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Lunches Selected and Consumed from the National School Lunch Program in Schools Designated as HealthierUS School Challenge Schools Are More Nutritious than Lunches Brought from Home

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ABSTRACT

Purpose/Objective
The purpose of this study was to compare the nutrient content of National School Lunch Program (NSLP) lunches and lunches brought from home (LBFH) lunches in elementary schools participating in the HealthierUS School Challenge (HUSSC).

Methods
Participants included students in grades 2-5 in four Washington state HUSSC elementary schools. Data were collected during the 2011-12 school year. A multiple analysis of variance (MANOVA) followed by post-hoc analyses of multiple t-tests was used to analyze nutrients provided and consumed by students to show differences between NSLP lunches and LBFH. Data were further separated by the child's eligibility status for free and reduced price meals. A MANOVA test followed by post-hoc analyses using multiple t-tests compared differences in mean nutrient amounts between LBFH and NSLP lunches within these groups. The average percentages of NSLP lunches and LBFH meeting School Meal Initiative (SMI) guidelines were compared.

Results
A total of 1,085 lunches were evaluated including 547 NSLP meals from 344 students and 538 LBFH from 276 students. NSLP lunches provided significantly more protein, calcium, iron, cholesterol, sodium, and vitamin C compared to LBFH. Students with NSLP lunches consumed significantly more protein, calcium, iron, cholesterol, sodium, vitamin A, and vitamin C compared to students who had LBFH. Students eligible for free and reduced price (FRP) meals who ate LBFH brought and consumed more calories, fat, and saturated fat. Lunches brought from home were less likely to meet SMI guidelines in nearly all categories.

Applications to the Child Nutrition Professionals
Based on the results from the current study, child nutrition professionals planned and prepared NSLP meals that met the current standards. As a result NSLP lunches were more nutritious than LBFH. While continuing efforts to improve the NSLP, the nutritional quality and content of LBFH should be more extensively studied. Nutrition education regarding LBFH is important for both parents and students. Further research is needed to determine factors affecting choice of LBFH food items.

Keywords: National School Lunch Program; child nutrition; nutrient requirements; HealthierUS School Challenge; Dietary Guidelines for Americans.

INTRODUCTION

Since 1980, the prevalence of obesity among children in the United States has tripled. Approximately 17% of school-aged children have a BMI-for-age at or above the 95th percentile (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Children who become overweight or obese are more likely to still be overweight at older ages (Cunningham, Kramer, & Venkat Narayan., 2014), which increases the risk for chronic diseases such as type 2 diabetes and cardiovascular disease. Because children spend a substantial amount of time at school, the school environment is a practical area to improve children's diets and reduce their risk of obesity (Finkelstein, Hill, & Whitaker, 2008; Juby & Meyer, 2011).

In 2012, 30.8 million children received lunch through the National School Lunch Program (NSLP). This is down from 31.8 million children in 2011(School Nutrition Association, 2013). The NSLP is a federally-assisted program that is overseen by the US Department of Agriculture (US Department of Agriculture [USDA] Food and Nutrition Service [FNS], 2014a). NSLP lunches have been routinely evaluated through the School Nutrition Dietary Assessment (SNDA)(Fox & Condon, 2012; Gordon, Crepinsek, Briefel, Clark, & Fox, 2009). The School Meals Initiative for Healthy Children (SMI) was created following the first SNDA study (SNDA-I, 1991-92)(Federal Register, 1995). SMI guidelines required that NSLP meals provide less than or equal to 30% of total energy from fat, less than or equal to 10% of total energy from saturated fat, and set minimum levels for calories, protein, calcium, iron, vitamin A, and vitamin C based on the Dietary Guidelines for Americans (Federal Register, 1995).

In 2004, USDA developed the HealthierUS School Challenge (HUSSC) as a voluntary program to encourage more healthy food options and promote healthy lifestyles through activities and education provided in cafeterias participating in the NSLP (USDA FNS, 2014b). Food-related aspects of the program include serving foods with less added sugar, fat, and sodium . HUSSC is a designation applied for by the school. HUSSC encourages increased physical activity, promotes policies for celebrations and fundraising that encourage healthy food choices, and provides nutrition education in cafeterias and classrooms. As of August 12, 2014 there were a total of 6,655 schools nationally representing 49 states and the District of Columbia. Of these 4,468 were awarded Bronze, 1,219 were awarded Silver, 585 were awarded Gold, and 383 were awarded Gold Awards of Distinction. (USDA FNS, 2014c).

Lunches served at schools have been studied by several investigators (Crepinsek, Gordon, McKinney, Condon, & Wilson, 2009; Stang, & Bayerl, 2003; Briggs, Mueller, & Fleischhacker, 2010; Terry-McElrath, O'Malley, Delva, & Johnston, 2009). However, many students nationwide consume lunches brought from home (LBFH) (Johnson, Bednar, Kwon, & Gustof, 2009; Johnston, Moreno, El-Mubasher, & Woehler, 2000). Unfortunately there is limited research available regarding food items and nutrient content in LBFH. Rainville (2001) analyzed nutrient content of lunches selected and consumed. The data collection was limited to two school districts in southeast Michigan. Johnson et al. (2009) conducted a study in two north Texas schools and only compared home packed meals to NSLP standards. Johnston and colleagues (2000) investigated food item differences between LBFH and NSLP lunches, but without a nutrient analysis and only in second graders in one large suburban school district. No studies have been done to date on HUSSC schools comparing NSLP school lunches with LBFH.

Prior research methods for nutrient analysis of meals have included 24 hour recalls, dietary records, food frequency questionnaires, plate waste studies, and analysis of food service sales data (Livingstone, & Robson, 2000; Krukowski, Perez, & Bursac, 2011; Glanz, 2009). Visual estimation of plate waste from digital photography has been established as a reliable method, making larger scale research projects more feasible (Parent, Niezgoda, Keller, Chambers, & Daly, 2012; Rockett, & Colditz, 1997).

The purpose of this cross-sectional study was to examine the differences in nutrient content of lunches provided and consumed from LBFH and lunches served in elementary schools named as HUSSC schools.

METHODOLOGY

This cross-sectional convenience sample study was conducted in two school districts in the state of Washington in four elementary schools. Recruitment of the school districts began in fall 2011 from a list of HUSSC schools in Washington. Data collection occurred in March, April and May in 2012. To be eligible for the study, elementary schools needed to have received a HUSSC award. All second through fifth grade students in each qualifying elementary school were eligible for participation in the study.

Method Development

Since the authors were unaware of any similarly scaled investigation of both NSLP lunches and LBFH, a custom computer database management program was created at Central Washington University to aid in data collection. The computer program allowed researchers to record digital photographs of the NSLP lunches and LBFH, both before and after the lunch period. The amounts of food provided and remaining after the lunch period were visually estimated using these photographs. These amounts were then linked via the custom program to either the USDA's Child Nutrition Database or another custom database created by the researchers using nutrition information provided by the school districts' food service directors or from food manufacturers' online resources (USDA, National Agricultural Library [NAL], 2014). The custom program compiled and yielded calorie, carbohydrate, protein, fat, saturated fat, fiber, sodium, calcium, vitamin C, vitamin A, and iron content, served and consumed, for each lunch observed. In addition, each lunch was linked via a unique identification number to an individual student. This number was used to link the data collected to demographic data that was later provided by the school district for each student.

Subject Selection and Consent

Selection of school districts for the study was based on designation as a Washington state HUSSC school district with at least one HUSSC school and willingness to participate. From this set of school districts, two were selected because of the diverse socioeconomic status of the student population and because they were geographically on opposite sides of the state. Socioeconomic status was approximated by the number of students who qualified for free or reduced price (FRP) lunches in the school district (HUSSC, 2014). Federal Poverty Guidelines set the standard for qualification for free and reduced price meals. For example, for a household of four in the 48 contiguous states an income of $23,850 is the established poverty level for the 2014-2015 school year. If the family had this income or lower they would qualify for free lunch status. For reduced price status, the family of four with an income of 185% of the poverty level, or $43,568 would qualify (USDA, 2014a).

The first school district's student population included schools with 15% of students qualifying for FRP lunches. The second school district included schools with 83% of students qualifying for FRP lunches. Once the school districts were selected, the school food service directors chose two elementary schools in their districts to be used for data collection. All students in grades 2 through 5 in the four schools were considered as potential subjects for this study.

Internal review boards at Central Washington University and the University of Southern Mississippi (the sponsoring institutions) approved the study prior to data collection. Passive consent was obtained prior to data collection by a letter, written in both English and Spanish, mailed to the parents/guardians of all potential subjects. The letter described the study purpose and methods and explained that demographic information (sex, age, grade level, FRP meal status) would be accessed from the school district and linked to their child's lunch. The letter was signed and returned to the school if the parent/guardian chose to exclude their child from participating in the study. The researchers kept an opt-out list to ensure that those students whose parents/guardians had signed and returned the informed consent sheet to the school's administration would not be selected to participate during the data collection phase. Additionally, students were asked if they would like to participate and were allowed to opt-out at the time of data collection.

Validation of Methods

Prior to data collection, a local elementary school served as a test site for validating methods and establishing reliability among the researchers who visually estimated portion sizes. All visual estimations were completed by two trained graduate student researchers with nutrition and food science bachelor degrees.

Prior to the student lunch service, a NSLP lunch was obtained from the serving line. Each food item from the tray was weighed and recorded. Confirmation was obtained that standard serving scoops were being used throughout the food service to ensure accuracy. As students arrived during the lunch service, those obtaining a NSLP lunch were given a numbered tray and instructed to obtain their lunch as usual. Students with LBFH were asked to go to the research table for a "before" photo of their meal. Additionally, each food item was individually weighed.

After students completed their lunch, an "after" photo of each tray was taken from which each researcher visually estimated the amount remaining of each food item. The tray was stored so that later each item could be weighed for validation of the estimate. Twelve NSLP lunches and 16 LBFH, for a total 136 food items, were evaluated.

The researchers' ability to accurately estimate food portions as they were presented on the trays was determined to be statistically valid. The intra-class correlation coefficients (ICC) for intermodal agreement between the actual weights and each researcher's estimates were above 0.9. Validity data were analyzed using IBM SPSS Statistics for Windows, Version 19.0. Data from the validation portion of the study were not included in the study results.

Data Collection
Prior to data collection, the NSLP lunch menu was obtained from the school district. Serving sizes and nutritional information for each food item were entered into a custom database. These data were used later when assessing the nutrients for each NSLP lunch.

Data collection for both LBFH and NSLP lunches occurred during the same lunch periods on 10 days at each school in the spring of 2012 while the SMI guidelines were in place. At the start of a lunch period, students were visually identified as either having LBFH or receiving a NSLP lunch. Student consent to participate was obtained, and the researcher then verified the student was not on the opt-out list. Each participating student was issued a numbered lunch tray. NSLP participants were instructed to obtain their lunch as usual and then approach the research table. Those with LBFH were requested to proceed directly to the research table.

When a student came to the research table, the student's name was obtained, compared again to the opt-out list and the identification number was verified. The identification number was provided by the school district for each student and used to link the lunch and the child's demographic data. The tray number and identification number were entered in the custom database and a "before" photo was taken. For photos of NSLP lunches, students placed their tray onto a tray holder and a picture was taken. For LBFH, lunches were unpacked onto a disposable lunch tray and arranged to assure visibility for the photo. Researchers recorded food and beverage descriptors into the "notes" section of the custom database to allow food identification when later evaluating the photo. Participants were instructed to return with their tray when they had finished eating.

After eating, students returned to the research table. The tray number assigned earlier was used to link data collected prior to consumption with data collected after consumption. Students were asked if they had traded or spilled any of the items on their trays. This information was recorded in the "notes" section. In addition, estimated amounts of any food items in opaque containers (for example, milk) were also recorded in the "notes" section. For clarity of "after" photos, empty food wrappers and containers were removed from the tray before the photo was taken.

After completion of the lunch period, the researchers reviewed the notes and the photos for each lunch. Nutrient information of items not found in the Child Nutrition Database was entered into the custom database using either information on the wrapper or from food manufacturers' online resources. The nutritional content of homemade items was approximated by using a similar item already in one of the databases. Finally, the researchers used the photos and notes to estimate the food amounts in the custom database. "Before" amounts were indicated as a percentage of the standard portion; "after" amounts were recorded as the percentage remaining on the tray.

Upon completion of the data collection the custom computer program compiled the information and gave the total nutrient content of each lunch as it was selected and consumed. This information was linked with demographic data provided by the school districts. Data were then compared against the SMI guidelines to determine which standards were met for each lunch.

Data Analyses

Data were analyzed using IBM SPSS software 21.0. For all tests, a significance level of $\alpha = 0.05$ was used. Prior to data collection, the research statistician determined assessment of 500 LBFH and 500 NSLP lunches would provide sufficient statistical power.

For key nutrients, the mean contents of LBFH and NSLP lunches were compared by first applying a multiple analysis of variance (MANOVA) test, followed by a post-hoc using multiple *t*-tests. Lunches provided and lunches consumed were considered separately. To account for the fact that a minority of the children were sampled more than once, the average nutrient values for each child were used for NSLP lunches and LBFH.

Data were further separated by the child's eligibility status for free/reduced price meals. A MANOVA test followed by post-hoc analyses using multiple *t*-tests compared differences in mean nutrient amounts between LBFH and NSLP lunches. As above, the average nutrient values for each child were used for NSLP lunches and LBFH.

Lastly, the nutrient content of each lunch was compared against the SMI guidelines for the Traditional Food-Based Menu Planning Method as shown in Table 1. For each child, the percentage of NSLP lunches and LBFH that met each standard were computed. Analysis of each student meal used the appropriate age-specific SMI guidelines for that student.

These percentages were then averaged for NSLP lunches and LBFH and compared for each standard with a simple 2-sample t-test. The higher percentage of students meeting the guideline indicates that there was a better nutrient makeup of the lunch offered or consumed. It should be noted that in the SMI guidelines, the percentages of kilocalories from total fat and saturated fat are upper bounds. All other SMI standards are lower bounds.

RESULTS AND DISCUSSION

Demographic Information

Two elementary schools in each of two Washington State school districts were selected as sites for data collection during the spring of 2012. Data were collected from the students in grades 2 through 5. A total of 863 students were invited to participate in the study. Of these, 3.8 % were opted out by their parents/guardians. A total of 1,085 lunches were evaluated, including 547 NSLP lunches from 344 students and 538 LBFH from 276 students. Demographic data were available for a limited number of students accounting for 758 lunches (354 NSLP lunches from 251 students and 404 LBFH from 211 students). This was due to data limitations in the school districts included in the study. Demographic data collected included age, ethnicity, free and reduced lunch status, sex, and grade level.

Although more extensive demographic data were collected, only results related to the socioeconomic status of the children (as approximated by whether they qualified for free or reduced price lunch) are reported in this paper. This is due to space constraints. It should be noted, however, that when the data were controlled for sex and age, relationships in nutrient consumption reported between NSLP meals and LBFH remained consistent. That is, neither sex nor age had a confounding effect on the major findings of this study.

Nutrient Content of Lunches

Table 1 shows the mean nutrient content of NSLP lunches and LBFH, including both what was selected and what students consumed. NSLP lunches provided significantly more of the following nutrients compared to LBFH: protein, calcium, iron, vitamin C, cholesterol, and sodium. On the other hand, NSLP lunches provided less of the following: calories, total fat, saturated fat, carbohydrates, and fiber. Note that in Table 1, large standard deviations are seen in both vitamins A and C. These large standard deviations are due to serving of carrots (vitamin A) and oranges (vitamin C) on some of the days that were analyzed. This resulted in some days with relative large amounts vitamin A or vitamin C offered and other days with much smaller amounts of these two vitamins being offered.

Table 1. ***Nutrient Content of Elementary Student NSLP and LBFH Lunches: Selected and Consumed***

Nutrient	Selected		Consumed	
	NSLP (n=344) *M ± SD*	**LBFH** (n=276) *M ± SD*	**NSLP** (n=344) *M ± SD*	**LBFH** (n=276) *M ± SD*
Food Energy (633[1], 785[2] Calories)	604.53 ± 118.76 [a]	649.29 ± 227.30 [a]	444.46 ± 138.61 [b]	513.23 ± 198.86 [b]
Total Fat (g) (≤30% of Calories[1,2])	18.79 ± 6.60 [a]	23.28 ± 11.96 [a]	13.72 ± 6.14 [b]	18.41 ± 9.69 [b]
Saturated Fat (g) (≤10% of Calories[1,2])	6.27 ± 2.96 [a]	7.36 ± 4.27 [a]	4.57 ± 2.67 [b]	5.89 ± 3.79 [b]
Carbohydrates (g)	82.13 ± 22.75 [a]	93.13 ± 35.02 [a]	60.41 ± 21.41 [b]	73.35 ± 30.40 [b]
Protein (9[1],15[2] g)	28.41 ± 6.28 [a]	21.57 ± 9.60 [a]	20.96 ± 8.03 [b]	17.27 ± 8.91 [b]
Calcium (267[1],370[2] mg)	512.45 ± 193.95 [a]	238.35 ± 180.63 [a]	373.69 ± 195.57 [b]	189.04 ± 155.05 [b]
Total Dietary Fiber (g)	6.08 ± 2.89 [a]	7.18 ± 3.86 [a]	4.41 ± 2.35 [b]	5.45 ± 3.28 [b]
Cholesterol (mg)	54.73 ± 37.24 [a]	39.73 ± 43.57 [a]	41.04 ± 35.87 [b]	32.46 ± 37.94 [b]
Iron (3.3[1], 4.2[2] mg)	3.64 ± 1.29 [a]	2.22 ± 1.831 [a]	2.69 ± 1.30 [b]	1.69 ± 1.52 [b]
Sodium (mg)	1,160.37 ± 380.68 [a]	931.79 ± 449.57 [a]	845.90 ± 374.62 [b]	746.41 ± 410.61 [b]
Vitamin A (2000[1], 2850[2] IU)	2,182.65 ± 2,779.91	1,801.00 ± 4,546.15	1,596.96 ± 2,419.48 [b]	1,114.71 ± 2,812.91 [b]
Vitamin C (15[1], 17[2] mg)	37.04 ± 40.87 [a]	23.70 ± 34.78 [a]	27.37 ± 31.96 [b]	17.77 ± 26.27 [b]

Note: NSLP indicates National School Lunch Program lunches; LBFH indicates lunches brought from home.
[1] School Meal Initiative guidelines for grades K-3; ages 5-8.
[2] School Meal Initiative guidelines for grades 4-12; ages 9 and older.
[a] Two-sample *t*-test indicates a significant difference ($p < 0.05$) between nutrients in NSLP selected lunches and LBFH.
[b] Two-sample *t*-test indicates a significant difference ($p < 0.05$) between nutrients consumed in NSLP lunches and LBFH.

As seen in Figure 1, when these nutrients were compared to the SMI guidelines, NSLP lunches compared to LBFH had a greater likelihood of meeting the requirements for total fat, protein, calcium, iron, vitamin A, and vitamin C. LBFH had a significantly higher percentage of students meeting SMI guidelines for calories. Since this research was done with SMI guidelines in place, the Traditional Menu Planning method calorie guidelines were used for comparison. These were different for the grades/ages used. Grades K-3 was 633 calories, and grades 4-12 was 785 calories. The current study compared SMI calorie guidelines to the meals consumed relative to the grade level standards.

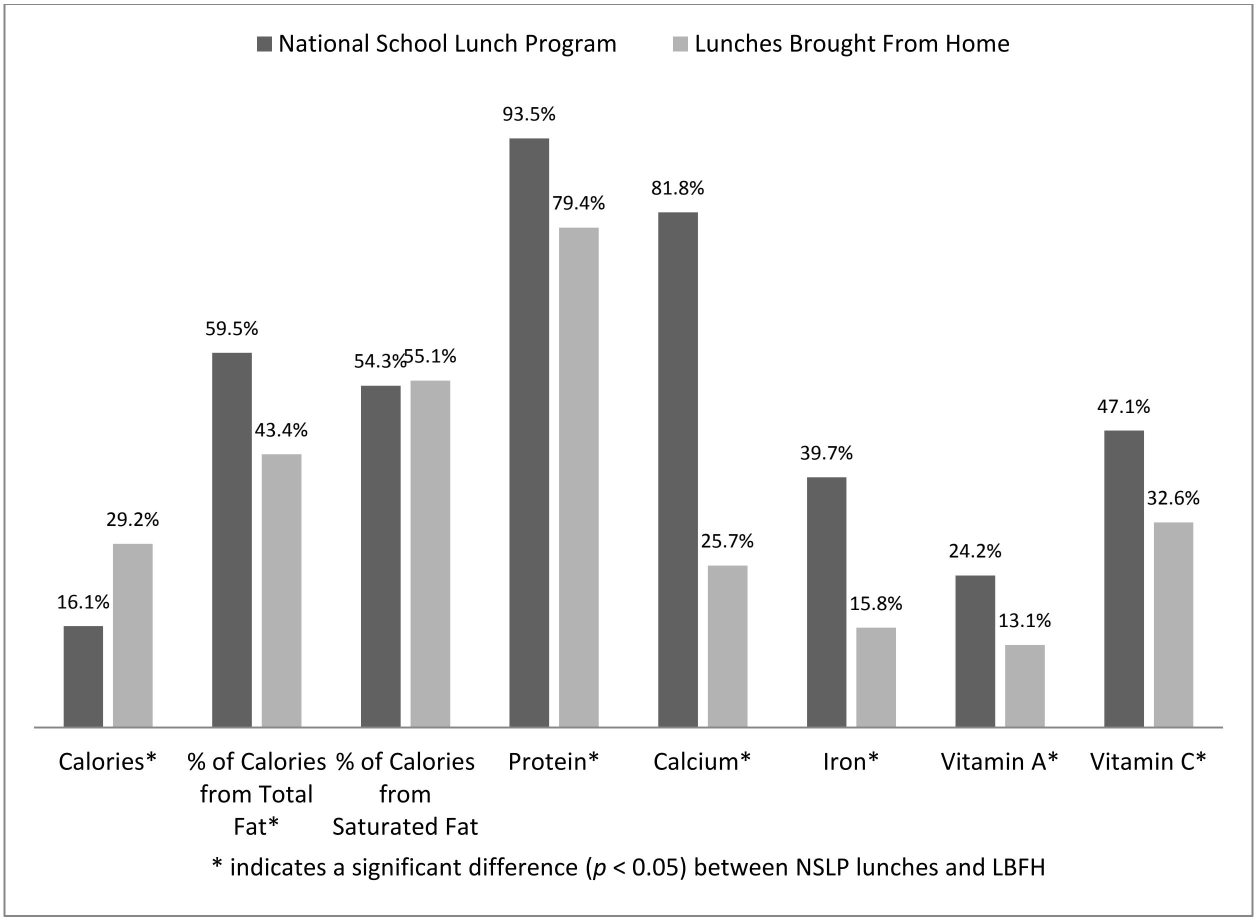

Figure 1. ***Percentage of Lunches Selected Meeting School Meal Initiative Guidelines***

Nutrient Content of Consumed Lunches

Table 1 also shows that students who ate NSLP lunches consumed more protein, calcium, cholesterol, iron, sodium, vitamin A, and vitamin C. On the other hand, students who ate NSLP lunches consumed significantly less calories, total fat, saturated fat, carbohydrates, and dietary fiber compared to students who ate LBFH.

When these results were compared to the SMI guidelines (Figure 2) a significantly greater percentage of students receiving NSLP lunches met the requirements for every nutrient, except for calories and saturated fat. A significantly lower percentage of students consumed NSLP lunches that met the standard for calories.

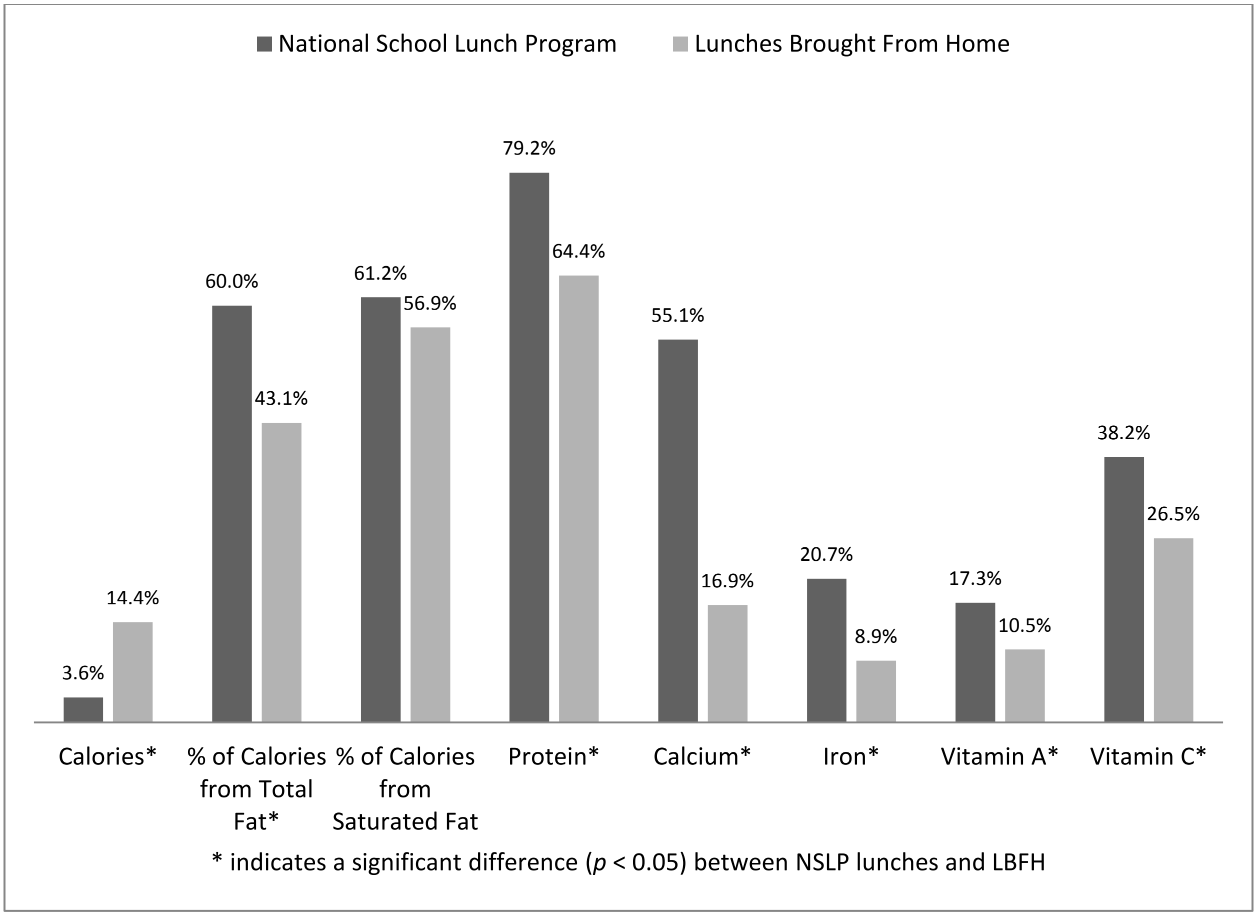

Figure 2. ***Percentage of Lunches Consumed Meeting School Meal Initiative Guidelines***

Free and Reduced Price Status

Table 2 presents the mean nutrient content from NSLP lunches and LBFH when subjects were stratified by whether they qualified for a FRP meal or did not qualify (non-FRP students or Paid). The first group is referred to as FRP students while the second group is referred to as Paid students.

Not all students who qualify for FRP meals actually receive these meals. There are a variety of reasons for this. In some cases, parents who would qualify if they applied do not apply for FRP status. Or if the family does qualify, some students choose to bring lunches from home. For example, of all FRP students in the present study (n=185), 32 opted to bring lunches from home at least once. Data indicate that FRP students who ate LBFH were provided with and consumed more calories, fat, and saturated fat than they would have if they had been provided with a NSLP meal. Additionally, they were provided less protein, calcium and iron and consumed less protein, calcium, iron and vitamin A.

Among Paid students (n=277), 179 ate LBFH at least once. Data indicate that Paid students who ate LBFH were provided with and consumed more fat, saturated fat, carbohydrates, and dietary fiber. In addition, they consumed more calories. On the other hand, these students were provided with and consumed less protein, calcium, iron, vitamin A and vitamin C. They were provided with less cholesterol and sodium.

Table 2. ***Nutrient Content of Elementary Student NSLP and LBFH Lunches Selected and Consumed by Free/Reduced Status and by Paid Status***

	Free/Reduced Status			
	Selected		**Consumed**	
	NSLP (n=153) *M* ± *SD*	**LBFH** (n=32) *M* ± *SD*	**NSLP** (n=153) *M* ± *SD*	**LBFH** (n=32) *M* ± *SD*
Food Energy (Calories)	610.30 ± 141.48	687.42 ± 256.59	444.95 ± 143.84 [b]	542.15 ± 250.17 [b]
Total Fat (g)	19.57 ± 7.05 [a]	26.06 ± 11.95 [a]	14.20 ± 6.77 [b]	20.77 ± 11.11 [b]
Saturated Fat (g)	6.63 ± 3.08 [a]	8.24 ± 4.12 [a]	4.83 ± 2.81 [b]	6.87 ± 4.29 [b]
Carbohydrates (g)	82.18 ± 27.91	93.57 ± 41.46	60.19 ± 22.86	73.35 ± 37.62
Protein (g)	28.41 ± 6.53 [a]	21.56 ± 11.26 [a]	20.59 ± 7.92	17.13 ± 10.06
Calcium (mg)	521.87 ± 206.44 [a]	237.64 ± 196.01 [a]	369.87 ± 185.16 [b]	204.27 ± 186.57 [b]
Total Dietary Fiber (g)	6.55 ± 3.13	6.24 ± 4.47	4.78 ± 2.53	4.87 ± 4.06
Cholesterol (mg)	59.94 ± 45.40	51.93 ± 58.50	45.86 ± 45.82	39.86 ± 47.71
Iron (mg)	3.96 ± 1.37 [a]	2.06 ± 1.50 [a]	2.86 ± 1.49 [b]	1.58 ± 1.32 [b]
Sodium (mg)	1,137.73 ± 388.64	1,107.33 ± 528.80	816.96 ± 370.72	886.44 ± 471.84
Vitamin A (IU)	1,938.00 ± 2766.32	1,141.55 ± 3156.88	1,439.24 ± 2564.97 [b]	510.62 ± 1,105.59 [b]
Vitamin C (mg)	34.85 ± 44.61	25.36 ± 34.85	26.40 ± 33.93	18.07 ± 25.28
	Paid Status			
	Selected		**Consumed**	
	NSLP (n=98) *M* ± *SD*	**LBFH** (n=179) *M* ± *SD*	**NSLP** (n=98) *M* ± *SD*	**LBFH** (n=179) *M* ± *SD*
Food Energy (Calories)	573.13 ± 97.53	600.98 ± 187.73	450.78 ± 132.32	486.68 ± 168.03
Total Fat (g)	17.18 ± 5.70 [a]	21.32 ± 10.34 [a]	13.15 ± 5.65 [b]	17.24 ± 8.13 [b]
Saturated Fat (g)	5.69 ± 2.16 [a]	6.69 ± 3.63 [a]	4.29 ± 2.17 [b]	5.49 ± 3.21 [b]
Carbohydrates (g)	78.87 ± 16.38 [a]	86.27 ± 27.62 [a]	62.14 ± 20.05 [b]	69.69 ± 25.11 [b]
Protein (g)	26.14 ± 6.26 [a]	21.02 ± 8.54 [a]	20.76 ± 7.60 [b]	17.04 ± 7.76 [b]
Calcium (mg)	481.83 ± 220.11 [a]	224.68 ± 170.77 [a]	388.33 ± 231.32 [b]	181.52 ± 143.51 [b]
Total Dietary Fiber (g)	5.76 ± 3.06 [a]	7.29 ± 3.53 [a]	4.32 ± 2.41 [b]	6.65 ± 3.04 [b]
Cholesterol (mg)	41.19 ± 16.44 [a]	34.63 ± 36.06 [a]	32.29 ± 16.77	29.27 ± 33.15
Iron (mg)	3.01 ± 1.29 [a]	2.18 ± 1.69 [a]	2.41 ± 1.14 [b]	1.68 ± 1.32 [b]

Sodium (mg)	929.26 ± 298.20 [a]	824.56 ± 377.50 [a]	739.69 ± 295.86	675.14 ± 348.48
Vitamin A (IU)	2,954.50 ± 2,826.13	1,997.51 ± 4,824.82	2,361.69 ± 3,288.81 [b]	1,199.13 ± 2,482.15 [b]
Vitamin C (mg)	41.69 ± 47.72 [a]	24.03 ± 35.92 [a]	30.15 ± 28.47 [b]	19.00 ± 28.03 [b]

Note: NSLP indicates National School Lunch Program lunches, LBFH indicates lunches brought from home.
[a] For provided nutrients, two-sample *t*-tests indicates a significant difference ($p < 0.05$) in the nutrient amount between NSLP and LBFH lunches.
[b] For consumed nutrients, two-sample *t*-tests indicates a significant difference ($p < 0.05$) in the nutrient amount between NSLP and LBFH lunches.

Calorie and Nutrient Differences between NSLP Lunches and LBFH
Consistent with previous studies, the current study indicated that NSLP meals were less likely to meet or exceed SMI guidelines for calories (Rainville, 2001; Johnson et al., 2009; Johnston et al., 2000). Fewer calories were selected and consumed by NSLP lunch students when compared to students with LBFH.

SMI guidelines required that NSLP meals provide less than or equal to 30% of total energy from fat, and less than or equal to 10% of total energy from saturated fat. SMI guidelines also set minimum levels for calories, protein, calcium, iron, vitamin A, and vitamin C based on the Dietary Guidelines for Americans. With NSLP lunches, students were more likely to select and to consume nutrients in amounts that met the SMI guidelines for total fat, protein, calcium, iron, vitamin A and vitamin C compared to students who ate LBFH. This can be partially attributed to the NSLP requirement that meals provide milk, meat or meat alternates, fruits and vegetables (Federal Register, 1995, USDA,2014a). Additionally, this can be partially explained by the emphasis on greater availability of fruits and vegetables in HUSSC schools. Schools participating in the current study frequently provided salad bars, which previous studies have shown to correlate with offering a greater variety of fruits and vegetables (Schmidt & McKinney, 2004).

Students who consumed LBFH were more likely to bring and consume a larger amount of carbohydrates. This is consistent with previous research that showed food items contributing to carbohydrate intake within LBFH tended to be cakes, cookies, salty snacks, and other sweets (Johnson et al., 2009; Johnston et al., 2000). This finding is also consistent with a study that showed an increased consumption of sugar with LBFH (Johnston et al., 2000). Carbohydrate intake in NSLP lunches has been shown to come mainly from milk, meat breading, and grain mixtures (Johnson et al., 2009).

Consistent with earlier studies, students who ate LBFH were provided with and consumed less cholesterol and sodium than those who ate NSLP lunches (Rainville, 2001; Johnson et al., 2009) (Johnston et al., 2000). In the case of cholesterol, both NSLP lunches and LBFH provided relatively small amounts when compared to the US *Dietary Guidelines* of 300 mg per day. A possible factor contributing to greater cholesterol intake in NSLP lunches may be the inclusion of milk, other dairy, and meat products (USDA, 2014a). On average, both NSLP (1148.5 mg) lunches and LBFH (922.7 mg) provided more sodium than recommended by the *Dietary Guidelines* for Americans (1/3 of 2,200 mg or 733 mg), with NSLP lunches providing more than

LBFH. Food manufacturers have reduced sodium content of their products in the past and further measures will be needed to meet the current recommendations.

LBFH Students Qualifying for FRP Compared to Paid Students
As seen in Table 2, 32 students who qualified for FRP brought lunches from home. With these lunches brought from home, students were provided with and consumed more calories, fat, and saturated fat than if they had selected a NSLP meal. Also, 179 Paid students out of 277 ate LBFH. Data indicated that Paid students who ate LBFH were also provided with and consumed more fat, saturated fat, carbohydrates, and dietary fiber than if they had chosen to eat a NSLP meal. In addition, Paid students consumed more calories. On the other hand, the Paid students were provided with and consumed less protein, calcium, iron, vitamin A and vitamin C. They were provided with less cholesterol and sodium. Consequently, for both FRP and Paid students, choosing a NSLP meal would have provided a more nutritious option on average.

Strengths and Limitations
Strengths of the current study include its contribution to the very limited research on LBFH. Additionally, the methodology using digital photography and customizable databases provides the ability to efficiently conduct large-scale food and nutrient investigations. These methods can be replicated to determine the content of meals provided and consumed.

Limitations of the current study include the use of a sample of convenience rather than a randomized sample of the National School Lunch Program or Healthier US School Challenge schools. Four elementary schools in Washington State were studied, limiting generalizability of results. Another limitation was that only HUSSC schools were studied. Thus results cannot be generalized to all schools participating in the NSLP. Due to school districts' procedures, demographic information was not available for all students sampled. Also, students were allowed to self-select and opt-out if they did not wish to participate on data collection days. In addition, the exact nutrient content of lunches brought from home cannot be ascertained. For example, the fat content of a home-made fruit bread made with a fat replacer such as apple sauce would be different than a fruit bread made with butter or shortening. By simply looking at the item, the exact ingredients cannot be determined. Lastly, although the methodology was validated, estimation errors are inherent when using a two-dimensional picture to estimate a three-dimensional food portion.

CONCLUSIONS AND APPLICATION

The current study examined lunches in four elementary schools in the state of Washington who were HUSSC participants and found that NSLP lunches were more likely to meet the SMI nutrient guidelines compared to LBFH. The NSLP continues to improve nutritional quality of lunches served in schools. The HUSSC award program provides good incentives for schools to enhance the learning environment in schools. In the current study, the HUSSC award winning schools sampled provided NSLP meals that were, on average, of better nutrient quality than LBFH. These results indicate that further research related to barriers to providing a quality LBFH is needed. This may include nutrition education for students and parents regarding lunch items selected for LBFH. It must also be recognized that only 6,655 school nationally have HUSSC designation. Most public schools in the US have not received HUSSC awards.

As seen in Table 2, whether students qualify for FRP lunches or not, the present study indicates that the children sampled received a more nutritious meal if they participated in the NSLP at these schools compared to LBFH.

Two major conclusions may be made: 1. Child nutrition professionals employed as school food service managers need to explore ways to encourage NSLP participation. Taste testing, student and parent focus groups, incorporating ethnic foods, incorporating fresh and/or local produce, and improving quality/variety, may be possible ways to accomplish this. 2. For those choosing to bring lunch from home, more studies are needed to determine personal and structural barriers that families face which limits the selection of healthy food choices. These barriers may include limited food budgets, taste preferences of children, and the perishable nature of healthy food.

From the conclusions above, two major potential application themes may be formed. First, an increased NSLP participation rate is essential to provide the balanced nutrition students need to develop mentally and physically. Best practices need to be explored, identified, and disseminated to child nutrition professionals in order to increase NSLP participation rate. This will require investigations that take into account many variables that include student age; ethnic background; region of the country; urban, rural suburban influences; physical environment in the cafeteria; and menu selection methods, including use of student taste panels. Wojcicki and Heyman (2006) have shown that including polling of middle school students concerning acceptable menu items that adhere to nutrition policies can be effective at improving the menu items presented to students and, ultimately, the nutrient density of lunches while increasing NSLP participation rates. Additionally, using parent ad hoc groups to identify and promote a healthy school food environment has been effective at improving the nutritional make-up of foods offered to students while increasing revenue.

A certain segment of the population will continue to provide LBFH. The current study shows that the average lunch from home is less nutrient dense than NSLP meals at HUSSC schools. Therefore, a second potential application may be formulated. Effective nutrition education programs and incentives are needed. The HUSSC program provides a voluntary way to improve the total school environment, including all aspects of the food system (USDA, 2014c). Although the HUSSC program does not address lunches brought from home, similar programs could be focused towards children and parents who choose to provide lunches from home. Nutrition education programs could use evidence based investigations to determine barriers that limit nutrient dense LBFH. Additionally, they could provide methods to overcome the barriers identified. Barriers could include a lack of time and/or resources to purchase nutrient dense lunch menu items. Barriers could also include a lack of knowledge about the types of foods that provide a well-balanced lunch that promotes good physical and mental development.

The American Dietetic Association Position Paper on Comprehensive School Nutrition Services advocated for an integrated cafeteria/classroom approach to nutrition education (Briggs, 2010). The American Dietetic Association is now the Academy of Nutrition and Dietetics. The name change occurred in 2012 after the Position Paper above was published. Child nutrition professionals are encouraged to educate parents and students about the importance of including nutrient rich foods, such as fruits and vegetables, in school lunches. This would help assure that child nutrient needs are met. Good nutrition education, infused in the curriculum of elementary schools, has the potential to help students develop good nutrition habits at an early age. It has been estimated that at least 50 hours of nutrition education are necessary to make a difference in food selection behavior. Nonetheless very few students receive the 50 hours of nutrition education in schools that is recommended necessary to positively influence behavior change (Connell, Turner, & Mason, 1985; Celebuski, & Farris, 2000). Additional research should be conducted on a large nationally representative sample to extend the generalizability of results.

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