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Research report

Timing of serving dessert but not portion size affects young children's intake at lunchtime ☆

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ABSTRACT

The purpose of this repeated exposure, randomized, cross-over quasi-experimental study was to determine the individual and combined impact of (a) the timing of serving dessert and (b) portion size of main course in 2–5 year old children ($n = 23$) on energy intake at lunch in a childcare setting. Children were served two study lunches (fish or pasta, each with dessert) twice a week for 12 weeks that differed in the timing of dessert (served with or after the main course) and portion size of the main course (reference portion or 50% larger portion). Analyses of variance revealed that serving dessert after the meal resulted in higher energy intakes from both the main course and from dessert, and therefore greater total intake at the meal. Portion size of the main course did not influence total energy intake at the meal. Results indicate that the timing of serving dessert affects children's energy intake regardless of the portion size of the main course. Specifically, serving dessert with the meal reduces total energy intake regardless of the main course portion size. This suggests that offering dessert with the main course may be an effective strategy for decreasing total energy intake at meals in preschool-aged children.

Introduction

It has been established that American children 2–5 years of age consume excess amounts of solid fats and added sugars (SoFAS) (Ball, Benjamin, & Ward, 2008). Desserts are a standard part of Western cuisine and contribute to SoFAS in children's diets. In 2–18 year olds, grain desserts (cakes, cookies, donuts, pies, crisps, cobblers, and granola bars) are the top source of energy (138 kcal/day), the second major source of solid fats (43 kcal/day from solid fat), and the third major source of added sugars (40 kcal/day from added sugars) with dairy desserts being the fourth major source of added sugars (29 kcal/day from added sugars) (Reedy & Krebs-Smith, 2010). Within any given day, about 85% of children 2–3 years of age consume some type of sweetened beverage, dessert, sweet, or salty snack (Fox, Condon, Briefel, Reidy, & Deming, 2010). The question of how dessert influences children's total energy consumed at meals has not been adequately examined.

Between the ages of 2 and 5 years old food intake is correlated with food preferences, which are established by the age of four (Kuhl, Clifford, & Stark, 2012). Innately, young children prefer sweet tastes, which likely contributes to their preference for and intake of a wide variety of desserts (Kuhl et al., 2012). Children also readily form preferences for high fat foods, which are commonly served as dessert (Birch, 1992; Cooke & Wardle, 2005). Since these types of foods may have high reward properties to stimulate eating even in the absence of hunger, modifying the timing of serving dessert might be particularly powerful in preschool aged children who have demonstrated a strong preference for high-fat and high-sugar foods commonly served as dessert (Birch, 1992; Cooke & Wardle, 2005; Kuhl et al., 2012). To determine if modifying when dessert is served would have an impact on children's total energy consumed at meals, the portion size of the meal must be increased to determine if children will increase intake at a meal.

Secular trends reveal increases in the average portion size of foods consumed by children over time (Briefel & Johnson, 2004; Fisher & Kral, 2008). However, being exposed to ever-increasing portion sizes may have contributed to what is now perceived as age-appropriate portion sizes for children in schools (Howell Davies et al., 2008) as well as at home (Croker, Sweetman, & Cooke, 2009). Experimental evidence supports the idea that large portions promote excessive energy intake at meals. In single meal studies, researchers have shown that increasing the portion size of an entrée increased children's total energy intake at the meal by 13–39% (Fisher, 2007; Fisher, Arreola, Birch, & Rolls, 2007; Fisher, Liu, Birch,

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& Rolls, 2007; Fisher, Rolls, & Birch, 2003; Rolls, Engell, & Birch, 2000; Savage, Fisher, Marini, & Birch, 2012). Research has also shown that increases in portion size at a meal either increased total daily energy intake (Cecil et al., 2005; Fisher, Arreola, et al., 2007) or showed that children are able to self-regulate total daily energy intake throughout a given day (Lown et al., 2011). However, the influence of dessert being served with the main course on children's intake of the main course has been understudied to date.

This research systematically compared serving dessert with versus after the main course and evaluated whether the effects differed based on the portion size of the main course. To determine if the timing of serving dessert would alter a child's intake, the size of the large portion was anticipated to be sufficient enough to avoid experimentally induced restriction of intake (50% larger than reference portion) (Fisher, Liu, et al., 2007). We hypothesized that total energy intake would decrease if dessert were served with the main course. If a larger portion of the main course were served at lunchtime, then intake of the main course and total energy intake would increase (Fisher, 2007; Fisher, Arreola, et al., 2007; Fisher, Liu, et al., 2007; Fisher et al., 2003; Rolls et al., 2000; Savage et al., 2012) especially when dessert were served after the main course.

Methods

Participants

Participants were recruited through flyers that were given to parents of children attending the Ben and Maxine Miller Child Development Laboratory School, a childcare center for children at Purdue University (West Lafayette, Indiana). Eligibility was restricted to children between the ages of 2–5 years old who attended childcare for the full day. Exclusion criteria included the presence of food restrictions, food allergies, or digestive diseases, such as Crohn's Disease or Cystic Fibrosis. Twenty-three children (17 boys and 6 girls) from four different classrooms were consented into the study. Each parent provided information on his or her child's demographic background (see Table 1).

Design

A randomized, repeated exposure, crossover, quasi-experimental design study with three within-subject factors (meal, timing of serving dessert and portion size) was employed. Each participant in each classroom received each of the four treatments four times (8-week intervention × 2 days/week = 16 intervention days/4 treatments = 4 times). The researchers randomly assigned the classrooms to one of the four possible combinations of portion size and timing of dessert (reference portion, dessert with lunch; reference portion, dessert after lunch; large portion, dessert with lunch; or large portion, dessert after lunch) on each day. In one given day, the children in one classroom were undergoing the same treatment. For 12 weeks (4 week baseline and 8 week intervention), the children received fish on Thursdays and pasta on Fridays. Randomization was not conducted for all weeks of the study to assure that each classroom had equal amounts of repeated exposures. Mondays to Wednesdays remained as the regular 4-week menu rotation as these days and foods were not part of the study. The first 4 weeks of the study period acclimated children to the researchers and the activities involved in plate-waste measurement. Thus, data were based on weeks 5–12 of the study, which represented two 4-week menu rotations.

Table 1
Sociodemographic characteristics of total sample population of 2- to 5-year-olds ($n = 23$).

Sociodemographic variables	*n*	%
Sex (n = 23)		
Boys	17	73.9
Girls	6	26.1
Age[a](n = 23)		
2	6	26.1
3	7	30.4
4	5	21.7
5	5	21.7
Race (n = 23)		
Asian	7	30.4
Caucasian	13	56.5
Other	3	13.1

[a] No statistically significant associations were found between sex or race and age (Fisher exact test, $P > 0.25$ for both).

Experimental meals

The two lunches chosen were baked freshwater fish (Thursdays) and pasta (Fridays) based on lunches teachers observed to be most liked by the children, which foods parents knew to be liked and disliked by the children, and which foods foodservice staff could most easily increase the reference portion size by 50% (Tables 2 and 3 and Fig. 1). Although fish is not usually considered a meal preference by children, many children that attended the childcare center were of Asian descent and were accustomed to eating fish.

The study lunches were already part of the childcare's 4-week menu rotation. The study lunches were not served on non-study days during the experiment. The 4-week menu rotation was modified so the study lunches were served every week for the duration of the study (12 weeks). The reference portions of the childcare meals were based on the United States Department of Agriculture Food and Nutrition Service Child and Adult Care Food Program Child Meal Pattern for Lunch for 1–2 year olds and 3–5 year olds, respectively (Foland & Graves, 2008). The reference portions of

Table 2
Child meal pattern for "Fish Thursday" reference portion versus large portion.

Meal component	2 Years		3–5 Years	
	Reference	Large	Reference	Large
2% Milk[a]	½ Cup	½ Cup	¾ Cup	¾ Cup
Mixed vegetables	¼ Cup	⅓ Cup	½ Cup	¾ Cup
Orange	¼ Cup	⅓ Cup	½ Cup	¾ Cup
Rice	¼ Cup	⅓ Cup	¼ Cup	⅓ Cup
Fish	1 oz	1½ oz	1½ oz	2¼ oz
Chocolate chip cookie[a]	1 Cookie	1 Cookie	1 Cookie	1 Cookie
Total energy (kcal)	325	488	400	600

[a] 2% Milk and chocolate chip cookie were not increased by 50% for the larger portion size.

Table 3
Child meal pattern for "Pasta Friday" reference portion versus large portion.

Meal component	2 Years		3–5 Years	
	Reference	Large	Reference	Large
2% Milk[a]	½ Cup	½ Cup	¾ Cup	¾ Cup
Mixed vegetables	¼ Cup	⅓ Cup	½ Cup	¾ Cup
Mixed fruit	¼ Cup	⅓ Cup	½ Cup	¾ Cup
Pasta	¼ Cup	⅓ Cup	¼ Cup	⅓ Cup
Meat sauce	1 oz	1½ oz	1½ oz	2¼ oz
Chocolate chip cookie[a]	1 Cookie	1 Cookie	1 Cookie	1 Cookie
Total energy (kcal)	330	495	400	600

[a] 2% Milk and chocolate chip cookie were not increased by 50% for the larger portion size.

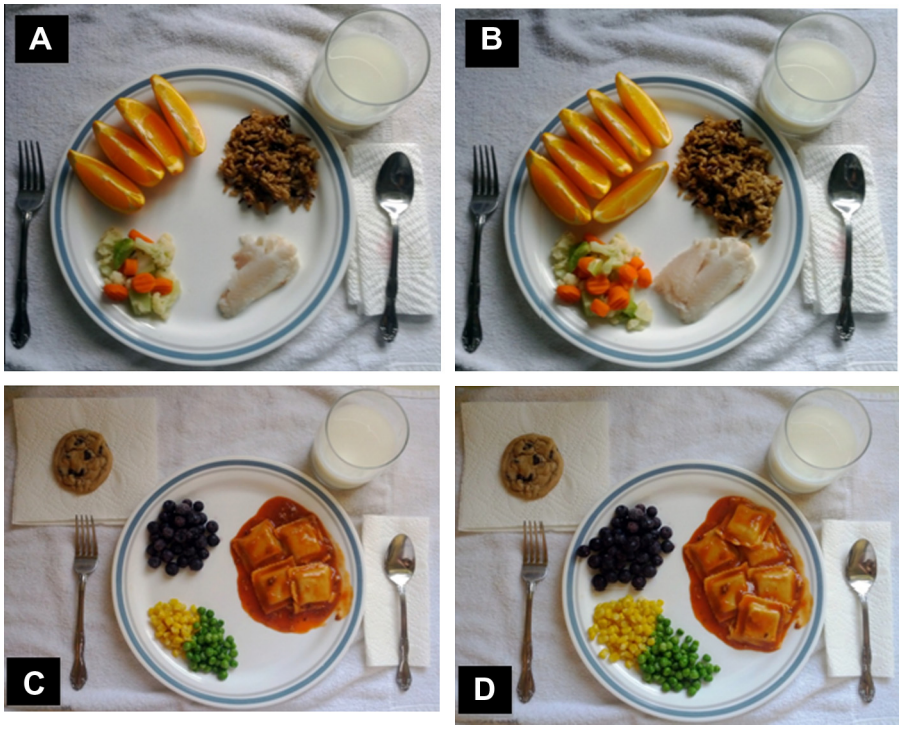

Fig. 1. Reference portion and 50% larger portion of two study lunch meals. Fish reference portion (A), fish 50% larger portion of main course items (B), pasta reference portion (C), pasta 50% larger portion of main course items (D).

the main course (vegetables, fruits, grains, and meat) were increased by 50% during half of the study occasions; however, the dessert portion (one chocolate chip cookie) and milk remained the same. The reference portion and 50% larger portion were visually similar on the plate (Fig. 1). Prior to choosing the meals to be increased in portion size, the researchers discussed with daycare staff and foodservice staff which foods would have the least visual change to the participating children. The researchers used the same sized plates for all meals. The dessert was served with the main course on an additional plate adjacent to the meal plate or immediately thereafter. The dessert plate was a Styrofoam plate 6″ in diameter. When dessert was served immediately after the main course, the main course was removed from the table, leaving the dessert as the only food item in front of each participant. Total energy provided in each reference condition was as follows: 325 kcal in the fish meal and 330 kcal in the pasta meal for 2 year olds and 400 kcal in the fish meal and 400 kcal in the pasta meal for 3–5 year olds (Tables 2 and 3).

Procedures

On each study day research assistants interviewed parents to collect the child's observed dietary intake (type of food, amount consumed, and time of intake) from that morning. Teachers in participating classrooms were instructed to follow standard mealtime procedures for mid-morning snack and lunch. In each classroom the participating children would sit at a table together and were served lunch by a research assistant. Children were not encouraged to eat more or less than usual and were instructed not to share food. The plate-waste method was used to measure children's consumption of mid-morning snack and lunch. Nutrition Data System for Research (NDSR) 2009 was used to convert intake in grams to energy for each food component and for the whole meal (kcal). The amount of snack consumed was categorized as missing snack intake data if the child was not at the childcare center, no snack intake if the child chose not to eat snack, small snack intake if the child ate less than 60 g, and moderate snack intake if the child ate more than 60 g. This study was approved by the Institutional Review Board of Purdue University.

Statistical analysis

All statistical analyses were conducted using the Statistical Analysis Software (version 9.2, 2008, SAS Institute Inc., Cary, NC). Main course consumption, dessert consumption, and total (main course plus dessert) consumption were analyzed using a mixed model analysis of variance that accounted for between-subject as well as within-subject variation. The between-subject factors were room (four levels), age (2–5 years), and the 4-week menu rotation (data was based on the second and third 4-week menu rotations, with the first 4-week menu rotation established as the baseline period). The within-subject factors were meal (fish and pasta), dessert (with or after the main course), and portion size (reference or large portion of the main course). Main effects and interactions of other factors were examined to verify that inclusion of such terms in the analytical model did not affect the assessment of the factors that addressed the research aims (Table 4). Snack intake was examined as an additional explanatory variable in the models. The average age differed by room (2-year olds in one classroom, 3-year olds in another, and two classrooms with 4- to 5-year olds, $P < 0.0001$), reflecting the policy of the school to assign students to classroom by age. Room and age were analyzed together and separately. Due to the high correlation between the two variables - as children are assigned into classrooms by age - the variable classroom was selected for use in the analysis as it accounted also for age (and vice versa, thus, classroom and age are proxy variables for each other). The classroom variable was used to determine main effects and interactions. The researchers excluded missing data from the data analysis. Statistical significance was defined as $P < 0.05$.

Table 4
Main effects and interactions included in the mixed model ANOVA.

Variables	Age/room	4-Week menu rotation	Meal (fish or pasta)	Portion size	Timing of dessert
Age/room	–	X	X	X	X
4-Week menu rotation	X	–	X	X	X
Meal (fish or pasta)	X	X	–	X	X
Portion size	X	X	X	–	X
Timing of dessert	X	X	X	X	–

X = Interaction accounted for in the analytical model.
– = Crossover of same variable.

Results

Complete intake data were obtained for 23 children. A total of 368 eating occasions of measured food intake data were collected. Means and standard deviations of energy intake at lunchtime are provided (see Table 5). Main course energy intake increased by 81% when the main course was pasta as compared to fish [87 versus 48 kcal), $P < 0.0001$]. Total lunchtime energy intake increased by 26% on days when pasta was served (173 versus 137 kcal, $P < 0.0001$). Serving dessert after the meal resulted in a 14% increase in energy intake from the main course (72 versus 63 kcal, $P < 0.04$), a 7% increase in intake from dessert (90 versus 84 kcal, $P = 0.05$), and a 9% increase in total intake at the meal (162 versus 148 kcal, $P < 0.01$) (Fig. 2). Portion size did not have a statistically significant effect on energy intake from the main course, dessert, or on total intake at the meal ($P > 0.05$). The timing of dessert increased energy intake both when dessert was served immediately after reference portions and 50% larger portions ($P < 0.05$).

Interactions were examined to verify that there were no effects that would have an impact on the conclusions drawn regarding the primary research questions of this study, the effects of timing of dessert and portion size. There was a statistically significant interaction of room with meal for main course consumption where differences between pasta and fish consumption (21, 25, 51, and 60 kcal, $P = 0.002$) corresponded approximately with the mean ages in the rooms. Several other statistically significant interactions were found but none were readily interpretable and none had an impact on the major conclusions of this study.

Snack intake had a statistically significant effect on main course intake but not dessert or total intake (66 kcal for missing snack intake, 59 kcal for no snack intake, 65 kcal for small snack intake, and 81 kcal for moderate snack intake, $P = 0.04$, no pairwise differences were statistically significant). No statistically significant effects of portion size, sex, or race were found.

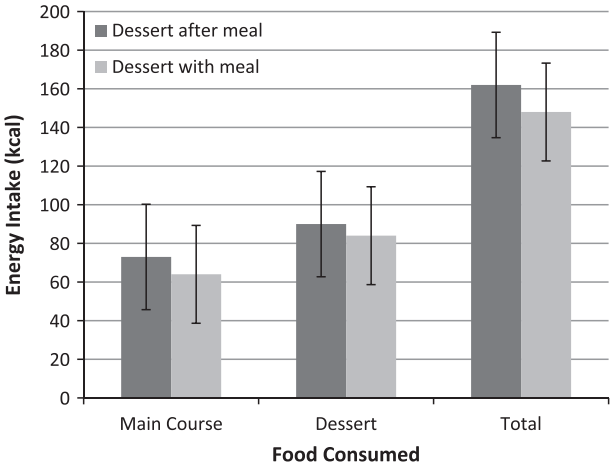

Fig. 2. Comparison of average energy intake (kcal) for main course, dessert, and total meal when dessert is served after the meal versus with the meal.

Discussion

The current results provide new evidence of decreased total energy intake at the meal when dessert is served with the main course, regardless of portion size. Children's intake increased by 14% for the main course, 7% for dessert, and 9% for total energy intake when dessert was served immediately after the main course. When portion size was increased by 50%, energy intake from the main course did not increase. When pasta was served, main course intake was increased by 81%, and total meal energy increased by 26% compared to when fish was served.

In the present study, children's intake decreased when dessert was served with the main course compared to when dessert was served immediately after the main course. By serving dessert alongside the main course, children reached the point of satiation (food intake was used as a proxy for satiation, not a true measure) sooner and chose to eat less overall. Since grain desserts (e.g. cookies) are a major source of children's energy intake and SoFAS intake (Reedy & Krebs-Smith, 2010), modifying dessert can prove to be an effective venue to reduce energy intake at meals when dessert is offered. Whether dessert was served with the main course or immediately thereafter, energy intake did not increase when serving larger portions of the main course. Together, these findings suggest that the timing of serving dessert, but not portion size, has a significant impact on children's intake.

Table 5
Comparison of children's energy intake of meal components by experimental conditions (reference versus large portions and dessert with the main course versus dessert following the main course) (mean + SD).

Meal	Fish				Pasta			
Portion size	Reference	Large	Reference	Large	Reference	Large	Reference	Large
Dessert	With main course		After main course		With main course		After main course	
Main course energy (kcal)[a]	47 ± 32	53 ± 36	62 ± 50	57 ± 34	94 ± 65	83 ± 68	91 ± 57	100 ± 57
Dessert energy (kcal)[b]	84 ± 38	85 ± 36	97 ± 25	88 ± 31	82 ± 37	85 ± 35	87 ± 31	87 ± 26
Total energy (kcal)[c]	131 ± 50	138 ± 44	159 ± 58	145 ± 40	176 ± 76	166 ± 78	172 ± 65	187 ± 67

[a] Meal ($P < 0.0001$) and dessert ($P < 0.04$) main effects are the only statistically significant effects.
[b] Dessert ($P < 0.05$) main effect is the only statistically significant effect.
[c] Meal ($P < 0.0001$) and dessert ($P < 0.008$) are the only statistically significant effects.

Serving larger portions of the main course (entrée, fruit, and vegetables) did not have statistically significant effects on children's intake of the main course, dessert or total energy intake at the meal. Our findings on portion size differ from recent studies that have shown increased portion size of a meal entrée increases children's total energy intake at the meal by 13–39% (Fisher, 2007; Fisher, Arreola, et al., 2007; Fisher, Liu, et al., 2007; Fisher et al., 2003; Rolls et al., 2000; Savage et al., 2012). Previous portion size studies increased the entrée alone (Fisher, 2007; Fisher, Arreola, et al., 2007; Fisher, Liu, et al., 2007; Rolls et al., 2000) or fruits and vegetables (Kral, Kabay, Roe, & Rolls, 2010; Savage et al., 2012; Spill, Birch, Roe, & Rolls, 2010, 2011), but did not increase all components of the main course. These studies evaluated the effects of portion size on daily energy intake (Fisher, Arreola, et al., 2007), energy density (Fisher, Liu, et al., 2007), and fruit and vegetable intake (Kral et al., 2010; Savage et al., 2012; Spill et al., 2010, 2011). In the present study, the effects of the timing of serving dessert on energy intake of a single meal were measured. In order for the timing of serving dessert to decrease energy intake at a meal, dessert should be served alongside the main course of the meal. Unlike previous findings, the present results imply that the timing of serving dessert had a greater impact on children's meal energy intake than portion size of the main course.

Although not hypothesized, we found that the pasta main course increased energy intake by 81% and total energy intake by 26% compared to the fish main course. The pasta entrée was chosen based upon previous portion size studies utilizing macaroni and cheese (Fisher, 2007; Fisher, Arreola, et al., 2007; Fisher, Liu, et al., 2007; Fisher et al., 2003; Rolls et al., 2000). Prior to the study, teachers and parents reported that the children liked the fish and pasta entrées, which were on the original menu, as were all other foods used in the study. Since fish intake is high among the Asian population (Park, Paik, Skinner, Spindler, & Park, 2004), and the majority of children enrolled at the daycare were of Asian descent, fish was chosen as one of the main course entrées to measure.

When assessing the dietary patterns of Korean adolescents, fish dishes such as kimchi, fish cake soup, and fish cutlets comprise the majority of meals whereas Korean–American adolescents consume a more typical American diet of milk, soda, hamburgers, etc. (Park et al., 2004). While some food intake patterns vary by country and culture, excessive intake of SoFAS is an issue not only for American children (as previously discussed) but also for Asian and Asian–American children. Cookies and sweets comprise 13% of Korean adolescent meals and 20% of Korean–American adolescent meals (Park et al., 2004). To examine this area, more research on the effects of larger portion sizes of other foods and the effects of ethnic diversity on preschooler's food consumption is needed.

The present study had several strengths and limitations. The strengths include, but are not limited to, the two-by-two crossover randomized control design with two within-subject factors, the serving of two very different food combinations as the main course, four-times repeated exposure to each study condition and the inclusion of children's morning snack food intake data and other important covariates in the data analyses. Changes in children's intake behavior in response to the small, no-cost modification of the timing of serving dessert has the potential to be of significance for children's health and well-being.

The main limitation was that all participants were from one childcare center. Therefore, results may not be applicable to children from other ethnic groups or other childcare centers. Out of sixty 2–5 year olds attending the childcare center full-time, only 23 volunteered to participate. Low recruitment may have been due to disallowance of recruiters to approach families (families must approach recruiters), a large number of studies being conducted at the childcare center at the same time and a high population of families whose primary language is not English. Due to the high correlation between the children's age and the classroom they were assigned to, we decided to use the classroom variable to account for both factors (to correct for the cluster effect and as proxy for age). In addition, for logistic reasons, not all four conditions were randomly assigned for each classroom in each week to assure that each classroom experienced a repeated exposure of the four conditions, which may have affected the results. Some participants missed a few days due to sickness or family vacation. Although variations were observed in the data from each meal, the fluctuations did not compromise the reliability of the study. Further, the power analysis showed that our sample was sufficiently large to test our hypothesis. Finally, randomization occurred at the group level, by classroom, rather than by child; thus, individual-level variations could not be captured.

Results indicate that the timing of dessert affects children's energy intake regardless of the portion size of the main course and that serving dessert with the meal reduces total energy intake at the meal. Future research on this topic should include larger and more diverse samples, a longer data collection period, and a larger variety of foods to determine if these findings can be generalized. If these findings can be generalized, recommendations for childcare centers should be updated to include offering dessert, when served, with the main course of a meal as this may decrease total energy intake at meals.

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Appendix A

See Tables A1–A4.

Table A1
Week 1 menu rotation.

	Monday	Tuesday	Wednesday	Thursday	Friday
Entrée	Chicken patty on whole wheat bun	Teriyaki chicken w/ rice	Mini pancakes/syrup, turkey sausage link	Baked freshwater fish w/wild rice pilaf	Pasta w/meat sauce
Veggie	Salad/celery/carrots	Steamed veggies	Celery/carrots	Zucchini	Celery/carrots
Fruit	Apples	Apples	Grapes	Orange smiles	Diced pears
Dairy	Milk, cottage cheese	Milk, cottage cheese	Milk, cottage cheese	Milk	Milk
Dessert				Cookie	Cookie
Theme	Sandwiches	International cuisine	Breakfast for lunch	Fish specials	Pasta

Table A2
Week 2 menu rotation.

Day	Monday	Tuesday	Wednesday	Thursday	Friday
Entrée	Sloppy Joe on whole wheat bun	Chicken salad wrap	French toast/syrup/turkey bacon	Baked freshwater fish w/wild rice pilaf	Pasta w/meat sauce
Veggie	Steamed peas/corn	Carrots/corn	Peas/corn	California blend steamed veggies	Steamed peas/corn
Fruit	Grapes	Grapes	Strawberries	Orange smiles	Blueberries
Dairy	Milk, cottage cheese	Milk	Milk, cottage cheese	Milk	Milk
Dessert				Cookie	Cookie
Theme	Sandwiches	International cuisine	Breakfast for lunch	Fish specials	Pasta

Table A3
Week 3 menu rotation.

Day	Monday	Tuesday	Wednesday	Thursday	Friday
Entrée	Cheeseburger	Bean burrito w/cheese	Waffles/syrup, turkey sausage	Baked freshwater fish w/wild rice pilaf	Pasta w/meat sauce
Veggie	Lettuce/pickle/tomato	Lettuce/tomatoes/olives	Tomato/cucumber	Zucchini	Celery/carrots
Fruit	Strawberries	Watermelon	Grapes	Orange smiles	Diced pears
Dairy	Milk, cottage cheese	Milk, cottage cheese	Milk, cottage cheese	Milk	Milk
Dessert				Cookie	Cookie
Theme	Sandwiches	International cuisine	Breakfast for lunch	Fish specials	Pasta

Table A4
Week 4 menu rotation.

Day	Monday	Tuesday	Wednesday	Thursday	Friday
Entrée	4 × 6 Tony's pizza	Chicken stir-fry w/rice	Egg/cheese on wheat bagel	Baked freshwater fish w/wild rice pilaf	Pasta w/meat sauce
Veggie	Carrots/peas	Stir-fry veggies	Salad/carrot/cucumber	California blend steamed veggies	Steamed peas/corn
Fruit	Strawberries & yogurt	Pineapple	Grapes	Orange smiles	Blueberries
Dairy	Milk	Milk	Milk, cottage cheese	Milk	Milk
Dessert				Cookie	Cookie
Theme	Sandwiches	International cuisine	Breakfast for lunch	Fish specials	Pasta