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Serving large portions of vegetable soup at the start of a meal affected children's energy and vegetable intake

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Abstract

This study tested whether varying the portion of low-energy-dense vegetable soup served at the start of a meal affects meal energy and vegetable intakes in children. Subjects were 3- to 5-year-olds (31 boys and 41 girls) in daycare facilities. Using a crossover design, children were served lunch once a week for four weeks. On three occasions, different portions of tomato soup (150, 225, and 300 g) were served at the start of the meal, and on one occasion no soup was served. Children had 10 minutes to consume the soup before being served the main course. All foods were consumed *ad libitum*. The primary outcomes were soup intake as well as energy and vegetable intake at the main course. A mixed linear model tested the effect of soup portion size on intake. Serving any portion of soup reduced entrée energy intake compared with serving no soup, but total meal energy intake was only reduced when 150 g of soup was served. Increasing the portion size increased soup and vegetable intake. Serving low-energy-dense, vegetable soup as a first course is an effective strategy to reduce children's intake of a more energy-dense main entrée and increase vegetable consumption at the meal.

Keywords

energy intake; portion size; children; vegetable intake; soup

In studies in adults, consuming low-energy-dense foods as a first course reduces energy intake of the main course and of the entire meal (Rolls, Bell, & Thorwart, 1999; Rolls, Roe, & Meengs, 2004; Flood-Obbagy and Rolls, 2009). A first course of low-energy-dense soup has been shown to be particularly effective for increasing satiety in adults (Flood & Rolls, 2007; Kissileff, Gruss, Thornton, & Jordan, 1984; Rolls et al., 1999; B. J. Rolls, Fedoroff, Guthrie, & Laster, 1990). It is not known, however, whether children will show a similar response to consumption of soup. Although it is thought that young children are better than adults at adjusting their energy intake in response to a first course, the results have varied among studies (Birch & Deysher, 1985; Cecil, Palmer, Wrieden, Murrie, Bolton-Smith, Watt, Wallis, & Hetherington, 2005; Johnson and Taylor-Holloway, 2006; Zandstra, Mathey,

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Graaf, & van Staveren, 2000). It is of interest to investigate serving vegetable soup to children at the start of a meal, because this has the potential both to reduce children's energy intake and increase their vegetable intake. The aim of the present study was to determine the effects of serving different portion sizes of a low-energy-dense, vegetable-based soup on children's energy and vegetable intake within a meal and over the next eating occasion.

Vegetable intake in children is well below recommended levels (Guenther, Dodd, Reedy, & Krebs-Smith, 2006; Lorson, Melgar-Quinonez, & Taylor, 2009) and effective strategies are needed to encourage consumption. Serving large portions of vegetables is a promising approach to increasing vegetable intake. Studies have shown that portion size affected intake of high-energy-dense foods in both children and adults (Wansink & Kim, 2005; Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Fisher, 2007; Fisher, Arreola, Birch, & Rolls, 2007; Fisher, Liu, Birch, & Rolls, 2007; Rolls, Morris, & Roe, 2002; Rolls, Roe, Kral, Meengs, & Wall, 2004; Rolls, Roe, Meengs, & Wall, 2004), and serving a larger portion of a low-energy-dense vegetable at a meal increased vegetable intake in adults (Rolls, Roe, & Meengs, 2010). The effect of increasing the portion size of low-energy-dense vegetables on children's intake is less clear. A recent study found that increasing the size of a vegetable side dish did not increase young children's vegetable intake (Kral, Kabay, Roe, & Rolls, 2010); yet, in another study, vegetable consumption was increased by serving larger portions of vegetables at the start of a meal (Spill, Birch, Roe, & Rolls, 2010). Thus, it may be more effective to increase the portion size of vegetables served at the start of a meal, when children are hungry and when there are no competing foods present, rather than vegetables served as a side dish.

The hypothesis of the present study was that increasing the portion size of a familiar, low-energy-dense soup served at the start of the meal would increase soup intake and would lead to a reduction in meal energy intake. We also predicted that increasing the portion size of a vegetable-based soup would increase children's vegetable intake at lunch and that this effect would be sustained over the next eating occasion.

METHODS

Experimental Design

A crossover design, using repeated measures within subjects, was used to test the effect on food and energy intake of varying the amount of tomato soup served to preschool-aged children as a lunch first course. On one day a week for four weeks, children in a daycare setting were provided with breakfast, lunch, and afternoon snack. Across the weeks, the portion size of soup served in the first course of lunch was varied (150, 225, or 300 g) and during one week no first course was provided. The foods and beverages served in the main course of lunch, as well as the foods and beverages served at breakfast and snack, were not varied in portion size. On test days, a standard breakfast was served approximately 3 hours prior to lunch in order to maintain a similar level of hunger before lunch, and afternoon snack was served approximately 3 hours after lunch. The soup as well as other foods and beverages were consumed *ad libitum*. The order of the experimental conditions across study weeks was randomly assigned across classrooms. During the week before the study, one day was used to acquaint the children and teachers with the test meal procedures; no data were collected on this day.

Participant Recruitment

Recruitment began by distributing letters to parents who had children within the age range of three to six years enrolled in two daycare centers on the University Park campus of The Pennsylvania State University. Parents and guardians provided informed written consent for

both their own participation and that of their child. The Pennsylvania State University Office for Research Protections reviewed and approved all procedures.

A power analysis was performed to determine the number of children needed in the study. The power analysis was based on the outcome of energy intake. In order to detect a difference in meal energy intake of 167 kJ (40 kcal), which is approximately 10-15% of typical meal intakes in this population, the required sample size was estimated to be 56 children using a significance level for a two-tailed test of 0.05 and a power of 80%.

Test Foods & Meal Procedures

The foods and amounts served at the test lunch and afternoon snack are shown in Table 1. Tomato soup was chosen as the first course because it is commonly served at daycare centers. The middle portion of 225 g was chosen because it is a typical portion of soup consumed by 2- to 5-year old children (Smiciklas-Wright, Mitchell, Mickel, Goldman, & Cook, 2003); this portion equates to approximately 1.5 half-cup vegetable servings based on information provided by the manufacturer. The other portion sizes selected, 150 g and 300 g, equate to approximately one and two vegetable servings, respectively. The items served as the main course of lunch (pasta with cheese sauce, broccoli, applesauce, and milk) were foods commonly served in the daycare centers. The portion sizes of these foods were based on consumption data from previous research with children in this age group (Leahy, Birch, Fisher, & Rolls, 2008; Leahy, Birch, & Rolls, 2008a, 2008b). Cooked broccoli was served as the vegetable component of the main course in all test meals in order to comply with the National School Lunch Program (U. S. Food and Dairy Administration & Food and Nutrition Service, 2009); this also allowed the examination of the effects of consuming a vegetable first course on vegetable intake in the main course.

Lunch was served to all children in the participating classrooms at the regularly scheduled time and was eaten at tables with three to six children and one teacher, which is the standard practice at these centers. Once children were seated at their tables, they were served the first course of tomato soup in insulated bowls at a temperature of approximately 130°F. Ten minutes after serving the first course, the remaining soup was removed and the main course of the lunch was served. A 10-minute interval for the first course was selected based on teacher recommendations and the amount of time allotted for the lunch meal. In the condition with no first course, children were served the main course upon being seated. Teachers were instructed to redirect conversations pertaining to food to other topics to minimize the influence on lunch intake.

On test days, breakfast and afternoon snack were served in each classroom at the regularly scheduled times. At breakfast, each child was served oatmeal, peaches, and milk. The foods at the afternoon snack (raw carrots, cucumbers, and cherry tomatoes, and pita bread) were served family style; children served themselves as much or as little as they wanted from large bowls shared at each table. To calculate snack food intake, the weight of each item was kept within a narrow range (carrots and cucumber slices: 6.0-9.0 g; tomatoes: 6.0-11.0 g; pita wedges: 13.0-16.0 g) and researchers recorded the number of pieces of each food item that were taken by each child in the study.

Liking of the experimental foods was assessed using a procedure developed by Birch et al. (1979a; 1979b; 1980b). Liking assessments were done midday during the week after the test meals were completed. Children were instructed on the use of three cartoon faces to indicate whether they thought a food was 'yummy', 'okay', or 'yucky'. After instruction, each child was presented with a sample of tomato soup followed by a sample of pasta. The child was asked to taste each sample and indicate their liking of the food by pointing to the appropriate face.

Participant Characteristics

Parents were asked to complete a 19 item questionnaire assessing family demographics and the health status of their child. Body weight and height measurements of the children were taken within two weeks of the final test meal. The children's height and weight measurements were used to calculate their sex-specific body mass index-for-age percentile and z-score using a software program from the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2010).

Statistical analysis

Data were analyzed using a mixed linear model with repeated measures (SAS version 9.1, SAS Institute, Cary, NC). The fixed factors in the model were soup portion size (0, 150, 225, or 300 g), classroom, and test session; subjects were treated as a random factor. The factors of the children's sex and ratings of food acceptability were tested as factors in the model. The main outcome measures were soup intake, vegetable intake, and meal energy intake. To assess vegetable intake, soup consumption was converted into the equivalent vegetable content (80%) based on information provided by the manufacturer and a vegetable serving was considered to be approximately one-half cup (118 ml) of vegetables.

Meals in which children consumed $\geq 95\%$ of the soup were identified and the main outcomes were analyzed both with and without these meals to determine whether consuming the entire portion of soup influenced the effect of portion size on intake. Individual children whose data were influential on the main outcomes in the mixed model were identified using the procedure of Littell et al. (2006).

Analysis of covariance was used to assess the influence of continuous subject variables (age, body weight, height, and BMI percentile,) on the relationship between soup portion size and the main study outcomes. T-tests were used to test differences between girls and boys in age, body weight, height, and BMI percentile. Data are reported as mean $\pm$ standard error and results were considered significant at $p < 0.05$.

RESULTS

Subject Characteristics

A total of 73 children from five classrooms were recruited. Data from one child was identified as having an undue influence on the results because of high variability across meals, and the data was therefore excluded from the analysis. The final group of 72 children had a mean age of 4.7 ± 0.1 years and a mean sex-specific BMI-for-age percentile of 59.8 ± 3.4 ; 27% of the children were overweight ($n=10$) or obese ($n=8$). Boys weighed significantly more than girls ($p=0.024$); otherwise, mean age, height, and BMI percentile did not differ significantly between girls and boys (Table 2). Parents provided demographic information for 66 of the 72 children; of these, 42 (67%) were white, 17 (27%) were Asian, and 4 (6%) were black or African American. Parents of the children had above average education levels and household incomes; approximately 95% of mothers and 88% of fathers had a college degree and 70% of households had an annual income above \$50,000.

Meal Food and Energy Intake

Food and beverage intake at the entire lunch meal (first course + main course) is shown in Table 3. Providing vegetable soup as a first course led to an increase in the weight of food consumed at the meal compared to having no first course ($p < 0.0001$). Consumption of the pasta entrée decreased significantly when any portion of soup was served ($p < 0.0001$). Intake of the other main course food items did not differ across the four conditions.

Serving soup at the start of the meal affected energy intake of the main course ($p<0.0001$) and energy intake of the entire meal ($p=0.008$). Having tomato soup as a first course, regardless of the portion size, resulted in a reduction in energy consumed in the main course compared to having no first course (Table 3). Energy intake from the pasta entrée decreased when any portion size of soup was served compared to when no soup was served ($p<0.0001$). Energy intake of the other meal components was not significantly affected by changes in soup portion size. When energy intakes for the soup and main course were combined, there was a difference in meal energy intake across the soup portion sizes. Serving 150 g of tomato soup led to a reduction in energy intake of the meal compared to either serving no soup or 300 g of soup. The average meal energy density was 4.8 ± 0.13 kJ/g (1.14 ± 0.03 kcal/g) when no soup was served, which decreased to a mean of 3.8 ± 0.08 kJ/g (0.92 ± 0.02 kcal/g) when any portion of soup was served ($p<0.0001$).

Soup and Vegetable Intake

Intake of tomato soup was significantly affected by the portion that was served ($p<0.0001$; Figure 1). Doubling the portion size from 150 g to 300 g led to a significant increase in soup consumption by 23%, or 25 g. Soup intake from the middle portion size was not significantly different than intake from either of the other portions.

Total vegetable consumption at the lunch meal (tomato consumed from the soup + broccoli from the main course) increased as the portion of soup was increased ($p<0.0001$; Figure 1). The amount of soup served as a first course did not affect broccoli consumption in the main course. When no first course was served, the mean vegetable consumption at lunch was 22.2 ± 2.5 g, or about one-sixth of a vegetable serving. Lunch vegetable consumption increased to 108.8 ± 5.7 g when 150 g of soup was served as a first course. When the soup portion size increased to 300 g, lunch vegetable consumption increased to 128.9 ± 9.2 g; this represents an increase in vegetable intake of approximately one serving compared to having no first course.

Consuming soup as a first course at lunch did not decrease vegetable intake at the afternoon snack. The amount of soup served at lunch did not significantly affect intake of carrots, cucumber slices, or cherry tomatoes during the afternoon snack (Table 3). Total vegetable consumption across lunch and afternoon snack increased as the portion size of soup increased ($p<0.0001$).

Approximately 44%, or 32 of the 72 children included in the analysis, consumed $\geq 95\%$ of the soup in the smallest portion condition, and approximately 24%, or 17 children consumed $\geq 95\%$ of the soup in the middle portion condition. Only 6 children consumed $\geq 95\%$ of the soup in the largest portion condition. After excluding from the analysis any intakes that comprised the entire portion of soup, the effect of portion size on intake was still evident ($p=0.004$).

Influence of Subject Characteristics

Liking ratings for the tomato soup and pasta were collected for 67 children. Of these children, 60 (90%) rated the soup as acceptable ('yummy' or 'okay') and 65 (97%) rated the pasta as acceptable. Ratings for soup liking affected soup intake ($p=0.006$); those who rated soup as 'yummy' ($n=46$) consumed significantly more soup than those who rated soup as 'yucky' ($n=7$). Because of the small number of children who rated soup as 'yucky', there was insufficient power to test the influence of soup liking on the effect of portion size. There were no significant differences in total food or energy intake at lunch based on the children's classroom or sex. Children with higher sex-specific BMI percentiles had significantly greater energy intake at lunch across all conditions ($p=0.025$). Analysis of covariance

showed that the effect of soup portion size on lunch energy intake was not influenced by the children's age, height, weight, or age- and sex-specific BMI percentile.

DISCUSSION

The findings from this study showed that serving children a low-energy-dense, vegetable-based soup as a first course reduced energy intake from the more energy-dense main course entree. Total meal energy intake, however, was reduced only when the smallest amount of soup was served. In addition to the effects on energy intake, serving a vegetable soup as a first course led to increased vegetable consumption. The vegetables from the tomato soup enhanced vegetable intake because soup consumption did not affect vegetable consumption at the main course or at the subsequent snack. Importantly, increasing the portion size of a low-energy-dense, vegetable-based first course increased vegetable intake. These results indicate that the amount of vegetables provided can influence children's vegetable intake.

Consuming low-energy-dense vegetable soup could influence hunger, satiety, and energy intake. In adults, consuming soup as a first course has been shown to enhance satiety, reduce intake of the main course, and reduce overall energy intake at the meal (Flood & Rolls, 2007; Kissileff et al., 1984; Rolls et al., 1999; Rolls et al., 1990). The present study, which was the first to examine the effect of consuming soup as a first course on meal energy intake in children, found that after serving each of the portions of soup there was a reduction in energy intake of the more energy-dense main entrée compared to when no soup was served. However, total meal energy intake (soup + main course) was reduced significantly only when the smallest portion size of soup was served. With larger portions of soup the increased energy intake from soup added to that from the main course, so that meal energy intake did not differ significantly from when no soup was served. This study showed that vegetable intake in children can be increased while maintaining energy intake, and in some circumstances increased vegetable consumption can lead to a reduction in meal energy intake.

Several studies have shown that portion size affects children's intake of energy-dense foods (Fisher, 2007a; Fisher et al., 2007b; Fisher et al., 2007c; Rolls, Engell, & Birch, 2000), but the few studies in children that have tested variations in the portion size of low-energy-dense foods have reported mixed results. In one study with 5- and 6-year-old children, doubling the portion size of one fruit and two vegetable side dishes increased fruit intake but not vegetable intake (Kral et al., 2010). The authors speculated that the presence of palatable, competing foods reduced the effect of portion size on vegetable intake. Serving vegetables as a first course removes the influence of competing foods, and may result in a greater influence of portion size on vegetable intake. Support for this suggestion comes from a recent study showing that doubling the portion size of a first course of raw carrots significantly increased carrot consumption in young children (Spill et al., 2010). Likewise, in the present study when soup was served to preschool children as a first course with no competing foods, doubling the portion size increased soup consumption significantly. These studies suggest that the timing of serving larger portions of vegetables could influence the response; however, the effects of varying portion sizes before or during a meal have not been compared in children. Portion size can be used strategically to increase vegetable intake, but factors such as the time of serving and the presence of competing foods may moderate the effect.

Because a goal of serving larger portions of vegetables as a first course is to increase daily vegetable intake, it is important to determine how vegetable intake at subsequent eating occasions is affected. In the present study, increasing the portion size of tomato soup at the start of the meal increased meal vegetable intake because consuming soup did not decrease

vegetable consumption at the main course. It was previously found that serving larger portions of carrots as a first course increased meal vegetable intake, though the magnitude of the effect was smaller (Spill et al., 2010). The present study extended these findings by measuring intake during the afternoon snack several hours later. The amount of soup consumed did not affect vegetable intake at the snack and therefore increased vegetable intake over these two eating occasions. The vegetables available at these eating occasions varied considerably in their sensory characteristics (tomato soup, steamed broccoli, raw carrots, cucumbers, and cherry tomatoes). If the vegetables had been more similar, vegetable consumption at later occasions may have decreased due to sensory-specific-satiety, which refers to the decline in pleasantness as a food is consumed (Rolls, 1986). Increasing sensory variety has been shown to reduce sensory-specific satiety and to promote increased food intake in adults (Rolls, Meengs, & Roe, 2010; Rolls et al., 1981). Studies in 8- to 12-year old children have shown that increasing the variety of energy-dense foods at an eating occasion increased intake (Epstein et al., 2009; Temple, Giacomelli, Roemmich, & Epstein, 2008). More work is needed to understand how serving a variety of low-energy-dense foods affects preschool children's intake within a meal and over several eating occasions.

Previous studies examining the effect of portion size on children's intake have looked at palatable, high-energy-dense foods, such as chicken nuggets, pasta, and cereal (Fisher, 2007a; Fisher et al., 2007b; Fisher et al., 2007c). A recent study extended these findings by showing that increasing the portion size of a low-energy-dense vegetable led to increased consumption in young children (Spill et al., 2010). The present study supports the findings that portion size affects intake of low-energy-dense, vegetable-based foods. In both studies, the vegetables tested were well-liked by the children. The effect of portion size on intake may depend on the degree of liking for the food; if a food is not well-liked, it is probable that serving larger portions will not affect intake. In one study, when the portion size of a fruit and two vegetable side dishes were increased, fruit intake increased but vegetable intake did not (Kral et al., 2010). The fruit was preferred to either vegetable, suggesting that the effect of portion size might be specific to liked foods. In order for portion size to be effective at increasing vegetable consumption, therefore, it may be necessary that the vegetable provided is well-liked. Methods have been identified to increase vegetable acceptability in children including repeated exposure and social modeling (Birch, 1980a; Birch & Marlin, 1982; Wardle, Cooke et al., 2003; Wardle, Herrera, Cooke, & Gibson, 2003), but further research is needed to identify strategies to increase acceptability of a wide range of vegetables in young children.

The present study had several strengths and limitations. First, the study was conducted in the children's usual eating environment with their peers and teachers, and with familiar foods. Secondly, this study measured intake beyond a single eating occasion in order to examine whether children altered their vegetable intake several hours later in response to consuming more vegetables at lunch. The portion sizes selected for this study were appropriate considering the typical intake of soup in this age group; however, testing a wider range of portion sizes may have resulted in greater effects on vegetable and energy intake. This benefit has to be balanced against the likelihood that serving larger portions would probably increase the amount of uneaten food. Studies are needed to find optimal portion sizes of various vegetables that maximize intake while keeping waste to a minimum. A limitation of the study is the use of a convenience sample from daycare centers on a university campus. Parents of the children had above average education levels and household incomes; therefore, a more diverse sample of children would be needed to generalize these results to a broader population.

This study is the first to show that consuming a low-energy-dense soup as a first course can reduce entrée energy intake in young children. The study strengthens and builds on previous

research showing that portion size influences intake in young children and that increasing the portion size of vegetables served as a first course can increase children's vegetable intake. Tomato soup is a particularly effective food for increasing vegetable intake because it is well-liked and easy for young children to consume. Providing vegetable soup to children at the start of a meal is a practical strategy that can be used by caregivers to increase children's vegetable intake, and reduce energy intake from a more energy-dense main entrée.

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Highlights

- Intake of a low energy-dense soup may reduce children's energy intake at a meal.
- We tested various portions of vegetable soup on energy and vegetable intake.
- Serving a soup first course reduced energy intake of a more energy-dense entrée.
- Children's intake of soup and vegetables increased as portion size increased.
- Increased vegetable intake at lunch was sustained through the next eating occasion.

Figure 1. Weight (mean $\pm$ SE) of vegetables consumed at lunch by 72 preschool children who were served varying portions of tomato soup as a first course and 60 g of broccoli in the main course. Intake of tomato soup was converted into the equivalent vegetable content based on information provided by the manufacturer. Differing letters for tomato soup intake indicate a significant difference based on a mixed linear model with repeated measures ($p < 0.0001$). Differing capital letters indicate a significant difference in total vegetable intake at lunch ($p < 0.0001$).

Table 1

Foods and beverages served to children during a study testing the effects of serving different portions of vegetable soup as a first course at lunch.

Meal component	Amount served (g)	Energy density (kJ/g)	Energy density (kcal/g)
Breakfast			
Oatmeal ^a	250	2.38	0.57
Diced peaches ^b	150	1.67	0.40
2%-fat milk ^c	236	2.09	0.50
Lunch first course			
Tomato soup ^d	0, 150, 225, or 300 ^e	1.55	0.37
Lunch main course			
Macaroni & cheese ^f	400	8.37	2.00
Steamed broccoli ^g	60	1.17	0.28
Unsweetened applesauce ^h	150	1.80	0.43
2%-fat milk ^c	240	2.09	0.50
Afternoon snack			
Pita bread wedges ⁱ	Served family-style ^j	10.29	2.46
Carrot sticks	Served family-style ^j	1.46	0.35
Cucumber slices	Served family-style ^j	0.50	0.12
Grape tomatoes	Served family-style ^j	0.75	0.18
Ranch dip ^k	30	2.80	0.67
Water	236	0.00	0.00

^aDiamond Crystal Brands Inc, Savannah, GA (prepared with 67 g water and 1.9 g brown sugar per 10 g dry oatmeal)

^bIndependent Marketing Alliance, Houston, TX

^cSchneider Valley Farms, Williamsport, PA

^dCampbell Soup Company, Camden, NJ

^eSoup portion size varied across conditions

^fNestle USA, Inc., Solon, OH (prepared with 2.6 g butter and 5.2 g vegetable oil per 100 g entrée)

^gBirds Eye Foods, Inc., Rochester, NY

^hKnouse Foods, Inc., Peach Glen, PA

ⁱGeorge Weston Bakeries, Inc., Horsham, PA

^jFoods served family-style were served in a communal bowl and children served themselves

^kThe HV Foods Products Co., Oakland, CA (prepared with 16.7 g reduced-fat buttermilk, 8.3 g skim milk, and 8.3 g fat-free sour cream per 1.0 g dry mix)

Characteristics of children participating in a study testing the effects of serving different portions of vegetable soup as a first course at lunch.

Table 2

Characteristic	Boys (n=31)		Girls (n=41)		Total (n=72)	
	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range
Age (y)	4.8 ± 0.1	3.4 – 5.7	4.6 ± 0.1	3.3 – 5.7	4.7 ± 0.1	3.3 – 5.7
Weight (kg)	19.4 ± 0.7*	13.6 – 29.2	17.9 ± 0.4*	14.2 – 27.5	18.6 ± 0.4	13.6 – 29.2
Height (cm)	109.2 ± 1.4	94.5 – 128.0	105.7 ± 0.9	94.0 – 117.3	107.2 ± 0.8	94.0 – 128.0
Sex-specific BMI-for-age percentile	59.3 ± 5.2	1.4 – 99.0	60.1 ± 4.4	1.8 – 98.4	59.8 ± 3.4	1.4 – 99.0

* p < 0.05

Table 3

Food and energy intakes of 72 children in a study testing the effects of serving different portions of vegetable soup as a first course at lunch.

	No soup	150 g soup	225 g soup	300 g soup
Lunch first course intake				
Tomato Soup				
Weight (g)	---	108.4 ± 6.1 ^{1,2,a}	122.1 ± 9.0 ^{ab}	133.0 ± 10.3 ^b
Energy (kJ)	---	166.5 ± 2.2 ^a	187.4 ± 13.8 ^{ab}	204.2 ± 15.9 ^b
Energy (kcal)	---	39.8 ± 2.2 ^a	44.8 ± 3.3 ^{ab}	48.8 ± 3.8 ^b
Lunch main course intake				
Macaroni and cheese				
Weight (g)	192.4 ± 12.1 ^a	145.8 ± 10.9 ^b	162.6 ± 11.2 ^b	166.6 ± 10.8 ^b
Energy (kJ)	1614.2 ± 101.3 ^a	1223.4 ± 91.2 ^b	1363.6 ± 94.1 ^b	1397.5 ± 90.8 ^b
Energy (kcal)	385.8 ± 24.2 ^a	292.4 ± 21.8 ^b	325.9 ± 22.5 ^b	334.0 ± 21.7 ^b
Broccoli				
Weight (g)	22.2 ± 2.5	19.9 ± 2.5	18.1 ± 2.4	19.8 ± 2.6
Energy (kJ)	26.4 ± 2.9	23.4 ± 2.9	21.3 ± 2.9	23.4 ± 2.9
Energy (kcal)	6.3 ± 0.7	5.6 ± 0.7	5.1 ± 0.7	5.6 ± 0.7
Applesauce				
Weight (g)	94.8 ± 6.3	86.2 ± 7.0	88.8 ± 6.7	88.4 ± 6.8
Energy (kJ)	170.7 ± 11.3	155.2 ± 12.6	159.8 ± 12.1	159.4 ± 12.1
Energy (kcal)	40.8 ± 2.7	37.1 ± 3.0	38.2 ± 2.9	38.1 ± 2.9
Milk				
Weight (g)	116.3 ± 9.1	123.3 ± 10.1	106.2 ± 9.6	104.7 ± 9.3
Energy (kJ)	243.5 ± 18.8	257.7 ± 20.9	222.2 ± 20.1	218.8 ± 19.7
Energy (kcal)	58.2 ± 4.5	61.6 ± 5.0	53.1 ± 4.8	52.3 ± 4.7
Total main course				
Weight (g)	425.7 ± 17.1 ^a	375.2 ± 17.2 ^b	375.7 ± 17.3 ^b	379.5 ± 18.3 ^b
Energy (kJ)	2054.3 ± 105.0 ^a	1659.8 ± 95.7 ^b	1767.3 ± 97.1 ^b	1799.1 ± 99.6 ^b
Energy (kcal)	491.0 ± 25.1 ^a	396.7 ± 22.8 ^b	422.4 ± 23.2 ^b	430.0 ± 23.8 ^b
Total lunch intake (first course + main course)				
Weight (g)	425.7 ± 17.1 ^a	483.6 ± 18.6 ^b	497.8 ± 18.1 ^b	512.5 ± 20.3 ^b
Energy (kJ)	2054.3 ± 105.0 ^a	1826.3 ± 97.1 ^b	1954.8 ± 96.2 ^{ab}	2003.3 ± 101.7 ^a
Energy (kcal)	491.0 ± 25.1 ^a	436.5 ± 23.2 ^b	467.2 ± 23.0 ^{ab}	478.8 ± 24.3 ^a
Afternoon snack intake				
Pita wedges				
Weight (g)	10.8 ± 2.1 ^{ab}	10.1 ± 1.9 ^b	11.5 ± 1.9 ^{ab}	16.7 ± 2.4 ^a

	No soup	150 g soup	225 g soup	300 g soup
Energy (kJ)	111.3 ± 21.8 ^{ab}	104.2 ± 19.2 ^b	117.6 ± 19.7 ^{ab}	171.5 ± 24.7 ^a
Energy (kcal)	26.6 ± 5.2 ^{ab}	24.9 ± 4.6 ^b	28.1 ± 4.7 ^{ab}	41.0 ± 5.9 ^a
Cherry tomatoes				
Weight (g)	11.7 ± 3.4	9.7 ± 3.0	14.0 ± 3.4	9.5 ± 2.1
Energy (kJ)	5.9 ± 1.7	5.0 ± 1.7	7.1 ± 1.7	4.6 ± 1.3
Energy (kcal)	1.4 ± 0.4	1.2 ± 0.4	1.7 ± 0.4	1.1 ± 0.3
Cucumber slices				
Weight (g)	6.8 ± 1.3	7.9 ± 2.0	6.9 ± 1.5	8.4 ± 2.7
Energy (kJ)	3.3 ± 0.8	3.8 ± 0.8	3.3 ± 0.8	4.2 ± 1.3
Energy (kcal)	0.8 ± 0.2	0.9 ± 0.2	0.8 ± 0.2	1.0 ± 0.3
Carrots				
Weight (g)	8.6 ± 1.5	9.2 ± 1.8	12.8 ± 2.5	10.9 ± 1.9
Energy (kJ)	12.6 ± 2.1	13.4 ± 2.5	18.8 ± 3.8	15.9 ± 2.9
Energy (kcal)	3.0 ± 0.5	3.2 ± 0.6	4.5 ± 0.9	3.8 ± 0.7
Ranch dip				
Weight (g)	4.5 ± 0.9	5.3 ± 1.0	6.3 ± 1.1	6.5 ± 1.2
Energy (kJ)	12.3 ± 2.5	14.6 ± 2.5	18.0 ± 2.9	18.4 ± 3.3
Energy (kcal)	3.0 ± 0.6	3.5 ± 0.6	4.3 ± 0.7	4.4 ± 0.8
Total afternoon snack intake				
Weight (g)	42.5 ± 5.9	42.2 ± 5.2	51.5 ± 6.7	51.9 ± 6.1
Energy (kJ)	146.0 ± 24.3 ^a	141.4 ± 21.8 ^a	164.8 ± 23.8 ^{ab}	214.6 ± 27.6 ^b
Energy (kcal)	34.9 ± 5.8 ^a	33.8 ± 5.2 ^a	39.4 ± 5.7 ^{ab}	51.3 ± 6.6 ^b

¹ All values are means ± SEM

² Means in the same row with different superscript letters are significantly different as assessed by a mixed linear model with repeated measures (p<0.05)