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Serving larger portions of fruits and vegetables together at dinner promotes intake of both foods among young children

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Abstract

Serving larger portions of energy dense foods has been shown to promote children's energy intake at meals. Whether larger portions increase children's intake of both fruits and vegetables (F&V) is less clear. A 2×2 within-subjects design systematically varied portion sizes of fruit (75 vs. 150 g) and vegetable (75 vs. 150 g) side dishes served at dinner. Children's F&V liking was measured

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using a validated tasting method. Thirty 4- to 6-year-olds were tested in a laboratory setting at 5:00 PM on weekdays from November 2008 through March 2009. Mixed linear models were used to determine effects of fruit portion size, vegetable portion size, and their interaction on food and energy intakes. Data are presented as model-based means ± standard error unless otherwise indicated. When portions were doubled, children increased their vegetable intake by 37% (12 ± 4 g; $P<0.01$) and their fruit intake by 70% (41 ± 6 g; $P<0.01$). Vegetable portion size effects were not influenced by offering more fruit and vice versa. Portion size effects were limited to children who liked that particular food. Total meal energy intake did not vary by portion size condition. These results indicate that serving larger F&V portions at meals can be used to promote young children's intake of both foods without influencing total meal energy intake. Effects were not seen in children who disliked F&V, suggesting a need to combine increased F&V portions with strategies to increase their acceptance.

Keywords

children; portion size; fruit; vegetables; intake; liking

Introduction

Despite the initiation of the 5-A-Day for Better Health program in 1991, children's intakes of fruits and vegetables (F&V) remain below recommended levels (1, 2). One potential method to promote F&V intake is to increase the portion sizes served at snacks and meals. Doubling portion sizes of energy-dense entrées has been shown to increase food intake by 25-60% among 5- to 9-year-old children (3–6). These effects have been observed among children of varying age, sex, race/ethnicity and weight status (7) and are thought to be partially explained by size-related visual cues (7) and inflated consumption norms (8).To date, only a few studies have researched the effect of portion size on young children's intake of low energy density foods such as F&V (9–11).

Studies that have incorporated more vegetables into the main entrée (9), or offered increased amounts of vegetables with a side of dip prior to the meal (10) have demonstrated benefits for vegetable intake among preschool-aged children. Kral and colleagues (11) found that doubling the portion sizes of applesauce, cooked broccoli, and carrot side dishes served along with a pasta entrée increased fruit intake by 43% among 5- to 6-year-old children. Increasing the broccoli portion size was only effective in promoting intake among overweight/obese children or those who preferred the broccoli over all other foods served at the meal (11). Because the portion sizes of both F&V were increased simultaneously, the extent to which the observed effects on vegetable intake were influenced by the amount of fruit served is unclear. Though F&V are often grouped together, it is well appreciated that young children accept fruits more readily than vegetables (12). Based on this observation it was hypothesized that vegetable portion size effects would be affected by the amount of fruit served. A second hypothesis tested was that given the central role of food preferences in children's consumption patterns (13, 14), portion size effects would be determined by the degree of liking a particular food.

Methods

Sample Size Calculations

Our previous portion size research led us to expect that effect sizes ≥0.75 would be clinically meaningful with ≥0.5 within-subject correlations (4, 7). Based on these assumptions, with $\alpha=0.05$, a sample size ≥30 yields power ≥0.8 for main effects and

interactions. We expected approximately 80% completion rates for all study conditions, therefore 38 children were recruited.

Participants

Participants were 38 children and their primary caregivers living in the greater metropolitan area of Philadelphia, PA. The convenience sample was recruited using advertising in a local pediatric/dental clinic, and an internet classified advertisement site. Eligible children were 4-6 years of age who rated the main entrée as tasting either “yummy” or “just-okay.” Three children were excluded at the beginning of the study due to disliking the main entrée. To examine the role of liking in F&V portion size effects, children had to like either the fruit or vegetable used in the experiment, but not necessarily both. One child disliked both the F&V and was excluded from the study. Four children ate negligible amounts of both foods (<10 g of fruit and <10 g of vegetable) at more than half of the visits, and were therefore excluded from the analysis. Children were also excluded from the study if they had severe food allergies, chronic illnesses, conditions affecting food intake, or were on a special diet. Participants were compensated $30 for each of their visits and received a $100 bonus if they attended all visits. All procedures and measures were approved by the Temple University Institutional Review Board, and parents provided written consent for their own participation and the participation of their child.

Design

A 2×2 within-subjects design was used to evaluate the effects of vegetable portion size (75 g vs. 150 g), fruit portion size (75 g vs. 150 g), and their interaction on children’s food and energy intakes at dinner meals. Fruit and vegetable side dishes, along with pasta, milk and dressing were provided in each of the four experimental conditions. Test visits were spaced one week apart to minimize carry-over effects. Children ate dinner with the same group of two to three children in all experimental conditions. Each group of children was randomly assigned one of 12 counterbalanced presentation orders. Previous research was used to identify F&V of potentially moderate liking by young children (15).

Procedure

Children and a primary caregiver visited an observational laboratory on Temple University’s Health Sciences Campus in Philadelphia, PA once a week for five weeks. The first visit was used to familiarize the children to the research setting, staff members, and the procedures. A child’s liking and preference of the foods on the experimental menu, anthropometric measurements, and caregiver self-reports were also assessed during this visit. At the beginning of each visit, parents were asked to report any sleeping problems, illnesses, or medication taken by their child in the previous 24 hours. Parents were asked to refrain from giving any food or beverages to their child two hours prior to arrival and to report any deviations from these instructions. A trained staff member sat at the table during the meal to ensure that procedures were followed, including preventing children from sharing foods, noting dropped foods, and redirecting food related conversation. The children were given 20 minutes to eat dinner. To minimize visual comparisons of portion sizes, all children in the same group were served the same experimental condition. Children were instructed to eat as little or as much as they liked.

Experimental Menu

The Table depicts the amounts, energy-density (kcal/g), and types of foods that were served at each experimental condition. Fixed portions of rotini pasta (204 g; SanGiorgio, Harrisburg, PA) with tomato sauce (106 g; Prego, Traditional, Campbell Soup Co., Camden, NJ), 2% milk (Acme Markets, Supervalu Inc., Eden Prairie, MN) and a side of light ranch

dressing (Hidden Valley, The Clorox Company, Oakland, CA) were offered in all conditions. Only the portion sizes of the drained canned peaches in light syrup (Del Monte, San Francisco, CA), and cooked broccoli (Birds Eye, Baby Broccoli Florets Rochester, NY) were manipulated. In the interest of matching the energy-density of the F&V, three grams of butter were added (Shop Rite, Wakefern Food Corporation, Edison, NJ) for every 72 g of cooked broccoli. The pasta, broccoli, and peaches were all served on a 10 ¼ inch-diameter three-compartment plate.

The broccoli reference portion size (75 g) fell between the 50th and 75th percentiles and the reference peach portion size (75 g) was between the 75th and 90th percentiles of reported intake of those foods for 2- to 5-year old children participating in the Continuing Survey of Food Intakes of Individuals (16). The amounts of milk (244 g) and the main entrée (310 g) were chosen based on previous work with children of a similar age as the subjects in this study (11); the entrée amount fell between the 75th and 90th percentiles of spaghetti and tomato sauce intake for children 2–5 years old (16). The amount of dressing (31 g) served was based on the manufacturer's recommendation for a single serving. The energy-density of the foods was calculated using manufacturer's nutrition labels except the peaches which was determined by a bomb calorimetry assay performed at NP Analytical Laboratories, St. Louis, MO.

Measures

Children's F&V Liking and Preference—A validated tasting method (13, 17) using cartoon faces was administered to assess children's liking of the F&V side dishes and relative preferences compared to other foods served at the meal. Children were presented with a small amount of each food and instructed to take a bite/sip and categorize the food as tasting either "yummy," "yucky," or "just okay." Children were then asked to rank-order the same food items based on relative preference.

Weighed Food Intake—Children's food intakes were measured to the nearest 0.1 g using electronic balances (Model PL6001-S, Mettler Toledo, Columbus, OH).

Demographics—The parent's self-reported demographic information including race/ethnicity, and employment status.

Weight Status—Heights and weights were obtained in duplicate following procedures described by Lohman (18). Heights were measured to the nearest 0.1 cm using a wall-mounted stadiometer (Harpenden, Holtain Ltd., Crymych, Pembrokeshire, United Kingdom). Weights were measured to the nearest 0.1 kg using an electronic physician's scale (Model 758C, Cardinal, Webb City, MO). Body mass index (BMI) age- and sex-specific percentiles and z-scores for children were calculated based on the 2000 CDC growth charts using SAS (version 9.2, 2008, SAS Institute Inc, Cary, NC).

Statistical Analysis

Statistical analyses were conducted using SAS. Primary outcomes were children's F&V intakes (g). Secondary outcomes were intakes (kcal) of each food as well as total energy intakes. Mixed linear models with repeated measures were used to conduct two-way factorial analyses of variance to test the effects of vegetable portion size (75 g vs. 150 g), fruit portion size (75 g vs. 150 g), and their interaction on children's food and energy intakes. In addition to counterbalancing the order the experimental conditions were served to different groups, the effect of changes in intake over time was included in preliminary models and found to not significantly affect portion size effects for fruit (P=0.27) or vegetable (P=0.59) intakes; therefore it was not included in any of the final models. Due to

the non-normality of residuals in some of the models, Wilcoxon Signed-Rank tests were conducted to confirm that the results from the mixed models were robust. Paired t-tests were used to separately test changes in fruit or vegetable intake across reference and large portions for children who rated the foods as "just okay" or "yummy." This post-hoc approach was taken given zero variance in the intake of fruits or vegetables of children who dislike those foods. Significance levels were set at $P<0.05$ for all statistical tests. Data are presented as model-based means ± standard error.

Results and Discussion

Participants

The 30 children included in the analyses were 5.4 ± 0.2 years old, with a mean BMI-forage-percentile of 72.3 ± 5.4. Half of the children were classified as overweight or obese (≥85th percentile) (19), and half of the primary care-givers had part-time or full-time employment. Of the 30 children, 18 were female, 14 were Non-Hispanic Black/African American, nine were Non-Hispanic White, and seven were Hispanic White.

Fruit and Vegetable Intakes

As shown in Figure 1, children consumed 41 ± 6 g or 70% more fruit in the large portion conditions than in the reference conditions (59 ± 5 g vs. 101 ± 9 g; $P<0.0001$), which corresponds to a 2/5th of a serving increase (20, 21). As shown in Figure 2, children consumed 12 ± 4 g or 37% more of the vegetable side dish in the large portion conditions than in the reference conditions (32 ± 6 g vs. 44 ± 9 g; $P<0.01$). Thirteen of 30 children ate negligible amounts of the vegetable (<10 g) in more than half of all conditions. For the other 17 children, doubling the vegetable portion size resulted in a 20 ± 7 g or 37% increase in vegetable intake (56 ± 5 g vs. 77 ± 9 g; $P<0.01$), which corresponds to a 1/5th of a serving increase (20, 21). Increasing the portion size of fruit did not affect vegetable intake and vice versa (Figures 1 & 2). Effects of fruit or vegetable portion size did not interact with each other ($P=0.91$); in other words the intake promoting effect of larger portions on vegetable intake was not affected by serving larger portions of fruit and vice versa.

Effects of Fruit and Vegetable Liking

Twenty six children rated the fruit as tasting "yummy," three as tasting "just ok" and one as tasting "yucky." Children who rated the fruit as "yummy," "just ok" and "yucky" ate on average 82 ± 7 g, 98 ± 12 g, and 0 ± 0 g of the fruit respectively. Increases in fruit intake (41 ± 6 g; $P<0.0001$) between the reference and large fruit portions were observed among children who rated the fruit as "yummy."

Seventeen children rated the vegetable as tasting "yummy," seven as tasting "just okay" and six as tasting "yucky." Children who rated the vegetable as "yummy," "just ok" and "yucky" ate on average 52 ± 9 g, 38 ± 15 g, and 0 ± 0 g of the vegetable respectively. The 17 children who rated the vegetable as tasting "yummy" ate significantly more of the vegetable side dish (17 ± 6 g; $P<0.05$) when portion size was increased.

Total Food and Energy Intake

Total food intakes (g) did not differ across conditions ($P=0.28$). Total food intakes were 389 ± 33 g, 386 ± 33 g, 416 ± 34 g, 384 ± 35 g in the Reference, 2x Veg, 2x Fruit, and 2x F&V conditions, respectively. In addition, total energy intakes did not differ across conditions ($P=0.33$). Total energy intakes were 368 ± 33 kcal, 366 ± 33 kcal, 383 ± 34 kcal, 342 ± 34 kcal in the Reference, 2x Veg, 2x Fruit, and 2x F&V, respectively. Energy intakes from milk ($P=0.39$) and the side dressing ($P=0.68$) also did not differ by condition. Energy intake from F&V, however, increased by 30 ± 5 kcal when portion sizes of both F&V were doubled (58

± 5 kcal vs. 88 ± 9 kcal; P<0.0001) as compared to the condition in which reference portions were served. Alternatively, children consumed less energy from the main entrée when both F&V portions were doubled than when reference F&V portions were served (172 ± 27 kcal vs. 217 ± 26 kcal; P<0.05); a main effect of condition on pasta intake, however, was not observed. The shift in energy intake between the F&V sides and the main entrée produced a 0.06 ± 0.03 kcal/g decrease in the energy-density of the overall meal (including the beverage) (0.94 ± 0.03 kcal/g to 0.88 ± 0.03 kcal/g; P<0.05).

Much of the previous research on food portion size effects on children has focused on energy-dense foods (3–6). These results contribute to recent evidence that intake promoting effects of large portion sizes among children may extend to lower energy-density F&V (10, 11). A novel and key finding of this research was that the benefit of increasing vegetable portion size on vegetable intake was not negated by serving more fruit. While children expressed a higher relative preference for peaches than broccoli (P<0.0001), the results suggest that intakes of both F&V can be promoted when larger portions of each food are served at the same meal. These results extend the work of Kral et al. (11) in which the portion sizes of a fruit as well as two cooked vegetables side dishes were doubled. Both studies observed increases in children's fruit intake when portions were doubled. The present study, however, observed increases in children's vegetable intake when larger portions were served. Differences in the broccoli preparation might explain the discrepancy between the studies. For instance, Kral and colleagues (11) served plain broccoli, whereas, the present study added butter and a side of salad dressing which have been shown to increase the palatability of vegetables (22).

Mixed results between portion size studies on vegetable intake might also be explained by differences in competing foods served at the meals. In one study with preschool children, increasing the portion size of carrots served alone with a side dip at the start of a meal increased carrot intake (10). In another study, increasing the portion sizes of F&V served together did not lead to increased vegetable intake (11). Vegetable portion size effects, however, were observed among children who preferred the vegetable over all other foods served at the meal. Similarly, the present study demonstrated that intake promoting effects of larger vegetable portions were prominent among children who liked the vegetable. Future research is needed to determine how vegetable preparation and competing foods served at the meal affect vegetable intake.

Similar to Kral and colleagues (11), increasing F&V portion sizes did not change total energy consumed by children at the meal, even though more F&V were consumed. Because of their high water content, the energy-density of F&V is relatively low (0.1–1.0 kcal/g) (15). Interventions with adults have shown that reducing dietary energy-density by regular consumption of low energy-dense foods is an effective dietary strategy for weight management (23, 24). Furthermore, previous research has shown that decreases to food and dietary energy-density reduced preschool-aged children's energy consumption at meals (5, 9, 25, 26). In this study, the energy-density of total food consumed at the meal decreased by a small but significant amount. This occurred because children consumed less of the energy-dense main entrée and more of the F&V side-dishes when larger portion sizes of both F&V were served. These findings suggest that modest increases to F&V portions can improve children's intake of healthy low energy-density F&V without increasing overall energy intake at meals.

A few aspects of this study qualify interpretation of the findings. Although the sample was diverse with respect to children's race/ethnicity and weight status, the overall sample size was small, and the extent to which these findings generalize to children of different socio-economic and family background cannot be determined from this particular study. The small

number of children reporting “just ok” in the sample limited our ability to fully examine F&V portion size effects across the entire liking spectrum. Lastly, more than half of the sample consumed the entire reference fruit portions, suggesting that the magnitude of the fruit portion size effect may have been inflated.

Conclusion

The results of this study provide new evidence that increasing the portion sizes of F&V separately or together at meals can increase children’s intake of both types of healthful foods. Moreover, serving larger portions of both F&V may decrease the total energy-density of foods consumed at meals. Children who dislike F&V will be unlikely to increase their intake when served larger portions without being exposed to feeding environments and strategies that increase their familiarity and acceptance of F&V. To the extent that such strategies are successful in promoting acceptance, serving larger F&V portions may have broad utility during interventions designed to promote healthy eating habits in children.

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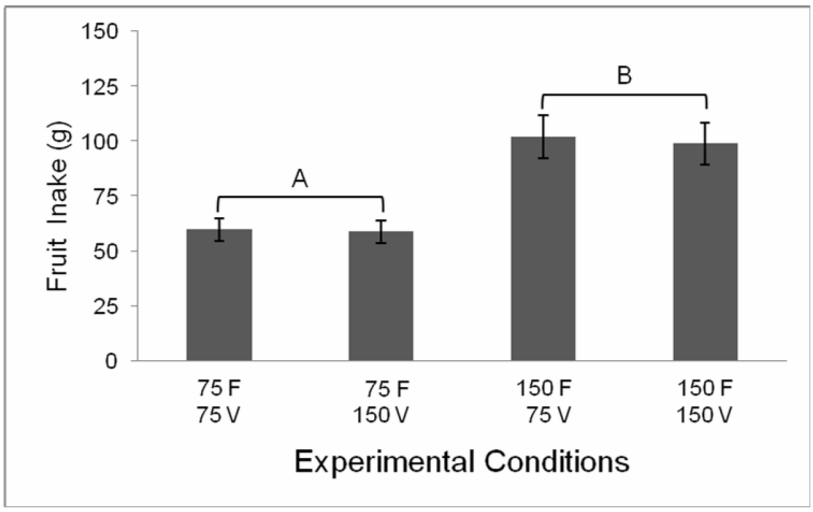

Figure 1.

Children's intakes of a fruit side dish (mean ± SE) at a dinner meal across four experimental conditions (n=30). **(75 F = 75 g fruit served, 75 V = 75 g vegetable served, etc.)** Mixed linear model analysis indicated a main effect of fruit portion size on intake (A vs. B, $P<0.05$). The effect of portion size on children's fruit intake was not influenced by the portion size of vegetable offered.

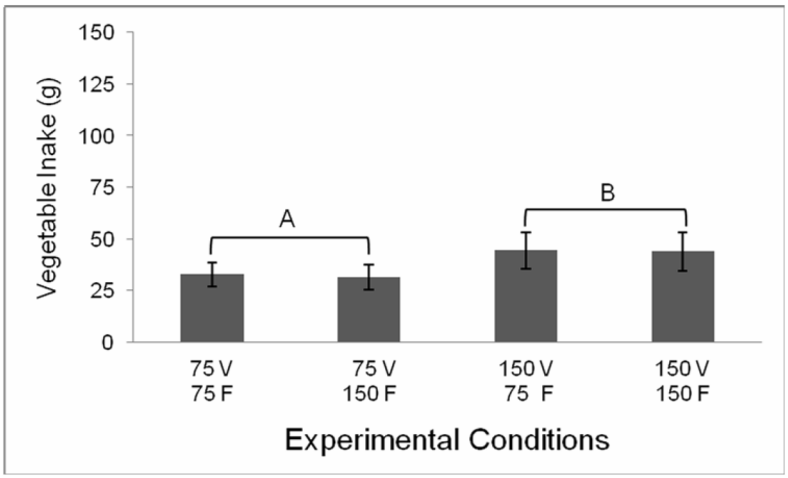

Figure 2.

Children's intakes of a vegetable side dish (mean ± SE) at a dinner meal across four experimental conditions (n=30). (**75 V = 75 g vegetable served, 75 F = 75 g fruit served, etc.**) Mixed linear model analysis indicated a main effect of vegetable portion size on intake (A vs. B, $P<0.05$). The effect of portion size on children's vegetable intake was not influenced by the portion size of fruit offered.

Table

Amounts and energy density of foods served in four experimental conditions differing in fruit and vegetable portion size

		Experimental Conditions			
		Reference	2x Veg	2x Fruit	2x F&V
Foods	**Energy Density[a]**	Weight (g)			
Broccoli	0.6	75	150	75	150
Peaches	0.6	75	75	150	150
Pasta & Sauce	1.4	310	310	310	310
Milk	0.5	244	244	244	244
Dressing	2.6	31	31	31	31
Total meal weight (g)		735	810	810	885
Total meal energy (kcal)		724	769	769	814

[a]Energy density defined as kcal/gram