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Middle School Cafeteria Food Choice and Waste Prior to Implementation of Healthy, Hunger-Free Kids Act Changes in the National School Lunch Program

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ABSTRACT

Purpose/Objectives
The study objective was to document choices of entrées, vegetables, fruits, grains/breads, and beverages on lunch trays and to determine the amount of each that was discarded after mealtime.

Methods
A convenience sample of two urban middle school cafeterias in Texas participated in the study which took place in the 2010-2011 academic year. Digital photography was used to document student food choices on lunch trays as they exited the serving line and to record portions remaining prior to disposal. Ultimately 1,418 matched before and after tray images were uploaded to a digital library where three investigators used a standardized protocol to determine the amount of each meal component discarded.

Results
Meat and cheese-based entrées were popular and produced very little waste. Few students chose dark green or red-orange vegetables or legumes as a lunch item. Over half of the students who selected mashed potatoes, corn, raw carrots, beans (pinto, ranch-style, or green), fresh apples, or rice discarded half or more of the food item. A third of trays photographed contained no fruit, and canned fruit was chosen more frequently than fresh. Bread/grains typically appeared as part of an entrée and were a moderate source of waste with the exception of white rice. Skim chocolate milk was heavily favored over 1% white.

Application to Child Nutrition Professionals
Transitioning school meals to a greater reliance on vegetable subgroups other than starchy vegetables, increasing servings of fruits and vegetables, and adding more whole-grain rich foods is challenging. Investigation of food choice and waste prior to HHFK implementation provides background for analysis of post implementation success.

INTRODUCTION

The Healthy Hunger-Free Kids Act of 2010 (HHFKA) updated the National School Lunch Program (NSLP) initiating a discussion of food choice and waste in school cafeterias (U.S. Congress, 2010; Pratt-Heavner, May 28, 2014). Citing recommendations promulgated by the Food and Nutrition Board of the Institute of Medicine (IOM) (2009), HHFKA launched a new food based menu system that incorporated key aspects of *Dietary Guidelines for Americans 2010* (DGA) (U.S. Department of Health and Human Services [USDHHS] & U.S. Department of Agriculture [USDA], 2010). Changes in meal components included those for meat/meat alternate, fruits, vegetables, grains, and milk (USDA Food and Nutrition Service [FNS], 2012).

Tofu and soy yogurt were added as meat alternates; daily servings of fruits and vegetables were required; whole grain rich foods replaced refined, and flavored milk was limited to fat-free.

Using data from the School Nutrition Dietary Assessment Data III and the School Lunch and Breakfast Cost Study II, Newman (2012) predicted that the new meal rules concerning dark green and red/orange vegetable subgroups would increase food cost even as reductions in starchy vegetables and overall calories reduced it. In Fall 2011, Gase, McCarthy, Robles, and Kou (2014) examined fruit and vegetable waste at four randomly selected Los Angeles middle schools and found that 31.5% of students did not select fruits, and 39.6% did not select vegetables. The researchers expressed concern about fruit and vegetable waste and recommended further research on strategies for increasing consumption.

As the new NSLP menu planning system took effect in the 2012-2013 school year anecdotal evidence grew concerning food choice and waste. A principal in South Dakota complained that students ate the entrée while discarding fruits and vegetables (Anonymous, March 2013). Associating food waste with new meal requirements, two school districts in Wisconsin opted out of the NSLP preferring to locally finance meals (Editors, June 2014). The USDA reported one million fewer students participating in school lunch from fiscal year 2012 to 2013 as the School Nutrition Association expressed concern over new meal requirements that increased cost and generated unacceptable levels of waste (USDA-FNS, 2014; Pratt-Heavner, October 7, 2014).

The current study documented lunchtime food selection in two urban Texas middle school cafeterias prior to NSLP meal changes and estimated waste using digital photography and standardized procedures for visual estimation. Results of the study add to knowledge concerning meal component choice in the year leading up to changes in school lunch standards and provide a baseline for comparison with post-implementation waste.

METHODOLOGY

Setting and Procedures

The University Internal Review Board reviewed the study protocol and deemed it exempt from further review in accordance with 45 46.101 (b) CFR. During Spring 2011, a research team documented food choice and waste by photographing lunch trays of seventh grade students at two urban middle schools in Texas composed of grades six, seven, and eight. Lunch trays were not associated with individual students, personal information was not collected, and students were not photographed. To prepare for photographic sessions, the research team observed lunchtime in the cafeterias for a total of 15 days in Fall 2010 to become familiar with menu items, serving line procedures, cafeteria layout, and traffic flow. Subsequently a four-day pilot study tested equipment and finalized procedures.

The school district where data collection took place participated in NSLP and used Nutrient Standard Menu Planning (NSMP) to routinely analyze menus for compliance with regulations. In this menu planning approach, a minimum of three lunch items (entrée, side dish, and milk) was offered to students (USDA-FNS, 2012). An entrée was considered a single food, such as chicken nuggets or a combination food such chili cheese nachos. A side dish, such as pinto beans or applesauce, was a nutritious food other than an entrée or milk. The middle schools also utilized Offer v. Serve, a system in which students are allowed to reject one meal item as long as it is not the entrée. If more than three lunch items are offered, students can refuse two (USDA-FNS,

2013). A typical lunch at the study site consisted of an entrée that included a meat/meat alternate accompanied by a bread/grain and/or vegetable, a fruit, and a milk. Menu items remained the same throughout the study period.

To match before/after lunch images of trays, address labels were coded using a random number generator and attached to the upper left corner of unused polystyrene foam trays. Three Cannon PowerShot™ 1400 cameras with 8 GB memory cards were connected to apparatus that formed a T-aerial constructed of ½ inch PVC pipe with fittings and a GorillaGripper™ that suspended each camera at a height of two feet above a 15x20 inch black FOAMCORE™ board. To position trays directly below the camera an 8x15 inch white rectangle that replicated the dimensions of a Genpak™ five-compartment polystyrene foam lunch tray was outlined on the FOAMCORE™ board. Each apparatus with camera was mounted on one of three food trolleys for easy relocation.

Data Collection and Analysis

Photographic sessions took place during 30-minute seventh grade lunch periods between January and April 2011. Six non-contiguous days of photo shoots were completed at school one, and five at school two. Both school cafeterias had three serving lines with a cashier stationed at the end of each. A digital camera was positioned approximately three feet past each cashier where photographs were taken as students placed their trays in the white rectangle before moving from the serving line to the cafeteria seating areas. A trained research assistant was assigned to each camera. To capture after consumption images, the cameras were moved to a common doorway where children disposed of trays and exited the cafeteria. After each photo session, images were downloaded to an external hard drive and subsequently edited using Photoshop Lightroom™ 3 to focus and align each picture. Twenty-six images were eliminated from analysis due to an obstructed view of food items or a missing before/after match. Subsequently 1,418 usable pairs were archived on a digital library to enable use by members of the research team and for public access to data.

Researchers analyzed data using a lunch tray image analysis protocol with photographs that described menu items, demonstrated portion sizes, and provided instructions on estimating the amount of each item remaining on a tray. The quarter visual estimation method (none, ¼, ½, ¾ or all) was used to estimate the amount of entrée remaining. The half visual estimation method (none, ½ or all) was used for breads/grains, as well as for vegetable and fruit side dishes. Beverages were analyzed as opened or unopened. Three trained analysts evaluated the same 50 photo pairs and compared results until analysis was consistent on 95% of all images reviewed. Subsequently 1,418 image pairs were analyzed using the analysis protocol and an online survey tool to record data.

RESULTS AND DISCUSSION

The two middle schools selected for the study served a combined average of 364 seventh grade lunches daily. The school lunch program had a 73% participation rate with 58% of students receiving free or reduced-price lunches. Ethnically the schools were composed of 42% white students, 41% Hispanic, 13% African-American and 4% other ethnicity.

In 2011 the minimum caloric level for NSLP lunches for grades 7-12 was 825 kilocalories (kcal) per meal when averaged over a school week. To determine the caloric contribution of the entrée, nutrition information available on the school district website was downloaded and the nutrient profile of each entrée reviewed. Calorie content for entrées included the following: hamburger/bun, 290 kcal; chicken nuggets, 290 kcal; cheeseburger/bun, 325 kcal; cheese pizza, 360 kcal; and chili cheese nachos, 414 kcal. Based on frequency of appearance on photographed trays, a weighted mean of 364 kcal per serving was calculated indicating that the entrée provided 44.1% of required calories. DGA 2010 recommends that sodium intake be limited to 2,300 mg/day (USDHHS, & USDA, 2010). The sodium content of the entrées reviewed ranged from 680 mg for a hamburger/bun to 1,383 mg for chicken fajita. A weighted mean of 948 mg per serving was calculated indicating that the lunchtime entrée accounted for 41.2% of recommended daily sodium intake.

Table 1. ***Entrées Selected and Discarded on Lunch Trays of Middle School Students***

Entrée*	Selected		Amount Discarded (n)				
	n	%	None	1/4	1/2	3/4	All
Pizza	428	(33.4)	305	94	22	5	2
Chili and cheese nachos	216	(16.8)	162	23	13	15	3
Chicken nuggets	180	(14.0)	170	8	2	0	0
Hamburger/cheeseburger	129	(10.1)	116	6	5	2	0
Steak fingers	71	(5.6)	61	8	1	1	0
BBQ rib sandwich	55	(4.3)	41	11	2	1	0
Beef and beans burrito	54	(4.2)	49	4	1	0	0
Crispito without cheese	45	(3.5)	37	5	1	2	0
Chicken in Asian sauce	33	(2.6)	23	6	3	0	1
Grilled chicken sandwich	32	(2.5)	22	3	4	0	3
Chicken fajita	24	(1.8)	8	8	4	4	0
Chicken strip in salad	15	(1.2)	8	2	3	2	0
Total	1,282		1,002	178	61	32	9

*Not all photographed trays contained an entrée

An entrée may be a single item or combination of food items. Entrées offered in school menus typically include a meat/meat alternate coupled with a cereal/grain or a vegetable. Although the static middle school menus offered an assortment of 12 entrée choices each day of the study, most students (74.3%) concentrated their choices among four entrées: pizza (33.4%), chili cheese nachos (16.8%), chicken nuggets (14.0%), and hamburger/cheeseburger with bun (10.1%) (Table 1). The predominance of these four entrées is consistent with previous research on school meals. In a review of the Federal Child Nutrition Commodity Program (FCNCP), Hecht et al. (2008) described beef, cheese, and chicken as meat/meat alternates that dominated school FCNCP spending and highlighted hamburgers, pizza, and chicken nuggets as lunchtime entrées that were typically fabricated from them. In an investigation of the healthfulness of entrées in California elementary schools, Woodward-Lopez et al. (2014) described pizza, chicken/meat nuggets, cheese-based foods, and hotdog/corn dogs as processed entrées common to school meals. The current study confirms the popularity of these familiar entrées and highlights the small amount of waste associated with them. Regardless of which entrée was chosen, the majority (78.2%) of students finished it completely. Only a small percentage (4.8%) discarded half or more of the entrée.

The USDA Vegetables Food Group is composed of five subgroups with a recommended pattern of 8% of dietary vegetables from the dark-green subgroup, 8% from cooked dried peas and beans, 32% from red and orange, 24% from other, and 28% from starchy (USDHHS & USDA, 2010). Prior to HHFKA the Third School Nutrition and Dietary Assessment Study revealed a preponderance of starchy vegetables in school meals (Condon, Crepinsek, & Fox, 2009). Most (64%) of the middle school menus reviewed by Condon et al. included at least one starchy vegetable with 40% listing French fries, 17% corn, and 15% white potatoes. Only a quarter (28%) of the middle school menus included orange/dark green vegetables, and only 23% listed legumes. In the current study, starchy vegetables appeared on 82.0% of photographed trays with 36.6% containing mashed potatoes; 30.7%, French fries; 10.6%, baked potato chips; and 4.1% corn (Table 2). While 81.9% of students ate all the French fries on their trays, less than half (42.5%) consumed the entire serving of mashed potatoes, and approximately a quarter (24.9%) ate none at all. Only 10.6% of vegetables photographed on lunch trays were from the dark green, red/orange, and legumes subgroups combined. Half or more of a serving was discarded on the tray 28.6% of the time for broccoli with cheese sauce (dark green), 57.4% for carrots (red/orange vegetable), 50.0% for ranch beans (legume), and 71.4% for green beans (other vegetable).

Table 2. ***Vegetables Selected and Discarded on Lunch Trays of Middle School Students***

Vegetable*	Selected		Amount Discarded (n)		
	n	%	None	1/2	All
Mashed potatoes	449	(36.6)	192	145	112
French fries, baked	376	(30.7)	308	60	8
Potato chips, baked	130	(10.6)	107	20	3
Vegetable sticks	93	(7.6)	65	14	14
Carrot, raw/dressing	61	(5.0)	26	17	18
Corn, canned	50	(4.1)	22	17	11
Broccoli with cheese	28	(2.3)	20	3	5
Ranch style beans	16	(1.3)	8	4	4
Green beans	14	(1.1)	4	5	5
Pinto beans	9	(0.7)	0	8	1
Total	1,266		752	393	181

*Not all photographed trays contained vegetables

Fruit was a typical side dish at the middle school cafeterias, and students were not required to select it. Approximately a third (29.6%) of photographed lunch trays contained no fruit at all. Of those trays where students did choose fruit, over half (58.5%) had no fruit waste after lunch while on a fifth (20.5%) of the trays all of the fruit was discarded (Table 3). Fresh apples constituted 22.3% of all fruit appearing on trays and oranges, 11.4%. When apples were selected, either half or all of the apple was discarded on 69.5% of trays making apples a remarkable source of waste. This is consistent with a report by Marlette, Templeton and Panemangalore (2005) that documented a 62% waste of fresh apples by sixth grade schoolchildren. Canned fruit accounted for 63.9% of all fruit photographed on trays. Among canned fruit choices, peaches (15.4%) were the most popular item followed by applesauce (14.3%), fruit cocktail (14.1%), pineapple (12.6%) and pears (7.5%). Although a quarter (26.8%) of the students who selected canned fruit ate all of it, 36.0% of those with pears, 31.9% with fruit cocktail, 24.5% with applesauce, 23.0% with pineapple, and 22.7% with peaches ate none at all. While the majority of the students did select fruit, the proportion discarded stood out, particularly when compared to entrées.

Table 3. ***Fruits Selected and Discarded on Lunch Trays of Middle School Students***

Fruit*	Selected		Amount Discarded		
	n	%	None	½	All
Apple, fresh	223	(22.3)	68	80	75
Peaches, canned	154	(15.4)	106	13	35
Applesauce, canned	143	(14.3)	77	31	35
Fruit cocktail, canned	141	(14.1)	79	17	45
Pineapple, canned	126	(12.6)	76	21	29
Orange, fresh	114	(11.4)	78	16	20
Pears, canned	75	(7.5)	40	8	27
Strawberries, fresh	13	(1.3)	12	0	1
Banana, fresh	10	(1.0)	7	2	1
Total	999		543	188	268

*Not all photographed trays contained fruits

Breads/grains typically appeared as part of an entrée, such as the crust of a pizza or a hamburger bun. Wheat was an ingredient in 70.9% of grain-based foods observed including pizza crust, dinner roll, breading, buns, and tortillas (Table 4). White rice represented 17.8% of photographed grain-based foods while corn tortilla chips represented 11.3%. Notable was the waste of rice with 26.6% of students discarding half a serving and 40.2% eating none at all. In comparison, only 14.4% of dinner rolls were left untouched, 0.5% of sandwich buns, and 1.4% of nachos. Of 1,095 cartons of milk photographed on trays, 75.5% were chocolate skim milk, and 24.5% were 1% white milk (Table 5). Milk waste was related to type with 13.3% of chocolate skim milk cartons unopened and 16.4% of 1% white unopened.

Table 4. ***Breads/Grains Selected and Discarded on Lunch Trays of Middle School Students***

Breads/Grains*	Selected		Amount Discarded		
	n	%	None	1/2	All
Crust on pizza	438	(23.0)	399	34	5
White rice	338	(17.8)	112	90	136
Dinner roll	263	(13.8)	187	38	38
Breading on chicken	227	(11.9)	201	24	2
Corn tortilla chips	216	(11.3)	185	28	3
Sandwich bun	214	(11.2)	199	14	1
Tortilla	123	(6.5)	111	12	0
Breading on veg sticks	85	(4.5)	65	14	6
Total	1,904		1459	254	191

*Not all photographed trays contained grains/breads

Table 5. ***Beverages Selected and Discarded on Lunch Trays of Middle School Students***

Beverages*	Selected		Amount Discarded	
	n	%	Open	Closed
Milk, chocolate skim	827	72.5	717	110
Milk, white, 1%	268	23.5	224	44
Sports drink	29	2.5	26	3
Water, bottled	10	0.9	8	2
Snapple juice	7	0.6	7	0
Total	1,141		982	159

*Not all photographed trays contained a beverage

CONCLUSIONS AND APPLICATION

The meat and cheese-based entrées served at the middle schools participating in the current study were popular with students and generated the least post-meal waste when compared to fruits and vegetables. Smith and Cunningham-Sabo (2014) conducted a plate waste study in Colorado middle schools and found that approximately 19% of the entrée was wasted. In the current study, 21.8% of students discarded some of the entrée while only 3.1% discarded all of it. Also the majority of the middle school students in the current study consumed all of the entrée making it a principal source of lunchtime calories and overall nutrient intake. Strategies for improving nutrition in school meals should begin with reformulated entrées that increase use of whole grains, vegetables, and fruits.

In the current study, starchy vegetables were overwhelmingly present on trays photographed prior to HHFKA with the majority (79.3%) containing mashed potatoes, French fries, baked potato chips, or corn. A minority of trays (9.0%) contained vegetables from other subgroups and waste was high. Cullen, Watson and Dave (2011) analyzed lunchtime intake as reported by middle school students and found that half selected a starchy vegetable while only a small minority (<4%) chose legumes, dark green, or orange vegetables. The authors cautioned that, due to student preferences, increased servings of non-starchy vegetables, as required by HHFKA, might not equal increased consumption. Goslinger (2014) evaluated the relationship between produce consumption and school factors such as the amount of time available for meals or student involvement in foodservice. She concluded that a comprehensive approach was needed that went beyond simple vegetable access to include a supportive school environment that changed patterns of consumption and challenged established food habits.

Despite the availability of both fresh and canned options, fruit was absent on a third of trays photographed indicating that students chose not to include it with lunch. These results agree with other reports concerning fruits in school cafeterias. Wengreen et al. (2013) found that 39% of elementary-school children consumed no fruit at school during a baseline period prior to an intervention. DiNoia and Contento (2010) examined the impact of availability on adolescent fruit consumption and reported that consumption was greater at breakfast and dinner than at lunch. In the current study, canned fruit was more popular than fresh and overall it generated less waste. These results were consistent with a digital photography study of elementary school lunch trays conducted by Yoder, Foecke, and Schoeller (2014) that documented raw fruits generating greater

waste than cooked. Conversely, in a review of the California Fresh Start Program, Crawford, Woodward-Lopez & Webb (2013) found that frequent offerings of fresh fruit coupled with greater variety increased consumption among schoolchildren. Further study is needed, then, to elucidate those cafeteria factors that favor canned fruit and to recommend new approaches for serving fresh fruit that increase consumption and reduce waste.

In an analysis of NHANES 2003-2008 data, Hanson and Olson (2013) measured dietary quality among children and reported that lunch alone did not modify whole grains (WGs) consumption and related this to limited offerings in school meals. Cohn and associates (2014) explored the impact of a school-based intervention designed to increase WGs access and found a positive trend while reporting that non-intervention cafeterias typically offered just one WGs serving per week. Dietary fiber intake increased among school children served a pizza crust rich in WGs indicating that reformulating a familiar food has the potential to positively impact diet quality (Hur, Marquart, & Reicks, 2014). In the current study, data on the whole grain content of menu items were not collected; however, grains/breads (with the exception of rice) were moderate sources of waste suggesting a potential to improve nutrient intake as more whole grain-rich products become available.

Yon and Johnson (2014) assessed the impact of changes in the caloric content of flavored milk and concluded that reducing fat and/or sugar had little impact on acceptance of school milk. Hanks, Just & Wansink (2014) investigated eliminating chocolate milk and reported that, although the majority of school children indicated they were willing to switch to white, 9.9% stopped selecting milk altogether when chocolate was removed. In addition, schools serving only white milk experienced greater waste when compared to those offering both chocolate and white. Results of the current study are consistent with previous research in which children expressed a preference for chocolate milk (Connors, Bednar, & Klammer, 2001). A study comparing nutrient intakes of children who drank milk to those who did not found that milk-drinkers consume more calcium, phosphorous, magnesium, potassium, and vitamin A (Murphy, Douglass, Johnson, & Spence, 2008). Using data from National Health and Nutrition Surveys (NHANES), the researchers observed that undesirable BMI outcomes were not associated with drinking either plain or flavored milk and concluded that limiting access to flavored milk reduced consumption with the potential to adversely impact nutritional status.

This study used digital photography, a validated method for documenting plate waste, and a standardized procedure that minimized impact on cafeteria lunchtime activities. Accurately measuring waste is essential to understanding the impact of changes in school meals. Hanks, Wansink and Just (2014) evaluated the reliability of visual techniques for documenting plate waste in school cafeterias and concluded that the on-site quarter-waste method was superior to photographic methods; however, the authors noted that photographs of individual trays before students ate were not available for comparison to post-consumption trays. Martins, Cunha, Rodrigues, and Rocha (2014) compared weight and visual estimation of plate waste in Portuguese primary schools and found that, although the visual method overestimated waste when portioning was inconsistent, it was a viable method for monitoring food waste in large group settings. Taylor, Yon and Johnson (2014) recently confirmed that digital photography was reliable for estimating fruit and vegetable intake and mean meal consumption in elementary school cafeterias.

In a study documenting a chef intervention in Boston middle schools, Cohen and associates measured plate waste by weighing menu items remaining on trays after lunch and comparing results to portion estimates determined by randomly sampling items prior to meal service (Cohen, Richardson, Austin, Economos, & Rimm, 2013). Based on results, the researchers concluded that over a quarter of the food budget was allocated to foods that were discarded by students. Although fewer vegetables were rejected at intervention than at control sites, overall

students discarded 19% of entrées, 47% of fruits, 73% of vegetables and 25% of milk. Subsequently the researchers conducted a natural experiment when HHFKA menu changes were implemented at the schools under study (Cohen, Richardson, Parker, Catalano, & Rimm, 2014). A comparison of food waste data from Fall 2011 (prior) to Fall 2012 (post) found negligible increase in waste despite greater vegetable variety and larger portions. The investigators cautioned, however, that fruit and vegetable waste was historically high in urban low-income schools and that student engagement in menu planning was needed for new meal options to successfully impact nutrient intake.

Results of this project document meal choice and waste in middle school cafeterias as it occurred in the year prior to implementation of new NSLP standards. Study results highlight the popularity of entrées such as pizza and chicken nuggets that generated little waste making them major contributors to calorie intake. Replacing these foods with main dishes that are lower in fat and higher in fiber would improve the nutritional quality of school meals. Dishes that incorporate beans, lentils, nuts, or soy yogurt should be encouraged and tested for acceptance as potential alternatives to processed foods. Waste of fruits and vegetables is not unique to school lunch programs that have incorporated NSLP changes. In this pre-HHFKA study, starchy vegetables were over-represented while dark green, red/orange vegetables and legumes underrepresented. Mashed potatoes, corn, raw carrots, pinto beans, ranch beans, and green beans produced the greatest waste. The majority of students discarded half or more of the mashed potatoes served suggesting that menu planners need to decrease this offering. Fruit was absent on a third of trays with canned fruit far more prevalent than fresh. The preponderance of canned fruit and excessive waste of fresh apples support the need for innovative ways of preparing and serving fresh fruits. Overall breads/grains generated the least waste with white rice as the exception. Results of this study provide a picture of food choice and waste in middle school cafeterias prior to changes in meal requirements and contribute to the continuing discussion of the impact of new standards that emphasize different meal components and challenge tradition approaches to serving meals to school children.

Study Strengths and Limitations

The large number of tray image pairs captured and analyzed strengthened this study. In addition, the project was conducted over a period of weeks thereby minimizing the impact of student absences or school events that might reduce lunch participation on specific days. The middle schools featured a standardized menu that was consistent throughout the study period allowing for a precise tracking of student choice and waste. The current study featured a convenience sample of two middle schools in the same school district, thereby limiting generalizability. Information was not collected on food play or sharing activities that may have altered waste appearance. Additionally the digital photography methodology disqualified photos in which food items were obscured and before/after matches were not available (n=26). Visually estimating waste lacks the accuracy of weighing; however, it is cost effective for evaluating a large numbers

of trays. Digital photography coupled with visual estimation minimized cafeteria disruption and accommodated the fast pace of a lunch period at school. Finally, this study highlighted patterns of waste rather than absolute measures of volume.

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REFERENCES

Anonymous. (March 2013). Principals feeling impact of new lunch regulations. *The Education Digest, 78*(7), 47-49.

Cohen, J. F W., Richardson, S., Austin, S. B., Economos, C. D., & Rimm, E. B. (2013). School lunch waste among middle school students: Nutrients consumed and cost. *American Journal of Preventive Medicine, 44*(2), 114-121. doi:10.1016/j.amepre.2012.09.060

Cohen, J. F. W., Richardson, S., Parker, E., Catalano, P. J., & Rimm, E. B. (2014). Impact of the new U.S. Department of Agriculture school meals standards on food selection, consumption and waste. *American Journal of Preventive Medicine, 46*(4), 388-394. doi:10.1016/j.amepre.2013.11.013

Cohen, J. F. W., Rimm, E. B., Austin, S. B., Hyatt, R. R., Kraak, V. I., & Economos, C. D. (2014). A food service intervention improves whole grain access at lunch in rural elementary schools. *Journal of School Health, 84*(3), 212-219. doi:10.1111/josh.12133

Condon, E. M., Crepinsek, M. K., & Fox, M. K. (2009). School meals: Types of food offered to and consumed by children at lunch and breakfast. *Journal of the American Dietetic Association, 190*(2), S67-S78. doi:10.1016/j.jada.2008.10.062

Connors, P., Bednar, C., & Klammer, S. (2001). Cafeteria factors that influence milk drinking behaviors of elementary school students: A grounded theory approach. *Journal of Nutrition Education, 33*(1), 31-36.

Crawford. P.B., Woodword, G. & Webb, K. L. (2013). Lessons of *Fresh Start* can guide schools seeking to boost student fruit consumption. *California Agriculture, 67*(1), 21-29. doi:10.3733/ca.v067n01p21

Cullen, K. W., Watson, K. B., & Dave, J. M. (2011). Middle-school students' school lunch consumption does not meet the new Institute of Medicine's National School Lunch Program recommendations. *Public Health Nutrition, 14*(10), 1876-1881. doi:10.1017/S1368980011000656

Di Noia, J., & Contento, I. R. (2010). Fruit and vegetable availability enables adolescent consumption that exceeds national average. *Nutrition Research, 30*(6), 396-402.

Editors. (June 2014). Two Wisconsin schools plan to leave school lunch program. *Nutrition Business Journal*, *ProQuest*. Web 17.

Gase, L. N., McCarthy, W. J, Robles, B., & Kou, T. (April 2014). Student receptivity to new school meal offerings: Assessing fruit and vegetable waste among middle school students in the Los Angeles Unified School District. *Preventive Medicine*. doi:10.1016/j.ypmed.2014.04.013

Gosliner, W. (2014). School-level factors associated with increased fruit and vegetable consumption among students in California middle and high schools. *Journal of School Health, 84*(9), 559-668. doi:10.1111/josh.12188

Hanks, A.S., Just, D.R., & Wansink, B. (2014). Chocolate milk consequences: A pilot study evaluating the consequences of banning chocolate milk in school cafeterias. *PLOS One 2014*. doi:10.1371/journal.pone.0091022 Retrieved from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0091022

Hanks, A. S., Wansink, B., & Just, D. R. (2014). Reliability and accuracy of real-time visualization techniques for measuring school cafeteria tray waste: Validating the quarter-waste method. *Journal of the Academy of Nutrition & Dietetics, 114*(3), 470-474. doi:10.1016/j.jand.2013.08.013

Hanson, K., & Olson, C. M. (2013). School meals participation and weekday dietary quality were associated after controlling for weekend eating among U.S. school children aged 6 to 17 years. *The Journal of Nutrition, 143*(5), 714-721.

Hecht, K., Sharp, M., Beller, D., Shimada, T., Samuels, S., Boyle, M., & Stone-Francisco, S. (2008). *The impact of the Federal Child Nutrition Commodity Program on the nutritional quality of school meals in California.* Princeton, NJ: Robert Wood Johnson Foundation.

Hur, I. Y, Marquart, L., & Reicks, M. (2014). Nutrient intakes among children and adolescents eating usual pizza products in school lunch compared with pizza meeting HealthierUS School Challenge criteria. *Journal of the Academy of Nutrition & Dietetics*,*114*(5), 768-773. doi:10.1016/j.jand.2013.07.034

Institute of Medicine. (2009). *School meals: Building blocks for healthy children*. Washington, DC: The National Academies Press.

Marlette, M. A, Templeton, S. B., & Panemangalore, M. (2005). Food type, food preparation and competitive food purchases impact school lunch plate waste by sixth-grade students. *Journal of the American Dietetic Association*, *105*(11), 1779-1782.

Martins, M. L., Cunha, L. M., Rodrigues, S. P., & Rocha, A. (2014). Determination of plate waste in primary school lunches by weighing and visual estimation methods: A validation study. *Waste Management, 32*(8), 1362-1368. doi:10.1016/j.wasman.2014.03.020

Murphy, M. M., Douglass, J. S., Johnson, R. K., & Spence, L. A. (2008). Drinking flavored or plain milk is positively associated with nutrient intake and is not associated with adverse effects on weight status in U.S. children and adolescents. *Journal of the American Dietetic Association, 108*(4), 631-639. doi:10.1016/j.jada.2008.01.004

Newman, C. (2012). The food costs of healthier school lunches. *Agricultural & Resource Economics Review, 41*(1), 12-28.

Pratt-Heavner, D. (October 7, 2014). Schools face challenges as they promote healthy meals during national school lunch week. School Nutrition Association. Retrieved from http://www.schoolnutrition.org/PressReleases/SchoolsFaceChallengesDuringNationalSchoolLunchWeek/

Pratt-Heavner, D. (May 28, 2014). Stories from the front lines: School cafeteria professionals discuss challenges with new standards. School Nutrition Association. Retrieved from http://www.schoolnutrition.org/Blog2.aspx?id=20502&blogid=564

Smith, S. L., & Cunningham-Sabo, L. (2014). Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the U.S. National School Lunch Program. *Public Health Nutrition, 17*(6), 1255-1263. doi:10.1017/S1368980013001894

Taylor, J.C., Yon, B. A., & Johnson, R.K. (2014). Reliability and validity of digital imaging as a measure of schoolchildren's fruit and vegetable consumption. *Journal of the Academy of Nutrition & Dietetics, 114*(9),1359-1366. doi:10.1016/j.jand.2014.02.029

U.S. Congress. Senate Committee on Agriculture, Nutrition and Forestry. (2010). *Healthy, Hunger-Free Kids Act of 2010: Report together with additional and supplemental views (to accompany S. 3307).* Washington DC: U.S. Government Printing Office. Retrieved November 7, 2014 from http://hdl.handle.net/2027/mdp.39015089032240

U.S. Department of Agriculture, Food and Nutrition Service. (2012). *Nutrition standards in the National School Lunch Program and School Breakfast Program,* Pub. L. No. 7 CFR Parts 210 and 220.

U.S. Department of Agriculture, Food and Nutrition Service. (2013). *Offer versus Serve: Guidance for the National School Lunch Program and the School Breakfast Program*. Alexandria, VA.

U.S. Department of Agriculture Food and Nutrition Service. (2014). *National School Lunch Program: Total participation data as of October 3, 2014.* Retrieved November 3, 2014 from www.fns.usda.gov/sites/default/files/pd/01slfypart.pdf

U.S. Department of Health and Human Services & U.S. Department of Agriculture. (2010). *Dietary Guidelines for Americans*, 7th ed. Washington, DC; U.S. Government Printing Office.

Wengreen, H. J., Madden G. J., Aguilar, S. S., Smits, R. R., Brooke, A., & Jones B. A. (2013). Incentivizing children's fruit and vegetable consumption: Results of a United States pilot study of the Fruit Dudes program. *Journal of Nutrition Education & Behavior*, *45*(1), 55-59.

Woodward-Lopez, G., Kao, J., Kiesel, K., Miller, M. L., Boyle, M., Grago-Ferguson, S. , & Crawford P. (2014). Is scratch-cooking a cost-effective way to prepare healthy school meals with U.S. Department of Agriculture foods? *Journal of the Academy of Nutrition & Dietetics*, *114*(9), 1349-1358. doi:10.1016/j.jand.2014.05.002

Yoder, A. B., Foecke, L., & Schoeller, D. (2014). School food environment factors affecting fruit and vegetable school lunch waste in Wisconsin elementary schools. *Journal of Nutrition & Education Behavior, 46*(4), S141-142. doi:10.1016/j.jneb.2014.04.118

Yon, B.A., & Johnson, R. K. (2014). Elementary and middle school children's acceptance of lower calorie flavored milk as measured by milk shipment and participation in the National School Lunch Program. *Journal of School Health. 84*(3), 205-211. doi:10.1111/josh.12135

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