

Vegetable Purée: A Pilot Study to Increase Vegetable Consumption among School Lunch Participants in US Elementary Schools

Angela Vale, MS, RD; Julie Raeder Schumacher, EdD, RD; Robert W. Cullen, PhD, RD; Hae Jin Gam, PhD

Please note that this study was published before the SY2014-15 implementation of the Smart Snacks Nutrition Standards for Competitive Food in Schools, as required by the Healthy, Hunger-Free Kids Acts of 2010. As such, certain research relating to food in schools may not be relevant today.

ABSTRACT

Purpose/Objectives

Recent US Department of Agriculture regulations increased the amount and variety of vegetables required for school lunches. Vegetables are the most wasted components of lunch while entrées are selected and consumed by the majority of children. This study examined how adding vegetable purée to an elementary school lunch entrée affected the weight and calories of the entrée consumed and the amount of vegetables consumed. Differences between genders and among grade levels were also assessed.

Methods

A convenience sample (839 students) from three elementary schools in a large Central Illinois school district participated in this study. A vegetable purée of carrots, beans, and tomato paste was added to a standard entrée to increase vegetable content from the Control of 0.25 cup to 0.4 cup (Recipe 1) and 0.45 cup (Recipe 2). Children were randomly served one of three entrées, and plate waste was measured by weighing the leftover portion of the entrées. Analysis of variance and *t* tests were used to compare the weight of the entrée consumed and the vegetable and calorie consumption for the entrées and identify differences between genders. Univariate linear models tested interaction between entrée and grade.

Results

There was no difference in consumption of the Control and Recipe 1 ($p = .279$). Recipe 2 was significantly less consumed than Recipe 1 ($p < 0.001$) and the Control ($p < 0.05$) suggesting that there may be a limit of how much vegetable purée one can add to an entrée for a student to consume a comparable amount. Significantly more vegetables ($p < 0.001$) and fewer calories ($p < 0.001$) were consumed from the entrées with added vegetables than the Control entrée. There were significant interactions between grade level and all factors, but no differences between genders were identified.

Application to Child Nutrition Professionals

The study suggests that adding puréed vegetables to lunch entrées may be an effective strategy to increase vegetable consumption and reduce energy intake of elementary school children. School nutrition programs can benefit by helping meet vegetable and nutrient requirements and reducing plate waste.

Keywords: vegetable consumption; elementary school meals; National School Lunch Program

INTRODUCTION

Schools can play a key role in obesity intervention due to the number of children that can be reached and the duration of time students spend at school each day (Institute of Medicine of the National Academies [IOM], 2005). In addition to hours of attendance, most children consume at least one meal daily at school providing a captive audience and an opportunity to offer nourishment. On a typical school day in 2012, 31.6 million children ate a school lunch and 12.9 million ate a school breakfast (US Department of Agriculture [USDA], 2013a; USDA, 2013b).

The USDA regulates both the National School Lunch Program (NSLP) and School Breakfast Program (SBP) programs. Guidelines for the nutrient content of school meals are provided to ensure the dietary needs of children are met. Despite the nutritional adequacy of meals, only about half (54%) of all children consume any fruits or vegetables from school meals (Briefel, Crepinsek, Cabili, Wilson, & Gleason, 2009).

In January 2012, the USDA issued revised nutritional standards for the NSLP and SBP programs (Nutrition Standards in the National School Lunch and School Breakfast Programs [Nutrition Standards], 2012). The aim of the new guidelines was to better align the composition of school meals with current dietary recommendations. To address children's suboptimal intake of fruits and vegetables, the ruling increased the size of fruit and vegetable servings and the variety of vegetables that must be served. The increased serving size and variety requirements provide the opportunity for children to consume more of these nutritious foods, but have led to an increase in plate waste (Smith & Cunningham-Sabo, 2014). Vegetables are the most wasted items in school lunch followed by fruits per a report to Congress by Buzby and Guthrie (2002). Due to children's aversion to fruits and vegetables, fulfilling the increase in servings of these foods required by the NSLP while minimizing waste will require creative approaches.

Serving larger portions of vegetables has been shown to increase consumption by preschool children; however, some argue that simply serving larger portions may not be effective in the school lunch setting (Condon, Crepinsek, & Fox, 2009; Spill, Birch, Roe, & Rolls, 2010). The utilization of vegetable purées in entrées is a novel approach to increasing vegetable intake. This strategy has produced a greater increase in vegetable intake than increasing the serving size (Blatt, Roe, & Rolls, 2011; Spill, Birch, Roe, & Rolls, 2011). A number of options have been evaluated in schools to encourage the consumption of fruits and vegetables with varying success. Studies that modified school meals to make them healthier were effective in increasing vegetable intake and improving the weights and blood pressures of students (Cohen et al., 2012; Hollar et al., 2010). However, there is minimal research regarding how increasing the vegetable content of the main entrée affects vegetable consumption. Children select and consume more school lunch entrées than side dishes making entrées a viable medium for vegetable supplementation with the potential to moderate waste (Georgiou, Martin, & Long, 2005).

The purpose of this pilot study was to examine the effect of incorporating puréed vegetables at three different levels (0.25 cup, 0.4 cup, and 0.45 cup) into entrées served as a part of an elementary school lunch. The weight of the entrée consumed, the number of vegetable servings consumed, and the amount of energy consumed were measured by grade level and gender.

This study attempted to answer the following questions: 1) How will the amount of vegetable purée incorporated into entrées served as part of an elementary school lunch program affect the weight of the entrée consumed, the amount of vegetables consumed, and the calories consumed? and 2) Is there significant difference in the weight of the entrée consumed, amount of vegetables consumed, and calories consumed based on grade level and gender?

METHODOLOGY

Participants

Three elementary schools (K-5 grades) in a large Central Illinois school district were selected as a convenience sample for this plate waste study as part of a pilot program to increase vegetable consumption. District schools varied widely in socioeconomic status. To achieve an equal distribution, three schools were selected to achieve an average of 41% of the children who qualified for free or reduced price meals. Children were included in the study if they consumed a school lunch on the days data were collected and excluded if they had known food allergies or other health conditions (e.g. diabetes).

Procedure

Spaghetti and meat sauce, the manipulated entrée, was selected from the district's lunch menu because it was familiar to students, and its characteristics increased the likelihood of maintaining a similar taste, appearance, and texture with varying vegetable content (Spill et al., 2011). Puréed carrots, puréed beans, and tomato paste were added incrementally to the standardized meat sauce recipe that already contained 0.25 cup of vegetables (Control) which increased the vegetable amount to 0.4 cup (Recipe 1) and 0.45 cup (Recipe 2). A serving of vegetables for elementary school children for the NSLP is defined as 0.5 cup (118 mL) (Nutrition Standards, 2012). The number of vegetable servings in each entrée was computed based upon reference weights in the Food Buying Guide Calculator for Child Nutrition Programs (National Food Service Management Institute, 2013). The serving size of the entrée remained constant at 0.5 cup using a #8 scoop based on the school district's meal planning process in compliance with NSLP guidelines (Nutrition Standards, 2012). The nutrient composition (Table 1) of the entrées was calculated using manufacturer's nutrition labels and NUTRIKIDS Menu Planning & Nutritional Analysis software (version 14.0, 2012, Heartland School Solutions, Rochester, NY). Due to inventory on hand, nutrient content of beans varied slightly for each school.

Data were collected from three schools on different days. Entrées were prepared in the school kitchens following recipes developed for the experiment. A #8 scoop was used to portion the entrées into dishes labeled on the bottom with a random, three-digit number to identify the entrée variation. One-tenth of the servings of each entrée variation were weighed using a digital food scale (The Sharper Image Acquisition, LLC under license by MerchSource, LLC, Foothill Ranch, CA) to the nearest 1 g to determine the weight of the entrées served.

Within each school and lunch period, a randomized block design was used to test the effect of varying the vegetable content in the school lunch entrée. Participants were served an entrée, along with the unmanipulated side dishes typically served with the meal per the school lunch menu, in the school lunchroom during their regularly scheduled time. Fluid milk was also served in compliance with the NSLP guidelines. All schools in the district employ the Offer vs. Serve

meal service option; thus, due to freedom of selection, meal components on each child's tray varied. The entire meal was consumed ad libitum.

Table 1. Attributes of Meat Sauce Served to Elementary School Children

	Control	Recipe 1 ^a	Recipe 2 ^a
Vegetables (cups)	0.25	0.40	0.45
Energy (kcal)			
School 1 (220 served)	194	146	139
School 2 (258 served)	194	158	162
School 3 (343 served)	194	147	140
Average nutrient content			
Total fat [g (%)]	3.4 (16)	2.2 (13)	1.8 (11)
Carbohydrate [g (%)]	35.0 (72)	27.4 (73)	26.6 (73)
Protein [g (%)]	1.3 (3)	2.1 (5)	3.1 (8)
Calcium (mg)	0.1	15.0	29.8
Iron (mg)	1.1	1.2	1.5
Vitamin A (RE)	248.0	194.7	200.1
Vitamin C (mg)	1.9	3.1	4.8
Sodium (mg)	300.8	242.4	255.3
Fiber (g)	5.3	4.6	5.0
Weight served^b (g ± SD)	128.0 ± 12.5	137.9 ± 5.2	127.0 ± 2.7
Range (g)	101 - 145	131 - 145	123 - 131

Note. Recipe information for manipulated entrées can be obtained by contacting the author.

^a Puréed beans, puréed carrots, and tomato paste were added to increase vegetable content.

^b Weight of the entrée served to children including weight of the cup it was served in (2.7 g).

All entrée dishes were collected at the conclusion of the meal period, separated based on gender and grade, and weighed to measure the amount of the entrée not consumed. Weighing is the most accurate means of assessing plate waste, and has been shown to provide detailed and accurate information (Buzby, 2002).

Data Analyses

Data from all schools were aggregated. Weight of the entrée consumed was evaluated using the weight of the entrée prior to serving minus the weight of the entrée discarded. Descriptive statistics were used to compute the frequencies, means, and standard deviations of the entrée consumed, vegetable servings, and calories for each entrée variation, as well as each gender and grade for each entrée variation. Analysis of variance (ANOVA) with post hoc comparisons of Fisher's least significant difference (LSD) was used to examine the differences in mean values for weight of the entrée consumed, vegetable servings consumed, and calories consumed for the three entrée variations and among grades. Linear regression and independent-samples *t* tests were used to further examine these associations.

To identify differences between gender for the amount of entrée, vegetables, and calories consumed, independent-sample *t* tests were conducted. ANOVA and LSD post hoc comparisons

tested differences in these factors among entrée variations within each gender. To test for interaction between the entrée variation and grade, univariate linear models were used to conduct two-way ANOVA on weight of the entrée, amount of vegetables and calories. Results were considered significant at $p < .05$. All statistical analyses were conducted using IBM SPSS Statistics software (version 20, 2011, IBM Corporation, Somers, NY).

RESULTS AND DISCUSSION

The average enrollment for the three elementary schools (grades K-5) was 1,467 students, and a total of 839 (57.2%) samples were collected. Nineteen samples (2.3%) were excluded from analysis due to contamination with other food or beverage or unknown gender or grade of the participant resulting in 820 (55.9%) usable samples. The demographics of participants are listed in Table 2. Due to variance in recipe yield and unusable samples, 31.3% (n=257) of samples were the Control (0.25 cup vegetables), 33.2% (n=272) for Recipe 2 (0.4 cup vegetables) and 35.5% (n=291) for Recipe 2 (0.45 cup vegetables).

Table 2. Demographics of Elementary School Students

	Total Sample	
	<i>n</i>	%
Gender		
Male	434	52.9
Female	386	47.1
Grade		
K	157	19.1
1	133	15.2
2	110	13.4
3	135	16.5
4	151	18.4
5	134	16.3

Among all three entrée variations, weight of the entrée consumed was not significantly affected by the amount of vegetables in the entrée ($F(2, 817) = 2.294, p = .102$). However, in examining the plot, some significant differences were observed. Therefore, independent-samples t tests were conducted to analyze the data in more detail. This revealed that Recipe 1 ($M = 76.7, SD = 52.5$) had significantly more entrée consumed ($t = 2.148, p = .00$) than Recipe 2 ($M = 67.7, SD = 46.0$) and resulted in a 12% increase in consumption. Conversely, Recipe 2 was significantly less consumed ($t = -1.191, p < .05$) than the Control ($M = 72.7, SD = 50.9$) with a 7% decrease in consumption. Entrée consumption of the Control and Recipe 1 did not differ ($p = .279$).

Two prior studies served entrées enhanced with puréed vegetables to reduce energy density (Blatt et al., 2011; Spill et al., 2012). All three versions of the entrées were equally acceptable to participants based upon hedonic ratings, and a consistent weight of the entrées was consumed with no observed effect from acceptability rating (Blatt et al., 2011; Spill et al., 2012). While children in the present study consumed a similar weight of all entrées, there was no difference in consumption of Recipe 1 compared to the Control in agreement with previous research (Blatt et al., 2011; Spill et al., 2012). Compared to Recipe 2, children ate significantly more of both the

Control (5g or 7%) and Recipe 1 (9g or 12%) indicating there may be a threshold of vegetable purée content that relates to the weight of the entrée consumed.

The amount of vegetables consumed was significantly influenced by entrée variation ($F(2, 817) = 36.192, p = .00$) as were calories consumed ($F(2, 817) = 19.107, p = .00$). Children consumed 57% more vegetables ($M = 0.16$) from Recipe 1 than the Control and 71% more ($M = 0.19$) from Recipe 2. A similar but inverse effect on calories consumed was observed among entrée variations. Significantly fewer calories were consumed from Recipe 1 ($M = 83.7, SD = 57.3; p = .00$) and Recipe 2 ($M = 78.7, SD = 54.0; p = .00$) than the Control ($M = 110.2, SD = 77.1$). The entrée with 0.45 cup vegetables resulted in a 24% decrease in calories consumed compared to the Control with 0.25 cup despite a 6% increase in the quantity consumed. While consumption of the entrée with 0.45 cup vegetables was only 7% less than the Control, caloric intake decreased by 51%. Increasing the vegetable content from 0.4 to 0.45 cup per entrée (Recipe 1 vs. Recipe 2) did not affect vegetable intake ($p = .136$) or caloric intake ($p = .35$).

Findings of this study add to existing evidence that using vegetable purée increases vegetable consumption and decreases energy intake (Blatt et al., 2011; Spill et al., 2012). Due to their high water content and low energy density, adding vegetables to entrées has a corresponding energy lowering effect on the dish and on participant's energy intake (Blatt et al., 2011; Spill et al., 2012). In agreement with previous reports, children consumed significantly more vegetables and fewer calories from the entrées with added vegetable purée. In spite of children consuming an average of 6% more of Recipe 1 than the Control, caloric intake was reduced by 24%.

Entrée, vegetables, and calories consumed for grade and gender groupings are detailed in Table 3. The grade level of students significantly influenced overall consumption ($F(5, 814) = 3.539, p < .01$). A regression analysis revealed that consumption of the entrée increased as grade level increased ($\beta = .138, p = .00$) except for 2nd ($M = 75.7, SD = 49.3$) and 3rd graders ($M = 75.6, SD = 48.1$), which were essentially the same. Several differences were observed between the lower grade levels and higher grades. Students in kindergarten ate significantly less than those in 2nd and 3rd ($p < .05$) and those in 4th and 5th ($p < .01$). First graders ate significantly less than those in 4th and 5th ($p < .05$). Vegetable intake also differed significantly among grades ($F(5, 814) = 3.674, p < .01$) as did caloric intake ($F(5, 814) = 4.006, p < .01$). As one may expect since older children need more calories, both factors increased as grade level increased ($\beta = .128, p = .00; \beta = .135, p = .00$) with differences between lower and higher grades. Exceptions included 3rd graders ($M = .43, SD = 0.29$) having the same vegetable intake as 2nd graders ($M = .43, SD = 0.30$) and students in 5th grade ($M = 98.1, SD = 65.6$) consuming fewer calories than those in 4th grade ($M = 100.0, SD = 67.0$). The quantity of vegetables consumed was significantly lower among kindergarteners than 2nd, 3rd, 4th, and 5th graders ($p < .01$), and 1st graders' intake was less than 5th graders ($p < .05$) (Table 3). Kindergarten students consumed significantly fewer calories than those in 2nd ($p < .05$) and those in 3rd, 4th, and 5th ($p < .01$). Caloric intake was also significantly lower for 1st graders compared to 4th and 5th graders ($p < .05$). When means of the measured data were subjected to two-way ANOVA, results showed an insignificant interaction effect between entrée variation and grade. There was no significant interaction between grade and entrée variation for entrée consumption ($F(10, 802) = 1.427, p = .163$), vegetable consumption ($F(10, 802) = 1.301, p = .225$), or calorie consumption ($F(10, 802) = 1.532, p = .123$).

Table 3. Mean Consumption of Entrée, Vegetables, and Calories of Elementary School Students Served NSLP Entrées with Varying Vegetable Content

Entrée Consumed (g)				
	Control^a	Recipe 1^b	Recipe 2^c	Total
	<i>M ± SD</i>	<i>M ± SD</i>	<i>M ± SD</i>	<i>M ± SD</i>
Gender				
Male	75.0 ± 49.7	74.5 ± 52.7	64.1 ± 46.1	71.0 ± 49.6
Female	69.9 ± 52.4	79.1 ± 52.4	71.7 ± 45.9	73.6 ± 50.1
Grade				
K	53.4 ± 45.8	76.1 ± 52.7	52.2 ± 42.6	60.8 ± 48.4
1	73.0 ± 52.0	54.5 ± 53.0	67.2 ± 45.1	65.0 ± 49.9
2	68.8 ± 53.4	86.0 ± 49.7	72.4 ± 45.0	75.7 ± 49.3 *
3	85.5 ± 44.6	77.5 ± 51.2	67.5 ± 47.5	75.6 ± 48.1 *
4	80.2 ± 52.8	78.2 ± 51.2	77.1 ± 47.2	78.5 ± 50.2 ** ¶
5	80.3 ± 52.5	86.3 ± 53.1	70.6 ± 46.8	79.5 ± 51.0 ** ¶
Vegetables Consumed (cups)				
Gender				
Male	.29 ± .19	.43 ± .31	.45 ± .33	.39 ± .29
Female	.27 ± .20	.46 ± .30	.51 ± .33	.42 ± .30
Grade				
K	.21 ± .18	.44 ± .31	.37 ± .30	.34 ± .28
1	.29 ± .20	.31 ± .31	.47 ± .32	.37 ± .30
2	.27 ± .21	.49 ± .29	.51 ± .32	.43 ± .30 **
3	.33 ± .17	.45 ± .30	.48 ± .34	.43 ± .29 **
4	.31 ± .21	.45 ± .39	.55 ± .33	.44 ± .30 **
5	.31 ± .21	.50 ± .31	.50 ± .33	.45 ± .30 ** ¶
Calories Consumed (kcal)				
Gender				
Male	113.7 ± 75.3	81.3 ± 57.5	74.4 ± 53.8	89.4 ± 64.8
Female	105.9 ± 79.4	86.3 ± 57.2	83.3 ± 54.1	91.8 ± 64.3
Grade				
K	80.9 ± 69.3	82.6 ± 57.1	59.7 ± 48.9	74.0 ± 59.0
1	110.6 ± 78.9	59.3 ± 57.9	78.5 ± 53.1	82.1 ± 65.8
2	104.2 ± 80.9	94.0 ± 54.8	85.3 ± 53.4	93.0 ± 63.4 *
3	129.6 ± 67.6	84.3 ± 55.4	76.2 ± 53.7	94.0 ± 62.5 **
4	121.6 ± 80.0	86.4 ± 56.6	90.8 ± 56.4	100.0 ± 67.0 ** ¶
5	121.8 ± 79.6	93.7 ± 58.0	83.1 ± 55.9	98.1 ± 65.6 ** ¶

^a 0.25 cup vegetables per 0.5 cup serving of entrée

^b 0.4 cup vegetables per 0.5 cup serving of entrée

^c 0.45 cup vegetables per 0.5 cup serving of entrée

* Mean scores of subgroups are significantly different than kindergarten ($p < .05$) based on post hoc analyses

** Mean scores of subgroups are significantly different from kindergarten ($p < .01$) based on post hoc analyses

¶ Mean scores of subgroups are significantly different from 1st grade ($p < .05$)

As children age their energy needs increase, and a difference in food intake has been found among grade levels in elementary school (Buzby & Guthrie, 2002; Cashman, Tripurana, Englund, & Bergman, 2010). Younger children consume less and waste a greater proportion of food and nutrients. Older children, specifically 5th graders, consume the most food (Cashman et al., 2010). Similarly, the grade level of students in this study influenced entrée consumption. In all but one grade, consumption increased as grade level increased.

Vegetable intake measured in the present study increased as grade level increased in contradiction to previous results that found no difference among grades (Cashman et al., 2010; Robinson-O'Brien, Burgess-Champoux, Haines, Hannan, & Neumark-Sztainer, 2010). Similar to grade level differences in overall entrée intake, lower grade levels in the present study consumed fewer vegetables than higher grades. Second and 3rd graders were exceptions to this trend having equal vegetable intake. Zapata, Bryant, McDermott, and Hefelfinger (2008) found the opposite trend in middle school students where intake was inversely related to grade level. Caloric intake also increased as grade level increased, except for 5th grade students, with differences between lower and higher grades. Age-related energy and nutrient needs may be the cause of increased intake. Repeated exposure to foods at school lunch also has the potential to decrease inhibitions to consumption (Cashman et al., 2010).

Girls consumed more of the entrée than boys (73.6 ± 50.1 g vs. 71.0 ± 49.6 g), more vegetables (0.42 ± 0.30 vs. 0.39 ± 0.29), and more calories (91.1 ± 54.3 kcal vs. 89.4 ± 64.8 kcal). Nonetheless, entrée consumption was not significantly different between genders ($t = -0.743$, $p = .470$) nor was there a significant difference in the amount of vegetables consumed ($t = -1.266$, $p = .179$) or calories consumed ($t = -0.364$, $p = .949$) by gender. Girls ate more of Recipe 1 than the Control (12%) and Recipe 2 (9%), while boys ate more of the Control compared to Recipe 1 (1%) and Recipe 2 (15%); however, analysis showed the three entrée variations were equally consumed among both males ($F(2, 433) = 2.311$, $p = .100$) and females ($F(2, 385) = 1.200$, $p = .302$). Similar to the aggregate results of the amount of vegetables consumed, both male and females had a significantly higher vegetable intake from Recipe 1 and Recipe 2 compared to the Control as shown in Table 3. Caloric intake of both genders also corresponded with aggregate results and was significantly lower for Recipe 1 and Recipe 2 compared to the Control. Neither gender differed in vegetables or calories consumed for Recipe 1 compared to Recipe 2.

Gender differences in school lunch consumption have not been well studied. While girls typically eat less of school lunch than boys, some studies have found that vegetable intake does not differ (Cashman et al., 2010; Robinson-O'Brien et al., 2010). Other research indicates girls have a greater preference for vegetables than boys (Caine-Bish & Schuele, 2009). While girls ate more of the entrées in this study, resulting in more vegetable servings and calories consumed, no significant difference between genders for any of the variables was found. In the current study based upon consumption girls appeared to prefer the entrée with the intermediate amount of vegetables while boys appeared to prefer the standard entrée.

CONCLUSIONS AND APPLICATION

The current study showed that incorporating puréed vegetables into main dish entrées of school lunches could be an effective strategy to increase children's vegetable consumption and decrease

energy intake at that meal. When the vegetable content of the standard entrée was increased from 0.25 cup of vegetables to 0.4 and 0.45 cup, children consumed a similar weight of the entrée, although the Control (0.25 cup vegetables) and Recipe 1 (0.4 cup vegetables) were more consumed than Recipe 2 (0.45 cup vegetables). The supplemental vegetables in Recipe 1 resulted in an increase in vegetable intake of 57% and a decrease in energy intake of 24%, and Recipe 2 increased vegetable intake by 71% while decreasing energy intake by 51%. Reducing the energy density can also help keep the meal within caloric guidelines of the NSLP. Further research is needed to maximize vegetable content of entrées while not decreasing the amount consumed.

Multiple factors have been found to affect children's intake of vegetables; having a preference for vegetables was a strong indicator of higher consumption (Baxter & Thompson, 2002; Blanchette & Brug, 2005). While the covert inclusion of vegetables into entrées is not advised as the only method of increasing children's consumption, it is a way to help children who do not like the taste of vegetables meet the recommended daily intake (Spill et al., 2011; Blatt et al., 2011). Liking for the vegetables used did not significantly influence intake of altered entrées in previous blind studies suggesting vegetable purées have a limited effect on palatability (Blatt et al., 2011; Spill et al., 2011). The present study did not evaluate children's preference for the vegetables used.

There may be concern that 'hiding' vegetables will not increase long-term consumption because children will not recognize the vegetables. A pilot study found that taste preference of vegetable-enhanced food samples was not affected by knowledge of the added vegetables, but it was related to prior exposure to the vegetables used (Pope & Wolf, 2012). Additional research is needed to evaluate how vegetable preference and familiarity affect results when participants are informed of presence of added vegetables.

Using vegetable purée may be time consuming and impractical in large schools due to labor involved in preparing the purée. Some commercially prepared purées are available, and other convenience foods could be used to limit labor costs. The authors recommend trying puréed vegetables in other entrées such as soups, casseroles, rice dishes, enchiladas. Additionally, baked goods could have puréed fruits and vegetables incorporated into the batter. Other preparation methods for vegetables, such as finely chopping, should be explored as well as creative use of vegetables that cannot be served before expiration.

Limitations

This study has several limitations that should be taken into consideration when interpreting the findings. Because this pilot study used a convenience sample of three schools in central Illinois, the results are not generalizable to all elementary school children. This study was also cross-sectional in nature; thus, the researchers are unable to evaluate the long-term effectiveness of increased vegetable content of the entrées on children's vegetable and energy intake. Lunch periods and morning snack policies were not standardized across schools possibly affecting the hunger of the children and their entrée consumption at lunch. The distribution method may also have affected children's widely varying intake; a repeated measures design would yield more exact results. All schools utilized the Offer vs. Serve meal service option; thus, the content of children's meals varied. Additionally, side dish and beverage consumption were not measured, and their effect on entrée consumption is unknown.

Application to NSLP

Results of this study suggest that adding vegetable purée to main dish entrées has the potential to improve vegetable consumption and reduce energy intake among elementary school children who participate in the NSLP. Gender differences were insignificant while interactions among grade levels were evident. Vegetable intake is inadequate for a majority of children while less nutritious foods are over-consumed. Increasing the vegetable content of school lunch entrées could improve children's health and assist school nutrition programs in meeting vegetable and nutrient requirements and reducing plate waste. Further research is needed to evaluate the long-term effectiveness and benefits of this strategy.

This study provides evidence that incorporating vegetable purée into NSLP entrées is an approach to increase children's vegetable consumption at the meal while decreasing the number of calories consumed. Both effects can have a positive impact on children's health by fighting disease and aiding in weight control. The revised USDA guidelines for vegetable servings and variety are at odds with reported typical intake of elementary school children. A multi-faceted approach to change children's perception of vegetables and increase intake is needed to minimize waste from required vegetable service. Successful interventions to increase vegetable intake include nutrition education, hands-on experience via gardening and vegetable tastings, and making vegetables available as classroom snacks. School administrators can assist by scheduling lunch periods with adequate time for children to eat and by scheduling recess before lunch. School food service personnel can increase children's exposure to a variety of vegetables and preparation techniques, as well as guide them to make more healthful choices through verbal prompts and thoughtful lunchroom design. In conjunction with these techniques, puréed vegetables can be added to school lunch entrées to help students meet vegetable serving requirements, increase vegetable intake, decrease energy intake, and likely decrease waste.

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BIOGRAPHY

Vale is Assistant Foodservice Director at McLean County Unit 5 School District in Normal, Illinois. Schumacher, Cullen, and Gam are respectively, Assistant Professor/Dietetic Internship Director, Assistant Professor Emeritus, and Associate Professor all in the Department of Family and Consumer Sciences at Illinois State University in Normal, Illinois.