoiding iron and calcium deficiencies and preventing long-term formation of chronic diseases.²⁰ Currently, preschool students have a lower intake of F&Vs than the recommended daily allowance,¹¹ which is set by the Institute of Medicine to reduce risks of chronic diseases such as diabetes, heart disease, stroke, and cancer.²¹ An opportunity for influencing a change in current trends would be to influence healthier food choices by encouraging intake of F&Vs among toddlers and young children. Beside reducing the risk for chronic disease formation,¹⁸ augmented intake of F&Vs will displace empty calories, notable for their contribution to weight gain in this population.^{22,23}

Researchers have explored various factors that might improve F&Vs consumption in young children.^{11,13,15,24} For instance, the Watch Me Grow intervention showed encouraging results when introducing gardening and classroom activities related to growing F&Vs in preschool

curriculum.¹¹ Another study concluded that role-modeling and rewards, as well as peer influence, can motivate children to consume a wide variety of F&Vs.¹⁵ Similarly, The Food Dudes intervention study noted that visual exposure to different foods (either through commercial advertising or simply showing children pictures of F&Vs) may reduce aversion for unfamiliar foods and can encourage children to select that food more often.¹³ A positive experience coupled with repeated exposure increased the willingness to taste new foods.²⁴

The purpose of this graduate student study was to determine whether preschool-aged children consume more F&Vs when designed into kid-friendly shapes. We hypothesized that the shape of the F&Vs will increase interest in eating, and thereby increase overall F&Vs consumption. Through this intervention, we aim to encourage further selection and subsequent increased consumption of these foods. We trust that the results of this study may be helpful to parents and caregivers dealing with picky eaters and be applied to school food service programs in the U.S. to increase F&Vs selections, displace empty calories, and ultimately produce overall benefits to the young, yet aging population.

Methods

A four-week-long pilot study was conducted with participants who actively attended Loma Linda Academy Children's Center (LLACC). We used a convenience sample of healthy preschool aged children (both male and female) between ages 2 and 5 that were served hot lunch from the Food Service Provider of the school. Children with allergies to any of the food items served and those that did not attend school during the weeks of the study were excluded. Data collection took place between August and September of 2018, for four days per week (Monday through Thursday), for a total of four weeks. Baseline data was recorded during the first two weeks, and intervention data during the last two weeks. At the time of our study, the hot-lunch program of

the school was serving approximately 30 students per day, Monday through Thursday. During the four weeks of the current study, their usual menus remained exactly the same, with the exception that during week three and four we shaped F&Vs into kid-friendly shapes and served to children as such. The current study did not pose a greater risk to subjects than they routinely encounter in day-to-day life. A possible breach of confidentiality could be considered a minimal risk for being part of the study; yet, all records and research materials that identify participants are held confidential and are only available to the study personnel. Participant's identity would never be disclosed without their permission. Also, none of the participants benefited directly from the study.

Each day, data collection took place in two stages, 'before serving' and 'after serving' and measurements were recorded using a calibrated scale (Escali San Jamar SCDGSL33). Before the students were served the food by their teachers, our team collected four measurements including, total weight in grams of food other than F&Vs, total weight of F&Vs, weight of remaining food other than F&Vs not served, and weight of F&Vs not served.

The way LLACC has placed children into classrooms, by age-group, was a favorable format to our study design especially for the collection of 'after serving' measurements: Kitten and Duck classrooms for ages 2-3, Puppy and Panda rooms for ages 3-4, Koala and Monkey rooms for ages 4-5. Each day before lunchtime two food service bus-tubs, labeled by gender and classroom name, were placed in each room. The same teachers that were serving the food were instructed to collect the plates (both empty plates and plates containing leftovers) and place them into the gender corresponding tubs. Also, trash cans were removed out of the classrooms to avoid any situation in which children could trash any of the food on their own.

After lunchtime we collected all the tubs and proceeded to the ‘after’ stage of measurements. Tubs from Kitten and Duck rooms were combined to represent the age group of 2-3 year olds, Puppy and Panda rooms were combined to represent ages 3-4, and Koala and Monkey rooms tubs were combined to represent ages 4-5. For accurate measuring purposes, our team took the time and divided the leftovers of each plate into two categories, food other than F&Vs, and the fruits or vegetables served for that day. For instance, the remaining fruit or vegetable was physically removed from each plate and measured separately. During weeks three and four, the shaped F&Vs were served in a separate plate than the other food to allow enough space for designing them, which made the ‘after’ measuring process less tedious. Twelve additional data points were recorded, as illustrated in Table 1. Two measurements including weight of F&Vs and weight of food other than F&Vs were taken for both boys and girls, in each of the three age groups, using the same calibrated scale. Each measurement was confirmed by at least two of the three student researchers and then recorded on the data collection sheet attached below. (Table 1)

Table 1. Data collection sample sheet

Data Collection Sheet											
Week: _____											
Monday	Before Serving			After Serving							
	Initial Weight (g)	Waste (g)	Total Served (g)	Ages 2-3		Ages 3-4		Ages 4-5			
	Food other than F&V (g)			Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:
Tuesday	Before Serving			After Serving							
	Initial Weight (g)	Waste (g)	Total Served (g)	Ages 2-3		Ages 3-4		Ages 4-5			
	Food other than F&V (g)			Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:
Wednesday	Before Serving			After Serving							
	Initial Weight (g)	Waste (g)	Total Served (g)	Ages 2-3		Ages 3-4		Ages 4-5			
	Food other than F&V (g)			Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:
Thursday	Before Serving			After Serving							
	Initial Weight (g)	Waste (g)	Total Served (g)	Ages 2-3		Ages 3-4		Ages 4-5			
	Food other than F&V (g)			Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:
Friday	Before Serving			After Serving							
	Initial Weight (g)	Waste (g)	Total Served (g)	Ages 2-3		Ages 3-4		Ages 4-5			
	Food other than F&V (g)			Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:	Male Qty:	Female Qty:

Table 2. Sample Menu

August 2017		Week 1 No shapes	Week 3 Shapes
Monday	Other	Cheese Enchilada, Beans, Buttered Rice	None
	F&Vs	Corn, Avocado, Carrot, Tomato, Celery	Palm tree
Tuesday	Other	Spaghetti, Veggie Sauce, Pretzel Stick	None
	F&Vs	Broccoli, Carrot	Broccoli Tree
Wednesday	Other	Teriyaki Veggie Chicken, Noodles	None
		Kiwi & Grape	Sea Turtle
Thursday	Other	Cutlet & Mushroom Gravy, Mashed Potatoes	None
	F&Vs	Peas & Carrots	Funny Face
September 2017		Week 2 No Shapes	Week 4 Shapes
Monday	Other	Veggie Beef Fajitas, Rice	None
	F&Vs	Watermelon & Black Berries	Flower
Tuesday	Other	Alfredo Pasta, Bread	None
	F&Vs	Kiwi, Strawberry, Banana	Butterfly
Wednesday	Other	Veggie Beef, Steamed Rice, Lo- Mein Noodle	None
	F&Vs	Broccoli, Peas, Red Bell Pepper	Smiley Face
Thursday	Other	Veggie Chicken Nuggets, Mac & Cheese	None
	F&Vs	Apple, Strawberry, Raisins	Caterpillar

We observed and recorded children's consumption of F&Vs before and after they were shaped into kid-friendly designs. The first two weeks of the study we served their usual menu. During the third and fourth weeks we served the exact same meals as the weeks before (same meal on the same day) making only one change: F&Vs were shaped into kid-friendly shapes.

ANOVA multiple variables comparisons tests were performed to look at the data in terms of the different variables within groups and between groups. Matched paired t-tests were used to analyze the change in baseline and post intervention. The independent variables measured in our analysis included age, gender, and shape of the fruit or vegetable either as usual or in a kid-friendly design. The outcome variables were analyzed based on two different measures: one as the percentage of the total food eaten that was fruits or vegetables, and the second as the change in actual weight (g) of fruits and vegetables eaten. Both outcome variables were taken to evaluate methods of comparison.

Results

In the present study intakes were recorded for 461 meals served at Loma Linda Academy Children's Center, a convenience sample of higher socioeconomic children, which cannot be generalized to all pre-school age populations. The 4-week pilot study included intakes for 270 baseline meals served (week 1,2) and 191 intervention meals served (week 3,4). For ease of collection daily measurements were pooled by age group (2-3, 3-4, 4-5) and gender, which generated approximately 6 data points daily to be used for statistical comparisons. This translates into a sample size of 46 during baseline weeks and 45 for intervention weeks, for a total of 91 data points. Pooling data by age-gender groups, allowed for ease of data collection, however variations in group size from day to day resulted in unequal weighting of individuals during statistical analysis. The unequal weighing makes comparisons between groups less ideal,

however no significant differences were observed between age or gender.

Overall, displaying F&Vs into kid-friendly shapes increased the preschoolers intake regardless of age and gender by 10.8% when compared to unshaped F&Vs ($p = .02$). The 2-3 year olds showed the greatest difference between baseline and intervention weeks, increasing their F&Vs consumption by 14.8%. The 3-4 and 4-5 year olds had similar results, increasing their consumptions by 9.1% and 10.8% respectively.

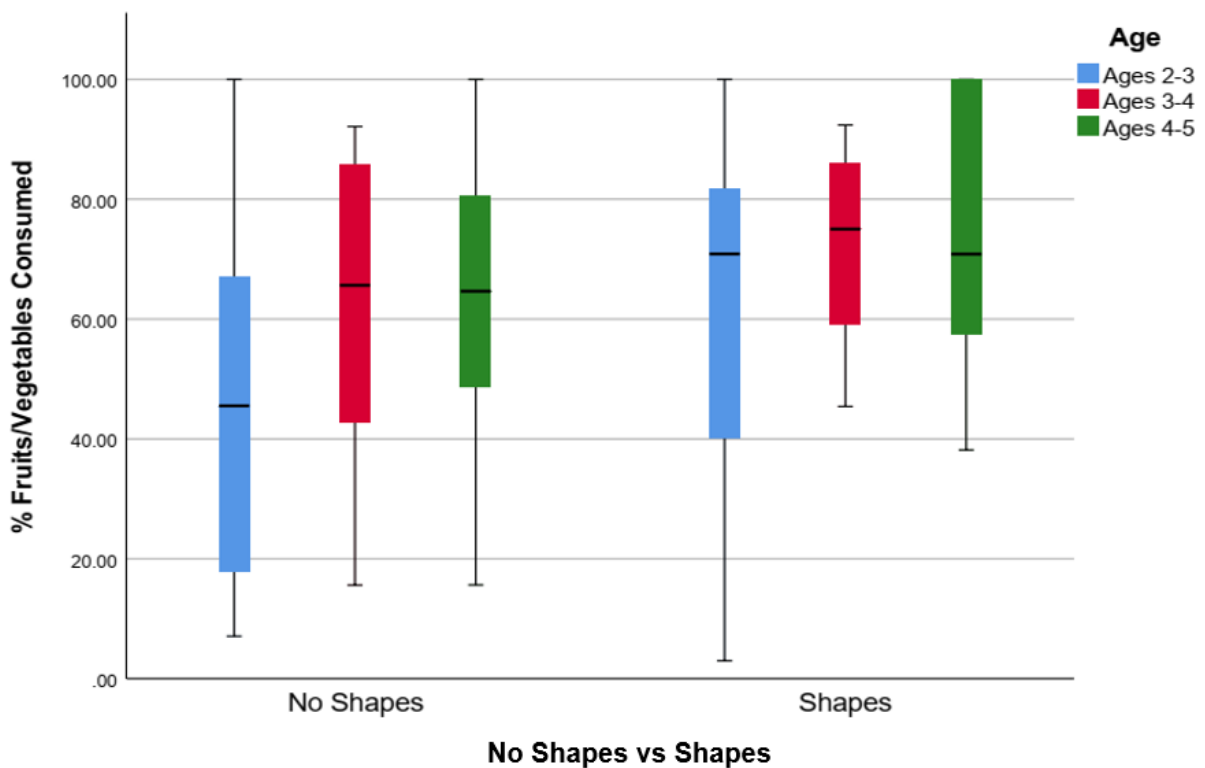


Figure 1. Mean Percentage of F&Vs Consumed by Age and Shape of Fruits and Vegetables.

When taking into consideration the difference in gender there was a 6% increase in F&Vs intake in males compared to females; yet, there was no significant differences between group means ($p = .13$). Taking another look at age group and percent of total F&Vs consumed, the 3-4 and 4-5 age-groups showed a 12% higher F&Vs intake when compared to the 2-3 age-group, but again

there was no significant differences between age-group means overall ($p = .11$). An interesting point worth noting was that a statistically significant difference was shown when comparing fruit vs. vegetable menus, with an increase of 24.5% fruit intake ($p < .001$). Children preferred eating fruits over vegetables. Table 3.

Table 3. Percentage of F&Vs Consumed for Meals Served by Type of Meal, Gender, and Age.

Variable	Mean (SD)	p-value
Type of Meal		.02
No Shapes (n=46)	57.9 (27.0)	
Shapes (n=45)	68.7(24.0)	
Meals		<.001
Vegetables (n =45)	50.9 (23.2)	
Fruits (n =46)	75.4 (22.8)	
Gender		.13
Male (n=45)	66.3 (23.3)	
Female (n=46)	60.3 (28.3)	
Age (year)		.11
2-3 (n=30)	55.2 (31.1)	
3-4 (n=33)	67.3 (20.8)	
4-5 (n=28)	67.2 (24.4)	

Discussion:

The findings of this study were consistent with the hypothesis that shaping F&V in kid-friendly shapes led to increased interest and therefore increased F&V intake in preschool children.

Results were consistent across all age groups (2-3, 3-4, 4-5) and in both males and female, with

children eating significantly more F&V when they were designed into one of our 8 kid-friendly designs. The 10.8% increase in F&V consumption demonstrates a significant preference for foods shaped in kid-friendly designs. We suspect that this increase could be due to the children found the shapes more familiar to them, which may have limited their aversions to eating fruits or vegetables. Another explanation may be by making F&V fun they were able to keep their attention on eating them longer, thus increasing intakes. Since the exact same menu was served just a month later, it is possible the repeated exposure of the menu with a particular fruit or vegetable may have played a role, since a previous study by Schindler et al suggests that repeated exposures can lead to increased intakes.¹² However, in the current study the confounding effects of repeated measures was minimized by using menus previously served to the children prior to the study. The study was designed to minimize the influence of repeated measures by collaborating with the pre-school's current food service provider and using menus, including fruits and vegetables, already familiar to the children.

The results of this study suggest that using creativity to design foods in ways appealing to kids can be an effective way to encourage healthy eating behaviors in preschools. Implementing this type of intervention into preschools or daycare facilities' current food programs may be an area of interest for public health policies since increased intakes of F&V have been shown to reduce obesity, a major current health concern among children in the U.S. Increased F&V consumption is an effective way to combat the growing rates of obesity as well as reduce overall mortality. F&Vs display empty calories and provide vitamins, minerals, phytonutrients and dietary fiber required for improved health.

The current study also demonstrated a preference for fruits over vegetables with a 24.5% greater ($p = .001$) consumption of fruits. This finding is consistent with observations made in previous

studies by National Cancer Institute, Witt KE et. al and data obtained from NHANES, which shows that 40% of children eat the recommended amounts of fruits, whereas only 7% of children eat the recommended amounts of vegetables.^{25, 26} This is not surprising given the sweeter taste of fruit compared to veggies, and infant's being born with a preference for sweet.¹⁴ Vegetables tend to have a more bitter taste, which according to Drewnowski et al. children and the majority of people dislike.²⁷ The rejection of bitter foods is a genetic trait inherited based on the instinct that bitterness predicts toxicity in nature. Therefore, repeated exposure to bitter flavors is how to overcome the aversion.²⁷

Limited literature exists for intervention programs aimed at increasing F&V consumption in pre-schools. Previous studies have not measured if plating preferences of preschool children influence consumption. To the best of our knowledge, our study is the first pilot study measuring consumption after a plating intervention in a pre-school setting. Previous intervention studies have used education or activities to encourage intakes, however, different outcome measures were used to quantify intakes. For example the "Watch me grow" intervention by Brouwer et al¹¹ measured intakes by a structured dietary observation method developed by Ball et al²⁸, where observers are trained to recognize serving sizes, then counts are recorded for food consumed, served and wasted.¹¹ The present study used instrumental measures with a calibrated scale to obtain weights in grams for amounts served and amounts of waste. Intakes were then arithmetically calculated by subtracting waste from the amounts served, outcomes were then measured by percent using grams of F&V consumed/grams of F&V served. This method of measure minimized the human error associated with visually assessing intakes however, may introduce the possibility of measurement error.

Limitations

Three major limitations exist in the current study. Firstly, the study design using pooled averages by age-gender groups generated confusion on how to best represent the data collected. Since data was collected in a pooled fashion, group averages were used for statistical comparison. The problem with analyzing data by group mean is it creates room for error since individuals are not equally weighted, especially when group sizes were very different. Secondly, since results were pooled, approximating amounts served per child was calculated using an average (total food served/number of meals served). Although the current study used portioning tools to standardize serving amounts, weights were not taken for each meal served, creating more room for error when calculating amounts consumed using averaged amounts served. Thirdly, this study design also allowed for error in collection of waste, since teachers were responsible for collecting waste. Teachers were instructed on how to collect waste, ensuring there was no waste left on the floor or table and on how to sort waste by age and gender. Variations may have existed in the ways teachers collected the waste in their classrooms and by introducing more participants in the research, our study had multiple exposures to measurement error.

Some secondary limitations to consider include portioning techniques and sample. Our data revealed that there were inconsistencies in portioning techniques as slightly more F&V were served during intervention weeks, which may have influenced outcomes. Previous studies have suggested that serving more F&Vs can increase intakes.²⁹ The amount of F&V served may have been a confounding variable that was not corrected for. Finally, our research was limited by the sample. We served an average of 29 meals per day at only one preschool, with a high socio-economic population. Our study can only be generalized to populations with similar demographics.

Future Studies

The information derived from this study directs future research in a promising direction. The current study lays the groundwork for future studies by demonstrating that F&V intakes can be influenced by plating preferences in a pre-school setting. Future studies would benefit from using children as the sampling unit, and tracking individual child's data throughout the study allowing for a repeated measures design.

It is recommended to use an established model for measures such as that developed by Ball et al²⁸ for reliability of an observation method to assess food intake of young children in child care. Using an established model for measure would make the study more comparable to other studies. Future studies should minimize exposures to possible unexpected confounding variables such as what other foods were served with the F&Vs, the order in which food is served (F&Vs first then main entree vs. other way around or everything served at once), cooking techniques used, ect. Minimizing the influence of other factors would allow researchers to get a more accurate representation on the true influence of shaping F&Vs.

Conclusion:

Increased intake of F&Vs in preschool-aged children increase the overall quality of diet providing a variety of nutrients important for growth and maintenance. A healthy eating pattern is established from a young age. As evidenced in the current study, food presentation may influence children's interest in F&Vs consumption and their willingness to expand food choices. While it is understandable that children's taste buds are more inclined toward sweeter food choices such as fruit, vegetables should constitute a considerable part of their diet. With childhood obesity rates on the rise, the nutritional value of vegetables, including fiber, phytonutrients, antioxidants, and an overall lower amount of sugar can notably decrease the risk of obesity and related chronic diseases. We believe that parents should implement various

methods to help children get accustomed to eating F&Vs every day. Using some creativity to design F&Vs into kid-friendly shapes is one tool that our study showed as successful. There is certainly reasonable scope for further studies to explore these preliminary, but beneficial results.

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