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School Lunch Quality Following Healthy, Hunger-Free Kids Act Implementation

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ABSTRACT

Purpose/Objectives
This study investigates the effect of meal component changes by the Healthy, Hunger-Free Kids Act of 2010 (HHFKA) on school lunch quality and consumption in elementary school students, grade 2-5 before and after the HHFKA guidelines were implemented in July 2012 using the Healthy Eating Index.

Methods
In Spring 2012, before implementation of meal standards mandated by the HHFKA, digital photographs were taken of second to fifth graders' lunches in four HealthierUS School Challenge (HUSSC) participating elementary schools before and after the meals were consumed. In Spring 2013, after implementation of meal standards mandated by the HHFKA, digital photographs of lunches were again taken in the same schools before and after lunches were consumed. The photos were used to visually estimate the amounts of food items selected and consumed. Meals selected and consumed were scored using the Healthy Eating Index (HEI-2010). The HEI-2010 scores of the lunches in 2012 were compared to those in 2013.

Results
Results based upon 1,033 lunches (509 pre-HHFKA in Spring 2012 and 524 post-HHFKA in Spring 2013) revealed improved HEI-2010 scores ($p < 0.05$) for both served (52.2 pre-HHFKA to 57.0 post- HHFKA) and consumed meals (49.8 pre-HHFKA to 53.2 post-HHFKA). Noteworthy component scores that improved included Empty Calories (served) from 14.1 to 15.3 (maximum score 20); Total Fruit (served) from 2.3 to 3.7 (maximum score 5); Total Fruit (consumed) from 2.3 to 3.4 (maximum score 5); and Sodium (served) from 4.6 to 5.3 (maximum score 10).

Application to Child Nutrition Professionals
The current study indicates that menus offered by child nutrition professionals in four schools in Washington improved the nutritional quality of lunches served and consumed post-HHFKA implementation.

Keywords: National School Lunch Program; Healthy Hunger-Free Kids Act; child nutrition; Healthy Eating Index; meal standards

INTRODUCTION

Proper nutrition is essential for the long-term health of children. According to the World Health Organization (2014), giving a child a supportive and adequate start in life with food and nutrition has a positive impact not only on their physical development, but their mental and social development as well**.** During the academic year, children spend more waking hours at school

than they do at home (Story, Nanney, & Schwartz, 2009). Because of the time spent at school, the school environment is an ideal area to improve children's diets and reduce their risk of obesity (Briefel, Crepinsek, Cabili, Wilson, & Gleason, 2009). In 2014, the National School Lunch Program (NSLP) provided meals to over 30 million school children in the United States (U.S. Department of Agriculture [USDA], Food and Nutrition Service [FNS], 2015). The NSLP utilizes federal funds to provide low cost or free nutritionally-balanced meals to prevent inadequate food and nutrient intake (USDA-FNS, 2013).

In 2004, the United States Department of Agriculture (USDA) introduced the HealthierUS School Challenge (HUSSC). The HUSSC is a voluntary initiative for schools that participate in the NSLP to make positive changes to their nutrition and wellness programs. Schools are recognized for reaching specific program goals. Food-related goals include serving food with lower sodium and fat content and serving more fruits, vegetables, and grains. HUSSC has also set goals on increased physical activity and nutrition education in the school setting (USDA-FNS 2014).

Most recently, the NSLP has implemented new guidelines mandated by the Healthy, Hunger-Free Kids Act of 2010 (HHFKA) (USDA-FNS, 2012b). All NSLP schools are required to abide by HHFKA guidelines. The HHFKA is intended to assist child nutrition professionals (CNPs) in providing school meals that align with the Dietary Guidelines for Americans.

The final rule contains a standardized food-based menu planning system to be used by all schools. Food based menu planning sets daily/weekly requirements for nutrient dense foods from all food groups. HHFKA also includes the requirements that meals be within a caloric range based on the Recommended Daily Allowance (RDA) including both minimums and maximums for each grade group (K-6, 6-8, 9-12). The HHFKA guidelines include an increase in the amounts of fruits and vegetables required to be served for each school meal. Additionally, the final rule limits the amount of sodium served and requires zero non-naturally occurring trans fats (USDA-FNS, 2012b).

One of the goals of the HHFKA is to improve children's overall diet, health status, and to prevent the overfeeding of low nutrient density foods that contribute to obesity (USDA-FNS, 2012b). Bergman et al. (2014) revealed that school lunches selected and consumed post-HHFKA were more nutritious than lunches served prior to implementation of HHFKA. This indicates that child nutrition professionals (CNPs) are making improvements to meal quality in regard to nutrient content.

There are many reliable ways to analyze quality of meals and overall diet quality. One method that is frequently used is the Healthy Eating Index (HEI) (Guenther et al., 2012; Guenther et al., 2013). The current version, referred to as the HEI-2010, was revamped from a 2005 version by an interagency working group. The intent is to measure diet quality in terms of how the diet conforms to the current Dietary Guidelines for Americans (U.S. Department of Health & Human Services & USDA, 2010), The HEI-2010 captures the major recommendations of the 2010 Dietary Guidelines. The HEI-2010 is intended to be used to assess dietary quality of the U.S. population and sub-populations especially related to the evaluation of interventions and also to evaluate different food environments. More details about the HEI-2010 may be found in Guenther et al. (2012). Because of these intentions, use of the HEI-2010 is very relevant in the school meal setting. The HEI-2010 analyzes 12 components (Table 1). Nine are adequacy

components. These include: Total Fruit, Whole Fruit, Total Vegetable, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, and Fatty Acids. Three are moderation components. These include: Sodium, Refined Grains, and Empty Calories. Adequacy components receive a higher score with a higher intake of the component. Conversely, moderation components receive a higher score with a lower intake of the component. The scoring model of the HEI-2010 aligns closely with the food-based menu planning requirements of the HHFKA, which make the HEI-2010 a good score tool to assess the quality of NSLP lunches. In a 2013 USDA study, total HEI scores for U.S. children ages 2-17 were reported to be between 47-50 points on the 100-point scale, indicating improvement in child nutrition in the United States is needed (Hiza, Guenther, & Rihane, 2013).

Table 1. ***Healthy Eating Index-2010 Components and Standards for Scoring***
(Guenther et al., 2013)

HEI-2010[1] Component	**Maximum Points**	**Standard for Maximum Score**	**Standard for Minimum Score of Zero**
Adequacy			
Total Fruit[2]	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit[3]	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Greens & Beans[4]	5	≥ 0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Beans and Peas
Whole Grains	10	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods[6]	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood & Plant Proteins[6,7]	5	≥0.8 oz equiv. per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[8]	10	(PUFAs + MUFAs)/SFAs ≥2.5	(PUFAs+MUFAs)/SFAs ≤1.2
Moderation			
Refined Grains	10	≤1.8 oz equiv. per 1,000 kcal	≥4.3 oz equiv. per 1,000 kcal
Sodium	10	≤1.1 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Empty Calories[9]	20	≤19% of energy	≥50% of energy

[1]Intakes between the minimum and maximum standards are scored proportionately.

[2]Includes fruit juice.

[3]Includes all forms except juice.

[4]Includes any beans and peas (called legumes in HEI-2005) not counted as Total Protein Foods (called Meat and Beans in HEI-2005).

[5]Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.

[6]Beans and peas are included here (and not with vegetables) when the Total Protein Foods (called Meat and Beans in HEI-2005) standard is otherwise not met.

[7]Includes seafood, nuts, seeds, soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.

[8]Ratio of poly- and monounsaturated fatty acids to saturated fatty acids.

[9]Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is >13 grams/1,000 kcal.

Purpose

The purpose of this study was to assess NSLP meal quality (selected vs. consumed) in grades 2-5 before and after implementation of HHFKA using the HEI-2010 meal component scoring index.

METHODOLOGY

This is a secondary study using an existing database. The initial study was conducted during school years 2011-12 and 2012-13 with secondary analysis performed during Spring 2015. Institutional review boards at Central Washington University and the University of Southern Mississippi (the sponsoring institutions) approved the initial study prior to data collection in April 2012. These methods are described in full in a previous study (Bergman et al., 2014)

Participants

Students, grades 2-5, from four Washington State elementary schools in two school districts participated in the study. Schools were selected based on their achievement of a HUSSC award in the school year prior to data collection. For one district located in western Washington, the participating schools had a free and reduced priced meal (FRP) rate of 83%. For the other district located in eastern Washington, the participating schools had a FRP rate of 16%. The kitchens at each location were a production/service system with some on-site preparation including some scratch cooking. All four schools were 'offer versus serve' systems where students were given a choice of menu items to place on their trays. All four schools also had daily salad bars for students to select fruit and vegetable options. Trays were consistently sampled from each school for 30 days in the months of April and May during each year.

Procedure

Teachers and administrators were provided a script to explain the study purpose and procedures. On the day of data collection, two laptops and two cameras were set up in the lunchroom. The researcher invited students to participate as they stood in line to pick up their NSLP meals. A photo was taken of each lunch prior to consumption and again after the student finished eating. A custom computer database management program was created to allow researchers to record and link together "before" and "after" digital photographs of each NSLP lunch studied. The amounts of food selected and remaining after the lunch period were visually estimated using these photographs. These amounts were then linked via the custom program to the portion sizes provided by the schools.

Information for each food item and the amount served were input into Nutrition Data System for Research software version 2014, developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN. The NDSR database includes over 18,000 foods, 160,000 food variations, and values for 165 nutrients, nutrient ratios and food components (34). These data were used to compute an HEI-2010 score for each component of each lunch, both served and consumed.

It should be noted that HEI-2010 standards are based upon consumption rates per 1,000 calories (Table 1). Consequently, scores are scaled for both very large and very small meals; that is, the Total Fruit score for 0.1 cup of fruit in a 100 calorie meal is the same as 1.0 cup of fruit in a 1,000 calorie meal. Thus the standards are readily applicable without modification to the relatively small average elementary school child's lunch.

Component scores were totaled to compute the Total HEI-2010 score for each lunch. HEI-2010 scores range from 0 to 100, with higher scores indicating better diet quality. HEI-2010 scores greater than 80 indicate a "good" diet, scores ranging from 51 to 80 reflect a diet that "needs

improvement," and HEI-2010 scores below 51 imply a "poor" diet (Kennedy, Bowman, Lino, Gerrior, & Basiotis, 1998)

Statistical Analyses

The mean HEI component scores of the NSLP lunches selected and consumed were calculated. Meals selected and meals consumed were scored separately. A multiple analysis of variance (MANOVA) statistical test was conducted to determine if there was a significant difference in the mean HEI-2010 component scores of NSLP meals selected and consumed in 2012 versus 2013. This test was followed by post-hoc analyses using multiple *t*-tests, which compared the 2012 meals to the 2013 meals data by individual food component HEI-2010 scores ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Results of this study were based on the analysis of 1,033 lunches (509 pre-HHFKA in Spring 2012 and 524 post-HHFKA in Spring 2013) from elementary school students, grades 2-5. When NSLP meals from 2012 and 2013 were compared, the results supported the hypothesis that the implementation of the HHFKA had a significant positive effect on the overall meal quality of NSLP lunches. Summary statistics displayed in Table 2 show that HEI-2010 total meal scores were significantly improved for both meals selected (52.17 in 2012 to 56.98 in 2013) and meals consumed (49.83 in 2012 to 53.21 in 2013). These scores are generally higher than the U.S. estimated HEI-2010 scores of 47 to 50 of the maximum score of 100 for children 2 to 17 years of age reported in a USDA study (Hiza, et al, 2013). Additionally, there were improvements to the selected and consumed component scores of Total Fruit, Whole Fruit, Seafood and Plant Proteins, Sodium, and Empty Calories. HEI-2010 scores for the Greens and Beans, Whole Grains, and Dairy were found to have decreased in both selected and consumed components.

Changes That Resulted in an Increase in HEI-2010 Score

Improvements in the HEI-2010 scores for Whole Fruit in both NSLP meals selected (2.57 for 2012 to 4.05 in 2013) and consumed (2.35 for 2012 and 3.43 in 2013) were noted. The USDA HEI-2010 requires at least 0.4 cup equivalent per 1,000 kcal for a maximum score of 5. The Whole Fruit component score does not include juice. The Total Fruit component (which does include fruit juice) HEI-2010 score also improved in both selected (2.31 in 2012 and 3.72 in 2013) and consumed (2.16 in 2012 and 3.22 in 2013) NSLP meals. In the current study, 82% of meals included fresh fruit, compared to 56 % of lunch menus in elementary schools nationwide.

The HEI-2010 score for sodium improved in both selected meals (4.61 in 2012 to 5.34 in 2013) and consumed meals (4.60 in 2012 to 5.30 in 2013). Meals must have ≤ to 1,100 mg sodium per 1,000 kcal to receive a maximum score of 10. An HEI sodium score of zero is awarded to meals that contain more than 2,200 mg of sodium per 1,000 kcal (Guenther, et al., 2012). Although, reducing sodium was not a specific goal of HUSSC, the goal of increasing fruits and vegetables, which are naturally low in sodium, likely resulted in an overall sodium reduction (Bergman, et al., 2014). Since HUSSC schools had higher nutritional standards compared to non-HUSSC schools, the findings would likely be more profound in non-HUSSC schools (USDA-FNS, 2014). Regardless, sodium has been identified as a target nutrient for school lunches (USDA-FNS, 2012b). Improved sodium and fruit HEI-2010 scores from 2012 to 2013 indicate that participating CNPs were making menu and recipe changes to reduce sodium and increase fruit offerings within their schools.

Table 2. ***Healthy Eating Index Scores of Four HealthierUS School Challenge Elementary School Lunches Selected and Consumed Compared by Year***

	Selected		Consumed	
HEI Component Maximum Score (Guenther et al., 2013)	**2012** (n=509) *M ± SE*	**2013** (n=524) *M ± SE*	**2012** (n=509) *M ± SE*	**2013** (n=524) *M ± SE*
Total Fruit (5)	2.31 ± 0.10[a]	3.72 ± 0.08[a]	2.16 ± 0.10[b]	3.22 ± 0.10[b]
Whole Fruit (5)	2.57 ± 0.11[a]	4.05 ± 0.08[a]	2.35 ± 0.11[b]	3.43 ± 0.10[b]
Total Vegetables (5)	2.07 ± 0.09	2.22 ± 0.086	1.88 ± 0.09	1.88 ± 0.09
Greens and Beans (5)	0.46 ± .064[a]	0.22 ± 0.05[a]	0.42 ± 0.06[b]	0.22 ± .044[b]
Whole Grains (10)	2.78 ± 0.19[a]	2.01 ± 0.14[a]	2.57 ± 0.19[b]	1.66 ± 0.13[b]
Dairy (10)	9.32 ± 0.10[a]	8.95 ± 0.13[a]	8.57 ± 0.14[b]	7.96 ± 0.16[b]
Total Protein Foods (5)	3.68 ± 0.08	3.71 ± 0.07	3.30 ± 0.09	3.47 ± 0.08
Seafood and Plant Proteins (5)	0.47 ± 0.06[a]	1.24 ± 0.09[a]	0.42 ± 0.06[b]	1.05 ± 0.09[b]
Fatty Acids (10)	4.55 ± 0.18	4.49 ± 0.17	4.56 ± 0.18	4.64 ± 0.18
Refined Grains (10)	5.16 ± 0.17	5.51 ± 0.18	5.18 ± 0.18	5.56 ± 0.19
Sodium (10)	4.61 ± 0.16[a]	5.34 ± 0.17[a]	4.60 ±0.16[b]	5.30 ± 0.17[b]
Empty Calories (20)	14.17 ± 0.23[a]	15.39 ± 0.19[a]	13.8 ± 0.25[b]	14.81 ± 0.22[b]
Total Score (100)	52.17 ± 0.62[a]	56.98 ± 0.51[a]	49.82 ± 0.61[b]	53.21 ± 0.53[b]

Note: School Meal Initiative guidelines (USDA-FNS, 1995) were followed in 2012 and HHFKA guidelines (USDA-FNS, 2012b) were followed in 2013.

[a] Indicates significant difference ($p < 0.05$) between HEI-2010 scores (selected) in 2012 and 2013.

[b] Indicates significant difference ($p < 0.05$) between HEI-2010 scores (consumed) in 2012 and 2013.

Changes That Resulted in a Reduction in HEI-2010 Scores

The HEI-2010 score of Whole Grains decreased in both meals selected (2.78 in 2012 to 2.01 in 2013) and consumed (2.57 in 2012 and 1.66 in 2013). The schools participating in this study were "offer versus serve"; therefore, students may have chosen not to take and consume the whole grain products. Whole grains provide dietary fiber, B vitamins and minerals that reduce the risk of chronic disease (USDA-FNS, 2012c). Because of the benefits of including whole grains in the diet, beginning Fall 2012, HHFKA required that half of the grains offered during the school week must meet the "whole grain-rich" criteria, which requires the food to be at least 50% whole grain (USDA-FNS, 2012a). Yet whole grain-rich products do not receive a maximum HEI-2010 score because they are not 100% whole grain. Starting in 2016, all grain products will be required to meet the whole grain-rich criteria, which will have a positive effect on future HEI-2010 Whole Grain scores.

The Greens and Beans component in NSLP meals both selected (0.46 in 2012 to 0.22 in 2013) and consumed (0.42 in 2012 to 0.22 in 2013) revealed a decrease in the HEI-2010 score from year 2012 to 2013. The consumed HEI-2010 score for Greens and Beans 2013 was only 4% of the maximum score of 5. Unlike any other HEI-2010 score component, bean and peas may contribute to two component scores, either the Total Protein score or the Greens and Beans score. If Total Protein does not receive maximum score (5 points), beans and peas in the meal will be allocated in Total Protein and not the Greens and Beans component. Thus a relatively low

protein meal with sufficient beans and peas may have a low Greens and Beans component score (Guenther et al., 2012).

In the current study, the Total Protein HEI-2010 score was not at the maximum, and therefore did not receive a maximum score of 5 in the meals selected and consumed in both 2012 and 2013. Consequently, the beans or peas were not accounted for within the Greens and Beans component. This indicates that although some improvements have been made to non-animal protein sources (like beans and lentils) being utilized in menus, there is still room for improvement to increase selection and consumption of proteins, greens, and beans.

Table 3. ***Comparison of Healthy Eating Index 2010 Component Scores and Percent of Maximum Scores for Lunches Consumed at Four Elementary Schools in 2012 and 2013***

	2012 Consumed Lunches		**2013 Consumed Lunches**	
HEI Component Maximum Score (Guenther et al., 2013)	**Component Score**	**% Maximum Score**	**Component Score**	**% Maximum Score**
Adequacy:				
Total Fruit (5)	2.16	43	3.22	64
Whole Fruit (5)	2.35	47	3.43	69
Total Vegetables (5)	1.88	38	1.88	38
Greens and Beans (5)	0.42	8	0.22	4
Whole Grains (10)	2.01	20	1.66	17
Dairy (10)	8.57	86	7.96	80
Total Protein Foods (5)	3.30	66	3.47	69
Seafood and Plant Proteins (5)	0.42	8	1.05	21
Fatty Acids (10)	4.56	46	4.64	46
Moderation:				
Refined Grains (10)	5.18	52	5.56	56
Sodium (10)	4.60	46	5.30	53
Empty Calories (20)	13.8	69	14.81	74
Total Meal Score: (100)	49.82	50	53.21	52

Table 3 illustrates the percent of maximum score of each HEI-2010 component in the current study comparing 2012 with 2013. Although all scores, except Dairy fall into either the "poor" or "needs improvement" category, most scores increased from 2012 to 2013. Notable improvements occurred in scores for Total Fruit and Whole Fruit while modest improvements occurred in Refined Grains, Sodium, and Empty Calories as well as Total Meal Score. It is apparent the Whole Grains component and Greens and Beans component are the lowest diet quality of the components consumed in 2013 NSLP lunches as they scored in the "poor" diet quality category. Assuming the Whole Grains and Greens and Beans components are low in other schools, CNPs should target these components and increase offerings to assure a balanced menu selection with a higher HEI-2010 meal component scores.

The HEI-2010 Fatty Acids score of 4.64 representing 46% of the maximum score of 10 also falls in the "poor diet" range of less than 51. CNPs could improve this component by offering more fish, seafood, beans, and lentils and offering other plant-based protein sources while limiting sources of saturated fat like beef, butter, and shortening. One way to reduce butter and shortening in recipes is by substituting applesauce for fat in baking. For example, ½ cup of applesauce can replace ½ cup of butter to moisten and hold baked goods together and lower the calories and saturated fat content. Another idea is to offer a vegetarian option for students to select. Stir frying using kidney beans and vegetables, black bean burgers, and tofu seasoned and tossed into burritos are all options that would effectively decrease saturated fat and increase HEI-2010 score for Fatty Acids.

In summary, CNPs are making positive changes to their menus, resulting in overall improvement in nutrition quality of meals when comparing lunches pre-HHFKA (2012) to post-HHFKA (2013) years. Additionally, actual intake of many food components after implementation of HHFKA has either improved or remained constant, which illustrates that school nutrition professionals are offering healthier foods that are still appealing to students.

CONCLUSIONS AND APPLICATION

Results of this study suggest that HHFKA had a positive impact on total meal quality and meal components. From 2012 to 2013, total mean HEI scores were improved for both selected and consumed meals. Specific improvements were observed in the mean HEI-2010 component scores for Total Fruit, Whole Fruit, Greens and Beans, Seafood and Plant proteins, and Sodium. Negative findings in the four schools sampled were the reduced HEI-2010 score of Whole Grains and the consistently low HEI-2010 score for Greens and Beans.

A practical way for CNPs to increase whole grain selection and consumption would be to make food items that students prefer such as pizza crusts or muffins, with 50% whole grain, to create a whole grain rich product. This could potentially increase the likelihood of students' acceptability of the new product. It would be beneficial for CNPs to actively participate in scratch cooking, recipe development, and taste panels to get feedback on food acceptability. These practices could assist in creating recipes that would meet both HHFKA requirements and improve palatability to increase student acceptance and consumption of these modified products.

CNPs could improve the Greens and Beans HEI-2010 score by increasing the use of greens and plant protein used in recipes. Adapting existing recipes to include finely chopped spinach, broccoli or kale with chili, spaghetti or other saucy entrées is one way to increase Greens and Beans. Adding pureed beans into sauces and soups, or hummus onto sandwiches are additional ideas to increase these important components. For example, pureeing two and two-thirds #10 cans (1 gal, 1 ¾ qt) of great northern beans and adding them to a 100-serving macaroni and cheese recipe would provide enough plant protein per serving (.5oz equivalent) to improve the plant protein score from 1.05 to a 5 for that component (Newman Elementary School, 2014). This single change in the menu could improve the total HEI-2010 score from 53.21 to over 57. Moreover, increasing protein in NSLP would help improve the Greens and Beans HEI-2010 score, without having to change the Greens and Beans offerings. The use of unsalted nuts or seeds on salads and side dishes or in baked goods would increase protein amounts of lunches offered.

In summary, the current study indicates that changes in the meal components required by the HHFKA meals standards improved the overall quality of the NSLP meals within the four elementary schools participating in this study. However, the low to mid-level HEI-2010 scores of all meal components illustrate that there is still significant room for improvement. Although these results are based on limited data for four schools, it is worthwhile for CNPs to be innovative in recipe development and meal planning to address areas of inadequacy. Ways that this can be accomplished include incorporating more dry beans or other legumes and 100% whole grains and combining greens and beans into sauces, meats, and soups.

Study Strengths and Limitations

Strengths of the current study include the reliability of the methodology of using digital photography and customizable databases, which prove 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.

Additional strengths included the timing of the data collection. Data were collected over two years in the same four schools. The first set of data was collected the pre HHFKA, while the second set of data was collected post HHFKA adoption. Collecting data from the same four schools controlled other factors from one year to another that could have affected school meals and therefore gave confidence that differences seen were because of implementation of HHFKA. Additionally, comparing food components to analyze the effectiveness of HHFKA on meal quality is more aligned with HHFKA menu planning guidelines than analyzing based on nutrient density, as seen in Bergman et al. (2014), due to the food component structure of the new meal pattern guidelines of HHFKA.

Limitations to the current study include the use of a convenience sample of only four HUSSC schools in one state. Results from these schools may not be generalizable to all schools that participate in the NSLP. Since this study only examined the meal quality of lunches consumed at school, the HEI-2010 scores did not account for all meals consumed during the day. A child's overall meal quality would be greatly influenced by other meals consumed. Future studies should include sampling from various regions of the country to get a better representation of the population. Future studies including non-HUSSC schools are also warranted.

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