Can School Lunches Deliver Better Nutrition Without Sacrificing Palatability?

An Evaluation of Nutritional Adequacy of School Lunches in Urban Washington State

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Abstract

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Background: USDA's National School Lunch Program (NSLP) was established in 1946 to deliver balanced nutrition for children at risk for under-nutrition; however, in recent years these same meals have been associated with over-nutrition and increased risk for childhood obesity. Changes to federal meal standards made in 2013 stand to improve the overall quality and nutritional adequacy of school meals, yet significant gaps exist between federal meal standards and actual implementation across all levels of participating schools.

Objectives: The aims of this study are to 1) Review annual trends in nutritional adequacy, 2) Describe the relative contribution of six key nutrients to the nutritional quality of school lunches, 3) Describe which foods and food patterns are most closely associated with measures of nutritional adequacy, and 4) Provide a set of recommendations that school districts can use in planning meals, to ensure maximum nutrient density and optimal student health outcomes.

Methods: This study utilized data collected from six schools in an urban school district in Washington State, prior to the implementation of new federal meal regulations. School meal

recipe data, daily lunch counts and detailed nutritional data were analyzed using Microsoft Excel for Macintosh 2011 to assess nutrient composition and nutritional adequacy as compared to federal requirements.

Results: This district did not meet NSLP guidelines during the study period. Protein and calcium were served in adequate amounts, but most other key nutrients were lacking. Frequent provision of low nutrient density items are contributing to overall lower nutritional quality of district meals. Opportunity exists to improve the nutritional adequacy of daily lunches by altering the meal pattern in the areas of menu composition, menu choice and item frequency.

INTRODUCTION

The federally funded National School Lunch Program (NSLP) was initially established by the US Department of Agriculture (USDA) in 1946 to provide a source of balanced nutrition for children from families with limited financial resources and at risk for malnutrition in the form of under-nutrition [1]. Now, many are concerned that these school meals may contribute to malnutrition of a different form, namely over-nutrition, leading to childhood obesity [2-5], and several studies have identified a positive association between BMI or obesity risk and school lunch participation [4, 6-9]. With more than one-third of all American children ages 2-19 either overweight or obese [10], public health professionals, school administrators, parents and lawmakers are actively seeking strategies to restore the health of our children. Because the majority of overweight and obese children will be overweight or obese as adults [11], thus leading to increased risk of chronic disease and early mortality, a sense of urgency in confronting this problem is both necessary and appropriate [11, 12].

While there are many different points of view about the specific role schools should play in the childhood obesity crisis, it is clear that the school environment and school meals have an enormous impact on the health and nutritional intake of our nation's school children [3, 5, 10, 13]. In 2011, on a typical school day, about 31 million children, or over 60% of children enrolled in school in the US [14], ate a school provided lunch; this equates to over 5.2 billion total lunches served annually [1]. Of these 5 billion lunches, more than 66% were provided free or at reduced price to children from low-income families [15], who are at increased risk for obesity and/or nutritional deficiencies [16-20]. And, many children, especially those from families of low socioeconomic status, depend on school meal programs for up to half of their daily calories [21]. Thus, the extensive reach of the NSLP makes it an important target in the effort to improve

children's diets and overall health.

Until recently, however, the nutritional content of school meals has not been in-line with the dietary needs of the majority of the nation's children. In the past, meals contained too many calories, and were high in fat, sodium and refined grains [22]. At the same time, the intakes of many school-aged children are typically inadequate for a variety of other important nutrients, including vitamins A, C and E; fiber; iron; potassium and calcium [5], leaving a clear role for school meals in improving nutritional adequacy.

In 2009, the Institute of Medicine (IOM) delivered a set of recommendations to the USDA for school meals that align with the Dietary Guidelines for Americans, in an effort to ensure healthy meals that provide age-appropriate levels of nutrients and calories [23]. In 2010, the White House Task Force on Childhood Obesity identified the provision of healthy food in schools as one of four priority areas in a report entitled *Solving the Problem of Childhood Obesity within a Generation,* and the Healthy, Hunger-Free Kids Act (HHFA) was passed, setting the stage for national attention on school meals [24, 25]. The HHFA directed the USDA to update NSLP's meal pattern and nutrition standards based on the latest Dietary Guidelines for Americans (2010) and the IOM recommendations. In 2011, USDA announced a new set of standards, which include age-appropriate calorie ranges, limits on sodium and saturated and trans fats, and increased servings of fruits, vegetables and whole grains in the NSLP meal pattern [1, 26]. The new meal standards will be implemented over several years. The first set of standards went into effect during the 2012-13 school year, and slight modifications to the standards were issued in late 2012.

While the new regulations are significantly changed from the previous meal patterns (Table 1), studies have shown that even the prior regulations were not consistently met [15, 27]. The third School Nutrition Dietary Assessment Study (SNDA-III) analyzed the energy and nutrient content of school meals available in US public schools between 2004-2005 and found that less than 6% of all schools met the federal meal standards [22]. Other SNDA-III findings included major gaps in meeting the requirements for vitamins, minerals and fiber, while exceeding the requirements in sodium, fat, saturated fat and energy [5]. As a result, meeting the new federal meal standards and ensuring nutritional adequacy for school-age children may be a challenge for many school districts.

The aims of this study are to: 1) review annual trends in nutritional adequacy in school lunches, 2) describe the relative contributions of six key nutrients to the nutritional quality of school lunches served to middle and high school students, 3) describe which foods and food patterns are most closely associated with measures of nutritional adequacy, and 4) provide a set of recommendations that school districts can use in planning meals, to ensure maximum nutrient density and optimal student health outcomes.

Although the USDA and related organizations provide significant training and resources for school districts and food service directors to update their food procurement practices and meal patterns to meet the new standards [28], many challenges remain. The purpose of this study is to provide insight into how previous patterns contributed to, or fell short of, nutritional adequacy.

A variety of methods can be utilized to assess nutritional adequacy of school meals and/or compare them to regulations, including comprehensive analysis of nutrition data using

nutrient analysis software, analysis of food-based menus (that evaluate numbers and types of food groups served), and composite indices, such as the mean adequacy ratio (MAR), that analyze a subset of nutrients or nutritional characteristics to provide a measure of nutritional quality. This study used MAR [29-31] to provide the basis for analysis of nutritional adequacy or quality of schools meals.

Table 1. Comparison of Previous and Current NSLP Meal Standards

NATIONAL SCHOOL LUNCH PROGRAM MEAL PATTERN		
	Previous Meal Standards (1995)	**Current Meal Standards (2012)**
Age/Grade Groups	K-8, 9-12	K-5, 6-8, 9-12
Menu Planning Protocols	Nutrient-based planning	Food-based planning
Fruit/Vegetable Servings	Interchangeable. ½ - ¾ cup fruits and vegetables combined per day.	2 separate meal components. ¾ - 1 cup of vegetables, plus ½ - 1 cup fruit per day.
Fruit Requirements	Not required	Required. No more than half of offerings may be juice. 100% juice only.
Vegetables	No weekly minimums for sub-groups.	Weekly minimums required for dark green, red/orange, beans/peas, starchy and other vegetables. Weekly total must be a minimum of 5 cups.
Grains	8 servings per week (minimum of 1 daily serving). No daily maximum. No whole grain requirement.	Daily and weekly minimum and weekly ranges (no maximum). By 2013-14, at least half of offerings must be whole grain-rich. By 2014-15, all offerings must be whole grain-rich.
Meat/ Meal Alternatives	Limited flexibility with meat alternatives.	Daily and weekly minimum, no maximum. Variety of alternates encouraged. Tofu and soy yogurt allowed as meat alternates.
Fluid Milk	1 cup daily. Variety of fat contents allowed; flavor not restricted.	1 cup daily. Must be fat-free (flavored/unflavored) or 1% low fat (unflavored). Fat-free or low fat for lactose-reduced or lactose-free.
Sodium	No set targets.	Targeted for phased reduction: target I: 2014-15, target II: 2017-18, final target: 2022-23.
Calories	Minimum requirements only.	Minimum and maximum targets specified by age group.
Saturated Fat	< 10% of total calories	No change.
Trans Fat	No limit.	Zero grams per serving (based on nutrition labels).

Table adapted from USDA Food and Nutrition Service, Nutrition Standards for Schools, http://www.fns.usda.gov/cnd/governance/legislation/comparison.pdf

METHODS

Study Design

This is a descriptive, cross-sectional study, using secondary data collected from research conducted by the University of Washington's Center for Public Health Nutrition (CPHN) and secondary schools in an urban school district in Washington State. The institutional review board of the University of Washington approved the study. The goals of the original project were to encourage healthy eating behavior among students by educating them about healthier food choices through a student-led media campaign and through labeling healthier choices using a variety of digital menu boards and point of purchase signage vehicles. The original CPHN-school district project spanned from August 2010 to mid-March 2012. Data used for the present study was collected from six schools (three middle and three high schools) in the district from January through December 2011. The study period represented 177 days of school lunches served, during the 2011-2012 school year.

Data Collection

Food Production Records: The Food Service Manager for each school provided daily production records for school lunch items served over the study period. Production records provided information about quantities of items served, including entrees, side dishes and milk. Total counts of daily lunch participation (number of servings taken) were also recorded on the production records. Finally, production records also provided details on a la carte items that were sold in the a la carte lines in the cafeterias.

Nutrition Information for School Lunch and A la Carte Items: Nutritional information for all items served as part of the school lunch program was provided by a consultant to the school

district, using NutriKids® nutrition analysis software. A combination of product labels and comparable items located in Food Processor SQL version 10.9.0 (ESHA Research), nutrition analysis software database, were used for a la carte items and any missing school lunch items.

Measures

Nutritional Quality: The nutritional quality of student food choices for school lunch was quantified using the mean adequacy ratio (MAR). The MAR was calculated (Figure 1) based on six nutrients that were included in the school food analyses provided by the consultant: protein, total fiber, calcium, iron, vitamin A, and vitamin C, as these nutrients are of particular importance for school-aged students. The MAR was computed as the average of percent daily value (DV) per month for the six nutrients in 1000 kcal of energy. For this age group the DV, as determined for the Food and Drug Administration (FDA), for each nutrient was as follows: protein, 50 g; vitamin C, 60 mg; vitamin A, 5000 IU; calcium, 1000 mg; iron, 18 mg; and dietary fiber, 25 g. Student meal choices on days that met or exceeded the recommended levels for these six nutrients would have a MAR of 100 percent or more. In the original study, MAR values ranged from 46 to 67 percent, as is shown in the Figure 2 below, highlighting significant room for improvement.

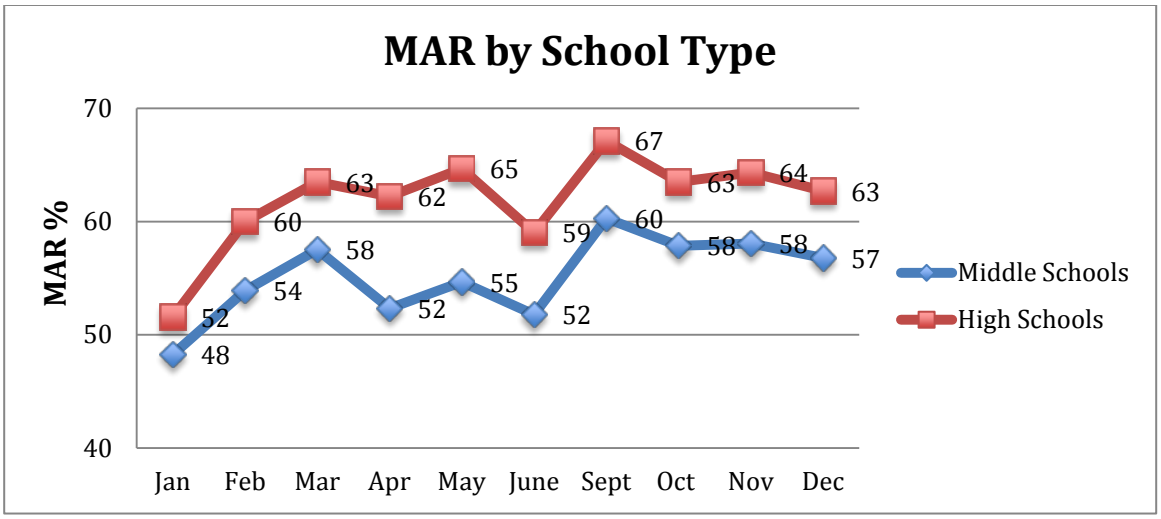


Figure 2: Monthly MAR percentage provided by Renton School District school lunches during 2011. *Data provided by CPHN, 2012.*

Analyses

Analyses were conducted using Microsoft Excel for Macintosh 2011. Daily production and nutritional data were combined and aggregated by school type, and a variety of analyses were completed. Analysis of the percentage of total DV contributed by each individual MAR nutrient was calculated by summing the total milligrams, grams or IU of each individual nutrient provided, dividing that by the total number of meals served, and then dividing by the FDA DV figure for that nutrient. The results of this analysis identified which nutrients are provided by school lunches in high amounts over the course of the school year, contributing significantly to higher MAR, and which are delivered in low or insufficient quantities. This analysis can be found in Figure 3 below.

Next, aggregate nutritional data were sorted, from highest to lowest content by nutrient for each meal item served. This led to development of a list of the top five meal items for each of the six MAR nutrients, ranked by nutrient content. This list was subsequently analyzed and re-sorted according to dosage (frequency of each meal item times the nutrient content of that item)

and “popularity,” in order to evaluate patterns or trends. The popularity ranking was developed by dividing the total annual number of servings for any individual meal item by the number of times it was served over the year, and represents the number of servings purchased per meal item per serving instance. This allows a standardized measure for comparison between meal items served very frequently with those served infrequently. The average popularity ranking for the top five food items in a particular nutrient category was then calculated to compare individual item popularity to the average popularity of the category (data not shown). Additionally, using the methods for establishing the popularity ranking above, a baseline popularity ranking was developed for pizza—one of the most frequently served and most popular items—for comparison purposes with other food items, to evaluate the degree of individual item popularity. Popularity comparisons within and among nutrient categories were performed, as well as comparisons between middle and high school data. Finally, counts of total menu items were completed, in order to evaluate the potential effects of choice and menu variety on nutritional adequacy. This analysis is presented in Table 4 below.

RESULTS

To meet federal requirements, the average school meal, analyzed weekly, must contain no more than 10 percent of calories from saturated fat and provide one-third of the Dietary Reference Intakes (DRIs) for calories, protein, vitamin A, vitamin C, iron and calcium [32] It is important to note that the DRIs are age-, weight- and gender-specific, which would necessitate multiple levels of nutritional and calorie requirements to include all school-age children. Instead, three different levels of energy and nutrient requirements have been outlined in the new USDA school lunch guidelines, to meet the needs of children in those age groups (Table 1). For this study, DV (used in nutrition labeling as a composite of DRI and Daily Reference Values) is used

as a general guideline for school-age children's nutrient requirements, in order to provide a single baseline nutritional comparison. Table 2 below provides a comparison of DV to DRI.

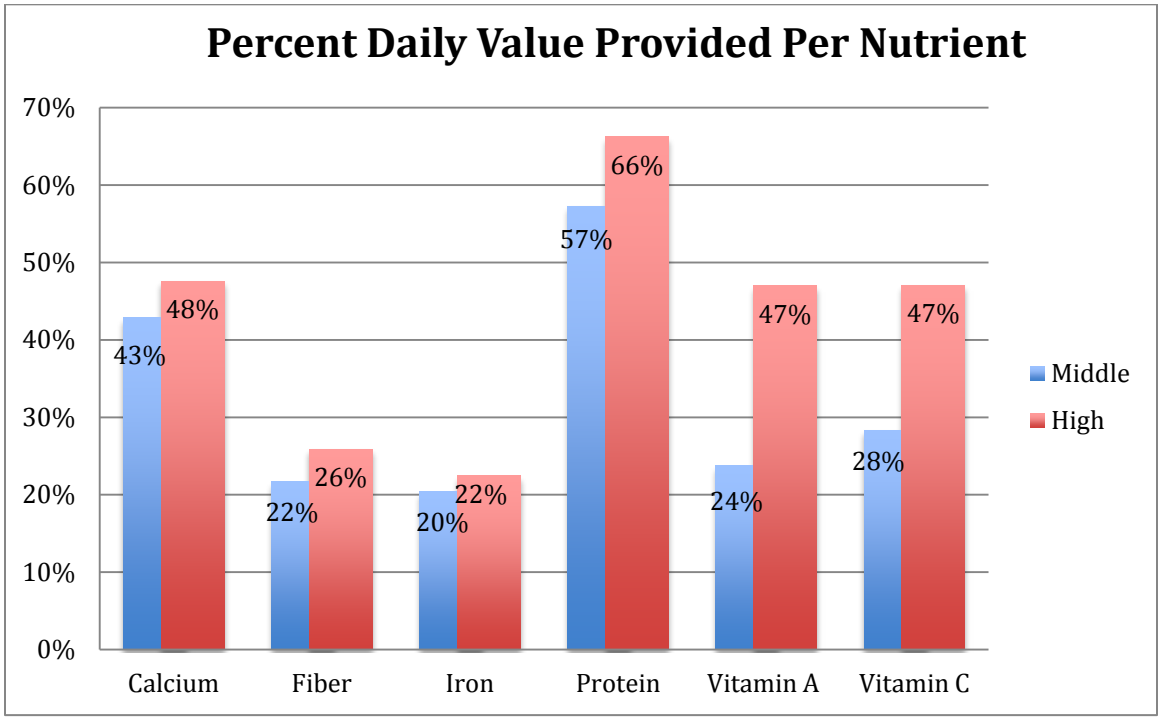
Table 2. Comparison of DRI versus Daily Value

	Protein grams	**Fiber grams**	**Vitamin A IU, mcg**	**Vitamin C mg**	**Iron mg**	**Calcium mg**	**Saturated Fat grams**	**Sodium mg**
DV	50	25	5,000 IU	60	18	1000	20	2400
DRI Ages 9-13	.76 g/kg/day (M/F)	31 (M) 26 (F)	445mcg/d(M) 420mcg/d(F)	39 (M/F)	5.9 (M) 5.7 (F)	1100 (M/F)	N/A	1500 (M/F)
DRI Ages 14-18	.73 g/kg/day (M) .71 g/kg/d (F)	38 (M) 26 (F)	630mcg/d(M) 485mcg/d(F)	63 (M) 56 (F)	7.7 (M) 7.9 (F)	1100 (M/F)	N/A	1500 (M/F)

M= male, F = female. *Table adapted from* *http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm064928.htm* and *http://www.iom.edu/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity%20Files/Nutrition/DRIs/5_Summary%20Table%20Tables%201-4.pdf*

For our analysis, school meals supplying more than a third of the DV for the six MAR nutrients would be considered adequate. Those contributing less than one-third of DV would be considered lacking or inadequate. Our investigation found that protein, calcium, and vitamins A and C were provided by RSD meals in adequate quantities over the course of the year, representing nearly half or more than half of the Daily Value recommended for high school students. However, fiber and iron were provided in relatively low amounts in these same schools, delivering just 22 and 20 percent of the DV respectively on an annual basis. Middle school meals present a different picture, delivering less of the DV for all six nutrients measured. Protein and calcium were again the leading nutrients, providing 57 and 43 percent of the DV respectively, but fiber, iron, and vitamins A and C all delivered less than the recommended one-third of the DV.

Figure 3. Percentage of Daily Value provided per MAR nutrient, annualized.



Sorting all meal items by nutrient content for each of the six MAR nutrients, from highest to lowest, we see that several menu items provide significant amounts of more than one of the MAR nutrients. Comparing the top five nutrient-providing foods for each individual MAR nutrient for middle school versus high school meals, we see a nearly identical hierarchy of menu items, with very minor variation; the latter likely due to reduced menu options available in the middle school meal pattern. The percent of DV provided by specific menu items varied widely by nutrient, ranging from 34 percent to 258 percent for high school meal items, and from 30 percent to 167 percent for middle school. Calculating and stratifying meal items by dosage, very little change in hierarchy occurs for any individual menu item; as a result, only the data sorted by nutrient content is presented in Tables 3 and 4. The availability or frequency of each of these "top 5" items varied widely, from as little as two serving instances to nearly 300. The popularity of menu items was also widely varied, ranging from 11 purchased items per serving instance to

nearly 300. Looking only at entrée items, the popularity rating ranged from 8 to 227. For high schools, the five most popular and nutrient-dense entrée items across the six MAR nutrient categories were burrito grande, ravioli and Texas toast, mandarin orange chicken with egg roll, mandarin orange chicken and chicken lo mein. In the middle schools, the top five most popular and nutrient-dense entrée items across the six MAR nutrient categories were the cheese and jalapeño corn dog, chicken lo mein, chicken lo mein with egg roll, spaghetti with meat sauce and macaroni and cheese. For a benchmark comparison, the high school popularity rating for pizza is 119 and 128 for middle schools. In relation to this measure, as is shown in Tables 3 and 4, many of the top nutrient-dense foods are relatively low in popularity as compared to other student favorites.

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Table 3: Top 5 Meal Items, Sorted by Nutrient Content (High School)

Nutrient	Menu Item	Nutrient Content	% Daily Value	Popularity	Total Annual Servings	Frequency	Dosage
Calcium (mg)	1. Grilled Cheese Sandwich and Tomato Soup	484	48%	44	400	9	193,412
	2. Grilled Cheese Sandwich	482	48%	85	683	8	329,479
	3. Texas Cheese Toast	450	45%	32	191	6	85,950
	4. Macaroni & Cheese	436	44%	129	515	4	224,550
	5. Spicy Grilled Cheese Sandwich	431	43%	108	216	2	93,156
Protein (g)	1. Chicken Lo Mein with Egg Roll	38	77%	138	1383	10	52,941
	2. Ravioli & Texas Toast	37	75%	152	3,200	21	119,232
	3. Spaghetti with Meat Sauce	35	70%	147	1619	11	56,260
	4. Macaroni & Cheese	35	70%	129	515	4	18,030
	5. Chili with Cheese Stick	32	65%	53	370	7	11,933
Vitamin C (mg)	1. Oranges	78	130%	113	4181	37	326,118
	2. Kiwi	64	107%	291	16,320	56	1,044,480
	3. Broccoli Florets	53	88%	34	2112	63	111,936
	4. Southwest Chicken Salad	49	82%	32	194	6	9,506
	5. Spaghetti with Meat Sauce	43	72%	147	1619	11	69,617
Vitamin A (IU)	1. Baby Carrots	8338	167%	107	7800	73	65,036,400
	2. Taco Salad with Dressing	7594	152%	28	220	8	1,670,680
	3. Buffalo Chicken Salad	7135	143%	25	149	6	1,063,115
	4. Chicken Caesar Salad	6703	134%	33	1725	52	11,562,675
	5. Baby carrots, fresh	6670	133%	200	600	3	4,002,000
Iron (mg)	1. Chicken Lo Mein with Egg Roll	16	89%	138	1383	10	22,128
	4. Chicken Lo Mein	13	72%	160	160	1	2,080
	3. Cheese & Jalapeno Corn Dog	10	56%	227	454	2	4,540
	2. Spaghetti with Meat Sauce	7	39%	147	1619	11	11,333
	5. Sloppy Joe	6	33%	11	11	1	66
Fiber (g)	1. Burrito Grande	13	52%	118	473	4	6,149
	2. Corn Dog	10	40%	153	16,110	105	161,100
	3. Fiesta Bean Burrito	9	36%	88	12,886	146	115,974
	4. Ravioli & Texas Toast	9	36%	152	3200	21	28,800
	5. Southwest Chicken Salad	8	30%	32	194	6	1,455

Table 4: Top 5 Meal Items, Sorted by Nutrient Content (Middle School)

Nutrient	Menu Item	Nutrient Content	% Daily Value	Popularity	Total Annual Servings	Frequency	Dosage
	1. Grilled Cheese Sandwich and Tomato Soup	484	48%	44	400	9	193,412
	2. Grilled Cheese Sandwich	482	48%	85	683	8	329,479
Calcium (mg)	3. Texas Cheese Toast	450	45%	32	191	6	85,950
	4. Macaroni & Cheese	436	44%	129	515	4	224,550
	5. Spicy Grilled Cheese Sandwich	431	43%	108	216	2	93,156
	1. Chicken Lo Mein with Egg Roll	38	77%	138	1383	10	52,941
	2. Ravioli & Texas Toast	37	75%	152	3200	21	119,232
Protein (g)	3. Spaghetti with Meat Sauce	35	70%	147	1619	11	56,260
	4. Macaroni & Cheese	35	70%	129	515	4	18,030
	5. Chili with Cheese Stick	32	65%	53	370	7	11,933
	1. Oranges	78	130%	113	4181	37	326,118
	2. Kiwi	64	107%	291	16,320	56	1,044,480
Vitamin C (mg)	3. Broccoli Florets	53	88%	34	2112	63	111,936
	4. Southwest Chicken Salad	49	82%	32	194	6	9,506
	5. Spaghetti with Meat Sauce	43	72%	147	1619	11	69,617
	1. Baby Carrots	8338	167%	107	7800	73	65,036,400
	2. Taco Salad with Dressing	7594	152%	28	220	8	1,670,680
Vitamin A (IU)	3. Buffalo Chicken Salad	7135	143%	25	149	6	1,063,115
	4. Chicken Caesar Salad	6703	134%	33	1725	52	11,562,675
	5. Baby carrots, fresh	6670	133%	200	600	3	4,002,000
	1. Chicken Lo Mein with Egg Roll	16	89%	138	1383	10	22,128
	4. Chicken Lo Mein	13	72%	160	160	1	2,080
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	4. Ravioli & Texas Toast	9	36%	152	3200	21	28,800
	5. Southwest Chicken Salad	8	30%	32	194	6	1,455

*Notes for Tables 3 and 4 on the following page.

*Notes for Tables 3 and 4:

- 177 days of meals served
- Frequency = Total number of times item served
- 3 Schools Represented
- Nutrient Content and % Daily Value = per serving
- Popularity = Number of items purchased per serving instance
- Dosage = Total annual amount of nutrient provided

Comparing menu choices between middle and high schools, middle schools offered more unique menu items during the school year, though fewer total daily food choices. In the middle schools, 133 different individual menu items were served during the year, whereas just 117 items were available via the standard lunch program in the high schools. However, in the case of the latter, many of these items were offered almost daily. Comparing total instances of food items served, over the 177 days of data collection, 5463 individual food records were collected from middle school meals served, whereas 7315 records represented the total number of food items and serving instances for high schools during the same period, again reflecting the greater choice and selection of meal items offered in high schools.

Consolidating similar menu items into categories (Table 5), the ten most frequently served menu items in middle schools were chocolate and white milk, French fries, pizza, salad, chicken nuggets or tenders, hamburgers, burritos, apples and celery. A slightly different ranking resulted from categorization of most frequently served items for high schools: hoagies, chicken burgers, white milk and chocolate milk, French fries, pizza, entrée salads, burgers, chicken nuggets and burritos were the top offerings. With the exception of the entrée salads, the most frequently served items are not included in the top five nutrient-dense items for any of the six MAR nutrients.

Table 5. Most Frequently Served Food Items, Categorized by Like-foods.

High School			Middle School		
Food Item	Number Times Served	Average Servings Per School	Food Item	Number Times Served	Average Servings Per School
Hoagie - all	601	200.3	Chocolate Milk	532	177.3
Chicken Burger - all	547	182.3	1% White Milk	530	176.7
Chocolate Milk	531	177.0	Fries or Taters - all	504	168.0
1% White Milk	531	177.0	Pizza - all	404	134.7
Fries or Taters - all	528	176.0	Salad mix - all	206	68.7
Pizza - all	527	175.7	Chicken Nuggets - all	192	64.0
Entrée Salad - all	526	175.3	Hamburger - all	163	54.3
Hamburger - all	422	140.7	Burrito - all	162	54.0
Chicken Nuggets - all	382	127.3	Apples, fresh - all	158	52.7
Burrito - all	339	113.0	Celery Sticks	100	33.3

Schools represented per school type = 3

DISCUSSION

Based on analysis of the data, the current Renton School District meal pattern did not consistently meet the recommended nutrition requirements (DV) for either high school or middle school students during 2011, and the frequent provision of less-healthy options like pizza, burgers and fries may be contributing to lower nutritional quality of student lunches. Certain nutrients were provided in adequate quantities, such as protein and calcium, however most of the measured nutrients, previously noted to be important for children's growth and largely inadequate in American children's diets, were delivered in inadequate quantities during the course of the school year. And, the nutrients that were delivered in relatively low amounts are also the nutrients that IOM and USDA have identified as critical to increase via the new federal meal standards. Thus, the results of this study reinforce the need for these new standards, and highlight the importance of improving nutritional content in school meals, not just for regulations' sake, but for the health of our children.

This school district has significant opportunities to improve nutritional adequacy of daily lunches by altering its meal pattern, including menu composition, frequency of items served, and number of menu choices provided. In considering specific changes, it will be important to take into account nutritional profile, frequency, and overall popularity of individual menu items, in order to identify appropriate menu substitutions or changes for a new pattern. For example, a popular item, high in nutritional adequacy but served infrequently, may be a good target for increased frequency, while a nutrient dense item that is low in popularity would require additional analysis before altering its serving frequency.

Any recommendations to improve nutritional adequacy of the school lunch program must take into account federal regulations, costs, preparation time, and availability of key resources, such as personnel and appropriate facilities, the latter of which are often limited. Thus, recommendations provided here focus on altering meal patterns using existing menu items, rather than on the development and introduction of new items, which can be costly and time-consuming and may require additional regulatory oversight. Strategies that may allow schools to increase nutritional adequacy without requiring the development or introduction of new menu items may include: increasing the frequency of certain meal items while decreasing the frequency of others, replacing specific meal items with other available menu items, increasing menu choice within the existing menu pattern and production capacity of the district, and/or developing or altering marketing strategies in order to increase distribution and consumption of items high in nutritional quality. Tables 5 and 6 provide a detailed list of recommendations, based on the data analyzed from RSD, for improving nutritional quality while largely retaining its existing inventory of menu items.

Table 6. Recommendations for Altering the Menu Pattern To Increase Nutritional Adequacy (High School)

HIGH SCHOOL	
MAR Nutrient	**Recommended Changes to Current Meal Pattern**
Calcium	• Increase the serving frequency of Texas Toast as it has a high calcium content (second only to milk) and a relatively high popularity rating (45 vs. the category average of 44), but was served only twice during the year.
Fiber	• The Burrito Grande is very high in fiber and popularity, with a popularity rating of 80 and delivering 52% of the DV for fiber, but was served only twice. This is an item that should be served more frequently. • Ravioli and Texas Toast is also high in fiber and popularity, but served infrequently. Given that this item is high in both calcium and fiber, increasing the frequency is recommended. • The Fiesta Bean Burrito was served 293 times and is third highest in fiber content, however it has a relatively low popularity rating of 11. Given the Burrito Grande's popularity, replacing the Fiesta Bean Burrito with the Burrito Grande is recommended to increase fiber intake and palatability.
Iron	• Chicken Lo Mein is a popular dish high that is high in iron, providing 89% of the DV per serving. With a popularity rating of 60, but served just 17 times (or 5.7 serving instances per school), an increase in the serving frequency of this dish can help increase student intake of this important nutrient. • The Corn Dog with Jalapeño is an item high in iron, but low in popularity. Replacing this item with another popular menu item high in iron, such as spaghetti with meat sauce or fried rice with egg roll, is recommended to increase iron intake.
Protein	• Maintain the top 5 items highest in protein on a similar frequency rotation to current. The average popularity of these top 5 items was 68 servings per instance. Additionally, these top 5 items provided an average of 74% of the DV for protein per item, which is important nutritionally.
Vitamin C	• Kiwis are high in vitamin C, but not very popular (rating of 8 versus an average of 71 in this nutrient category). To improve popularity, RSD may want to increase the frequency of serving and/or conduct taste tests and other marketing activities to help increase popularity of this nutrient-rich food. • Spinach Salad and Mandarin Chicken are also high in vitamin C and popularity, but not served frequently. Increasing the frequency of these items can serve to increase overall vitamin C intake, without sacrificing taste or palatability of meals.
Vitamin A	• Baby carrots are extremely popular and provide the second highest overall vitamin A content of any menu item. Offering these popular, nutrient-dense and easy-to-eat items daily may provide a simple way to increase vitamin A intake. • Taco salad with dressing, another item high in vitamin A, providing 152% of the DV, is a popular item that was served infrequently (5 times). Increasing the serving frequency of this item to a minimum of monthly is recommended.
General Recommendations	• To increase overall nutritional adequacy without adversely affecting student choice or menu palatability, RSD may want to consider reducing the frequency of less nutrient-dense items such as pizza, burgers or fries and replacing them with popular, more nutrient-dense items like those listed above. • Recipe modifications to popular and/or frequently served items that are low in nutrient density may also be an important step to improving overall nutritional quality of meals.

Table 7. Recommendations for Altering the Menu Pattern To Increase Nutritional Adequacy (Middle School)

MIDDLE SCHOOL	
MAR Nutrient	**Recommended Changes to Current Meal Pattern**
Calcium	• Macaroni & Cheese has a very high popularity rating (even higher than pizza) and provides 44% of the DV for calcium. However, it was served just 4 times in the 3 middle schools, making it a good target for increased frequency while increasing the availability of this key nutrient. • The grilled cheese sandwich is also extremely popular and represents the second highest meal item in total calcium content, but was served just 8 times. Increasing the serving frequency of this item is also recommended.
Fiber	• Burrito Grande's popularity rating of 118 nearly matches that of pizza, and its fiber content is the highest of any food item served in RSD middle schools, however it was served just 4 times. Increasing the frequency of this item is recommended. • The Corn Dog is another popular, high fiber item. It was served 105 times over the year. Maintaining this frequency can help ensure adequate fiber intake for children in this age group. • The Southwest Chicken Salad had both a low popularity rating and low frequency, however its fiber content puts it in the top 5 meal items for fiber. Conducting taste tests of this item may increase popularity and allow for increased frequency as well.
Iron	• Chicken Lo Mein's popularity surpasses that of pizza, at 160, along with the second highest iron content for a menu item. However, it was served just 1 time during the year. Increasing the frequency of this item is recommended, as iron is a nutrient consumed in inadequate quantities among school-aged children. • Other items recommended for increased frequency in this category, based on popularity and nutrient content include Chicken Lo Mein with Egg Roll and the Cheese & Jalapeno Corn Dog.
Protein	• Chicken Lo Mein with Egg Roll is at the top of this category, supplying 38 grams of protein per serving. Given this item's high content of both protein and iron (see above), an increased frequency will be important to improving nutritional adequacy. • The other items high in protein, including Ravioli & Texas Toast, Spaghetti with Meat Sauce (which is also high in iron), and Macaroni & Cheese, are also extremely popular. Maintaining or slightly increasing their existing frequency is recommended.
Vitamin C	• Oranges are both extremely popular and high in vitamin C. Increasing the frequency of this item is recommended, perhaps a daily offering. • Unlike with high school students, the kiwi is extremely popular in this age group. With the second highest vitamin C content, this item can easily be increased in frequency from its current 56 annual servings to something much more frequent. • The Southwest Chicken Salad is fourth highest in vitamin C and fifth highest in fiber, making it a nutrient dense item. However, it is served infrequently and purchased minimally. Increasing the popularity of this item should be a priority, along with increased frequency.
Vitamin A	• Baby carrots are the top item supplying 167% of the DV per serving, and featuring a popularity rating of 107. This item should be increased in frequency from its current 73 annual servings to a much more frequent menu rotation. • Entrée salads, including the Taco Salad, Buffalo Chicken Salad and Chicken Caesar Salad round out the top 5, but were served relatively infrequently and receiving minimal to moderate student interest. An effort to improve the taste and/or popularity of these salads should be a priority.
General Recommendations	• Entrée salads can provide a wide variety of nutrients, along with good taste. Increasing the frequency of such items can serve to improve overall nutritional adequacy and deliver significant nutrient density in one single dish. • Similar to the recommendations for high schools above, decreasing frequency of less nutrient dense items and substituting them for items from the top five lists provided here can serve to increase nutritional adequacy without incurring significant costs or labor.

Strengths and Limitations

The study has several important limitations. First, the data collected are for students' menu choices and not actual consumption. However, it's important to note that choice is typically the overriding influence on consumption [33]. And, previous studies have noted that even when meals meet USDA standards, students consume far less than the required level of key nutrients, making it even more critical that meals start out nutritionally sound [34]. Second, as with the parent study, nutrition information on school lunch items was based on standardized recipes provided by the district, and for any missing items, on similar items identified in nutrition analysis software or from product manufacturers. However, individual foodservice managers may exercise some discretion in the preparation and presentation of items, and this could alter the nutritional profile of a food item. Any such alterations were not captured in this analysis. Additionally, the nutritional data analyzed for this study was specific to the urban school district studied, and thus, while general recommendations for altering a school menu pattern may be applicable to other districts, the evaluation of specific menu items conducted here is not. Finally, the study data represents just six schools in one particular geographic area. Differences in the socioeconomic, ethnic or cultural profile of the student body and/or taste and preference among students in other regions may limit the applicability of this analysis beyond the current study.

Strengths of this study include analysis of both aggregate nutritional adequacy via calculated MAR and detailed analysis of individual menu items and patterns. By analyzing components of a district's meal pattern, including menu choices, frequency, and distribution, we are able to see a more detailed picture of nutritional quality in the context of student choices and preferences. This can help identify key areas for nutritional improvement, without sacrificing

palatability.

Implications for Policy and Practice

The new federal meal standards may make it possible for schools to provide healthier meals, by changing formulations of certain foods and mandating the inclusion of increased servings of fruits, vegetables and whole grains daily. However, based on the high frequency and popularity ratings of less healthy entrée choices, unless attention is paid to improving the quality of these items or reducing their availability by substituting with entrée items of higher nutrient content and quality, the actual effect of these new standards on student nutritional intake and overall health may be less than desired.

CONCLUSION

School lunches serve an important nutritional role for our country's children, delivering energy and critical nutrients to millions of growing children daily. New federal standards will help shape a new generation of healthier school meals, however making lasting changes will not be an easy task. Schools will need to generate new menu patterns and/or adapt existing recipes to meet the new requirements. Finding relatively simple ways to update their current meal plan will be key to success, while carefully managing limited budgets and personnel resources. This study provides a variety of recommendations, based on detailed analysis of menu items offering the highest levels of nutrition, that school districts can use as a guide. Increasing the quantity of vitamins A and C, fiber and iron will be especially important in these efforts, as these nutrients have historically been provided in less than adequate quantities.

This analysis can set the stage for future assessments of compliance with new federal school lunch regulations, assist in menu planning, and identify food items or groups that offer the

highest level of nutrition. In turn, these changes can lead to improved meal quality and better nutrition for middle and high school students.

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