Evaluation of a Food Waste Reduction Campaign in a University Dining Hall

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Abstract: The foodservice industry generates food waste in the kitchen as well as anything leftover on consumers' plates. While software programs have been developed to optimize inventory management and meal planning (and thus, reduce food waste) in the kitchen, fewer efforts have targeted plate waste. In all-you-care-to-eat dining settings, such as university dining halls or other buffet-style restaurants, concerns over food waste are even higher as there are no monetary incentives to take less food. In addition, university dining facilities primarily serve young consumers (ages 18-24) who tend to be more wasteful than the average adult, further increasing the likelihood of plate waste in these settings. Appeals to money-saving have been identified as the best motivator to reduce consumer food waste generally; however, alternative motivators will likely be needed when the quantity of food and its associated cost are not directly linked. The purpose of this study is to determine the efficacy of a student-centered food waste reduction campaign in a university dining hall setting. Consumer plate waste was collected, sorted, and weighed in a treatment and comparison dining hall for a semester to assess the impact of the campaign on both the quantity and quality of food waste. Preliminary results reveal that the campaign had a modest, but insignificant, impact on waste behavior, with waste reductions primarily occurring in the "other" (as opposed to protein or fruit/vegetable) waste category.

Key Words: food waste; plate waste; education campaign; dining hall; all-you-care-to-eat

Introduction

Food loss and food waste are growing concerns in the United States and abroad due to their economic, environmental and social impacts (see Gunders, 2012 and Buzby, Hyman, and Wells, 2014 for discussions on the costs of food waste in terms of dollars, calories, and resources used). While all actors along the supply chain generate food waste, the end stages of the supply chain – food retail, foodservice, and households (consumers) – have been identified as key targets for waste reduction efforts in developed countries.[1]

At the foodservice level, waste occurs in both the "back of house" (kitchen waste) and "front of house" (consumer waste). Back of house waste is generated from trimmings, overpreparation of food, and spoilage, for example, and is estimated to comprise 4-10% of total food purchased by restaurants (Gunders, 2012). Most waste reduction efforts in foodservice have targeted the back of house operations, as managers and staff have more control over waste generated in the kitchen.[2] Conversely, front of house waste is primarily driven by consumer plate waste; Gunders (2012) notes this form of waste can most often be attributed to oversized portions or consumers not liking their meals.

In the case of all-you-care-to-eat (buffet) establishments, including college/university dining facilities, there is concern that waste is higher in both the front and back of house operations because there is an expanded menu of food options (Buzby et al., 2011; Gunders, 2012; Mirosa, Loh, and Spence, 2016). The fixed entry fee may also be a contributor to food waste in these dining settings, as consumers can take (and waste) as much food as they want

[1] Several public and private initiatives have been formed to facilitate knowledge-sharing of best practices on reducing food waste across the supply chain. These include the Food Waste Reduction Alliance (FWRA, 2013); U.S. Food Waste Challenge (USDA, 2013) and SAVE FOOD initiative (FAO, 2016).

[2] Many foodservice operators have implemented the LeanPath software (www.leanpath.com) in their business, which is designed to track and quantify where waste is occurring in the back of house operations. The long-term goal of such tracking technologies is to better optimize menu planning and inventory management to reduce waste and improve margins.

without incurring additional costs. Research has shown that monetary incentives (appeals to saving money) are one of the best motivators for reducing food waste (Thyberg and Tonjes, 2016; Neff, Spiker, and Truant, 2015; Graham-Rowe, Jessop, and Sparks, 2014; Quested et al., 2013); however, a fixed rate pricing strategy does not allow for such an incentive to be realized.

College and university all-you-care-to-eat settings are uniquely challenged in reducing waste as they are home to one of the most wasteful segments of consumers – young adults (Quested et al., 2013; Thyberg and Tonjes, 2016). To combat food waste in these settings, many institutions have adopted trayless dining in their dining halls. Research has shown this small environmental adjustment can significantly reduce waste (Kim and Morawski, 2012; Thiagarajah and Getty, 2013), though Wansink and Just (2015) caution that the reductions made may not always align with dietary goals. Another approach is to educate consumers about food waste in hopes of altering their behavior. Only one study to our knowledge has examined the impact of information in a college/university dining setting. Whitehair, Shanklin, and Brannon (2013) found that reminding diners to "eat what you take" resulted in a 15% food waste reduction; however, it is important to note the finding is based on diners that opted in to having their food waste tracked back to their student identification number. Plate waste was measured for all students (even if they did not opt in to the tracking), but results were only reported for those students who had observations recorded (linked to their identification number) in each of the three study periods (Whitehair, Shanklin, and Brannon, 2013). This approach may suffer from self-selection bias, such that diners who allowed their waste to be tracked multiple times may behave differently than the average diner (Heckman, 2010).

The purpose of this paper is to evaluate the broader impacts of a student-centered food waste reduction campaign in an all-you-care-to-eat university dining setting. To study this, we

conduct a field experiment in two dining facilities (one treatment site with the education campaign, one comparison site without the education campaign) over the course of a semester. We improve upon the existing literature by examining specific waste components (proteins, fruits and vegetables, etc.) rather than aggregate waste to determine how the education campaign impacts each individual waste component. For example, a foodservice operator would likely prefer to reduce protein waste as opposed to grain waste because protein is more costly; thus, it is important to determine where (if at all) the reductions in waste occur. Additionally, we examine waste across all diners and do not impose a tracking system. This should prevent diners from feeling "watched" and instead offer a more natural look at diners' behavioral responses to the education campaign (Harrison and List, 2004). Finally, we utilize a comparison dining site to account for any differences in food choice behavior over time that could impact waste results.

Data and Methods

This study took place in two dining halls at a large Midwestern university during the fall, 2016 semester.[3] The Ikenberry (IKE) dining facility was selected as the treatment site while the Pennsylvania Avenue Residence (PAR) facility served as the comparison site. IKE and PAR serve approximately 2,125 and 580 diners/day, respectively, during the lunch period. The two dining hall locations were selected based on (1) similarities in their choice structure and (2) geographic distance. Both sites utilized station-based dining, where diners can select food from several themed stations. Several stations overlapped across the two sites, including a pizza and pasta station, a grill station (hamburgers, etc.), and a deli station (build your own sandwiches, salads, etc.); however, there were some unique stations for each site, with the IKE location

[3] All campus dining halls employ trayless dining and an all-you-care-to-eat choice environment.

having more total stations. Geographically, the two dining locations are approximately 1.5 miles apart on campus. Although meal plans allow students to dine in any of the six campus dining halls, we wanted to minimize spillovers from the education campaign, so we chose the two locations that were farthest apart.

Experimental Design

Student plate waste data was collected three days per week (Monday, Wedensday, and Thursday) in both the treatment and comparison dining halls during the lunch period (11:00 am – 2:00 pm) for a total of thirteen weeks.[4] For approximately the first eight weeks of the study, baseline waste data was collected in both dining halls. During this time, all materials were developed for the education campaign. All campaign materials were posted in the treatment dining hall beginning October 20 (Thursday of week eight) and remained in place for the duration of the study (five weeks). No educational materials were posted in the comparison site, but data collection continued in this location for the remainder of the study.

Plates were collected from students at the end of their meals at the dish drop-off area. Edible food waste was sorted into three categories: protein, fruits and vegetables, and "other".[5] Proteins were meat-based (chicken, beef, pork, seafood, etc.); soy proteins were classified as "other" waste. In the case of mixed dishes where individual protein or fruit/vegetable components could not be easily sorted (for example, spaghetti with meat sauce or chicken noodle soup), the item was codified as "other" waste. Each waste category was weighed in aggregate rather than on a per-student basis due to the volume of diner traffic, particularly in the treatment

[4] The three days selected were based on availability of graduate and undergraduate research assistants. Data was not collected during the first week of the semester due to research assistant training or during the week of Thanksgiving. Data collection ended during the last full week of regular classes.

[5] The most common non-edible items were meat bones, banana peels, and fruit pits. These were excluded from waste calculations.

dining facility. Beverages were not included in the waste sorting procedure as this was deemed overly burdensome by the research team.[6]

Education Campaign

Research has shown saving money is a key motivator for consumers to reduce food waste (Thyberg and Tonjes, 2016; Neff, Spiker, and Truant, 2015; Graham-Rowe, Jessop, and Sparks, 2014; Quested et al., 2013). In an all-you-care-to-eat setting like a dining hall, however, the cost of entry is fixed, meaning there is no financial incentive for consumers to reduce waste. Thus, other motivating factors may be needed in these settings. To identify the specific needs of the college student population, we conducted qualitative focus group with approximately 60 students in the spring of 2016.

The focus groups revealed several key insights that shaped the education campaign. First, students' awareness of food waste was limited. They exhibited low knowledge on the extent of the food waste problem in the U.S. and abroad and the consequences of waste. To address this, a series of posters were designed that contextualized the problem of food waste in the U.S. (see Figure 1). These posters highlighted economic, environmental, and social concerns related to food waste and quantified the amount of food waste per person based on reports by Gunders (2012), Buzby, Wells, and Hyman (2014), and Coleman-Jensen et al. (2015). The posters were printed as pole wraps and placed in the student seating area.

Second, students had low awareness of their personal food waste. To be clear, students could acknowledge that they wasted food and what conditions might lead to waste, but few could quantify their waste. To aid in visualizing waste at a more personal level, we posted a 7'x7' wall

[6] Including beverages would fill up waste bins very rapidly and would require almost constant weighing. Again, due to the volume of diner traffic in the treatment facility, this was not feasible. Thus, beverages were excluded.

graphic that tracked student plate waste at lunch in the treatment dining hall (Figure 2). Using the baseline plate waste data from the treatment location, we calculated the average pounds of waste per student each week and multiplied it by 10,000 students[7] to report the weekly pounds of waste. The graph was updated each week of the campaign with the previous week's waste total. In addition, a separate graphic was placed beside the graph that listed the previous week's waste total and the current week's waste goal (calculated as 10% less than the previous week's waste). These graphics were displayed next to the dish drop-off area where waste was being sorted. Related to personal waste, several students voiced concerns that reducing their personal waste would not make much difference unless other students were doing the same. In an effort to combat this mentality, we developed a call to action centered around the message that "Every Plate Counts" (Figure 3). This signage was displayed at all dining hall entry points (for the treatment site) and at multiple stations throughout the serving area. The "Every Plate Counts" logo was included on all educational campaign materials for cohesion.

The final component of the education campaign was related to Dining Services' efforts to reduce waste. Many focus group participants commented that the dining halls did not care about food waste, arguing that they produce more food than is needed. Dining Services wanted to correct this misperception, so they developed napkin inserts that highlighted the variety of activities (food donation, use of aerobic digesters, etc. – refer to Figure 4) they pursue to reduce waste in the dining halls. These inserts were displayed throughout the student seating area in the treatment site.

Data Analysis

[7] The number of students visiting the dining hall changed daily, so we normalized the graph to represent weekly lunch waste for 10,000 students (2,000 students/day, Monday-Friday).

To examine the impact of the education campaign on food waste behaviors, we compare the average waste per student in the treatment and comparison locations (WPS_{treat} and WPS_{comp}, respectively) pre- and post-campaign. More formally, we model:

(1) $$\left(WPS_{treat} - WPS_{comp}\right) = \beta_0 + \beta_1 PostEdu + \beta_2 Monday + \beta_3 Wednesday + \beta_4 MenuWk1 + \beta_5 MenuWk2 + \beta_6 MenuWk3 + \varepsilon$$

Where $PostEdu$ is an indicator variable for post-campaign days, $Monday$ and $Wednesday$ are indicator variables for day of the week, $MenuWk1-3$ are indicator variables for the first three weeks of the four-week menu cycle, and ε is an error term. The intercept, β_0, represents the mean difference in waste per student between the treatment and comparison dining halls.

Based on Dining Services' waste audits, we hypothesize that $\beta_0 > 0$. The treatment location generated the highest waste per student in a one-week pilot study conducted by Dining Services in 2015. One explanation for this may be that the treatment location has more total food stations than the comparison location. Research has shown an increased variety in foods can lead to increases in selection and consumption (Wansink, 2004), so it is possible increased variety also yields more waste. Further, we hypothesize that $\beta_1 < 0$. If the treatment location generally experiences more waste than the comparison location, we would expect the education campaign to reduce this difference.

Preliminary Results

Table 1 presents the mean waste results for both dining facilities pre- and post-education campaign. The average student in the treatment site (IKE) wasted 0.195 pounds of food per meal before any educational materials were provided; this is equivalent to 3.12 ounces, or one chicken breast, per student per meal. In contrast, the average diner at the comparison site (PAR) wasted

less, 0.157 pounds per diner per meal. After the education campaign materials were posted in the treatment location, there was a slight decrease (4.1%) in total food waste for the treatment site. The reduction primarily occurred in the "other" waste category. We also observed a small decrease (2.5%) in total waste for the comparison site, despite no educational materials being provided. In this dining facility, the reduction was driven by the protein category. Across the two dining facilities, the approximate breakdown by waste category was 20% protein waste, 20% fruit and vegetable waste, and 60% other waste.

Figures 5 and 6 provide more insight on the daily and weekly fluctuations in waste behavior over the course of the semester, respectively. On both figures, the vertical line denotes the start of the education campaign. While Figure 5 shows much more movement in the daily waste averages, there is little overlap between the two dining facilities before the education campaign is introduced. After the campaign, though, there are more instances where the daily averages are comparable between the treatment and comparison sites. This is more clearly illustrated in Figure 6. Here, we see that the difference between the two sites is relatively constant up to the education campaign. For the first few weeks of the campaign, the lines begin to converge up to the week of November 7 (mean difference at Nov. 7 was 0.015 pounds per student); however, the difference begins to expand after this point and continues for the remainder of the study.

To determine whether the educational campaign significantly impacted food waste behavior, we estimate the model specified in equation (1). Table 2 presents the regressions results. The first specification is a reduced form model that strictly looks at the effect of the education campaign on total waste per student; the second model includes controls for the day of week and menu cycle week (equation 1). In both models, the intercept term is positive,

confirming our hypothesis. All else constant, the treatment site generates more pounds of waste per student (approximately 0.03 more pounds per student) than the comparison site. The question of interest, however, is whether the education campaign can reduce this difference. The $PostEdu$ coefficient in each model is negative as expected but not statistically significant. This suggests the education campaign led to modest improvements in waste behavior, but other efforts will likely be needed to obtain significant waste reductions.

One interesting result in the Model 2 specification is the significant impact of the $Wednesday$ coefficient. On Wednesdays, the waste difference between the treatment and comparison sites almost doubled, on average. This effect was driven by higher than average in the treatment dining facility on Wednesdays relative to other days of the week. The average waste per student in the treatment facility was 17% and 11% higher on Wednesdays compared to Mondays and Thursdays, respectively. Conversely, the average waste per student in the comparison site had little variation over the course of the week. Based on the lead researcher's observations in the treatment dining facility, this result can likely be attributed to a specific food item, broth bowls, on the Wednesday menus. Across all four weeks of the menu cycle, each Wednesday featured a type of broth bowl where students filled oversized bowls with noodles and meat (chicken, shrimp or pork) or vegetarian (tofu) protein. These bowls were commonly selected but rarely consumed, and thus, drove up food waste on these days.

Discussion

This study evaluated the impact of a food waste education campaign on plate waste in an all-you-care-to-eat dining environment. The campaign resulted in a modest, though not statistically significant, reduction in the average waste per student in the treatment dining

facility, with the majority of waste reductions occurring in the "other" food category. This suggests education alone is unlikely to be an effective intervention strategy for reducing plate waste.

Although behavior seemed relatively unaffected by the education campaign, it is possible that students' awareness, attitudes, and knowledge related to food waste improved as a result of the campaign. This could be a first step toward long-term behavior change. We collected pre- and post-campaign survey data to examine these constructs; however, we have not analyzed the data yet for inclusion in the current paper. We hope to have these results incorporated soon.

Our results are in contrast to the study by Whitehair, Shanklin, and Brannon (2013), which found that educational materials resulted in a 15% reduction in student plate waste in a university dining setting. We suspect the more conservative result in the present study is related to the anonymized data collection process. We did not ask diners to provide their student identification number in an effort to preserve a more natural dining environment, though we acknowledge individual accountability may encourage better waste behaviors. In high-traffic dining facilities, however, such tracking would likely be cumbersome for diners and staff.

To achieve greater reductions in food waste, foodservice managers may want to combine education efforts with structural changes in the dining environment. First, the pricing strategy may want to be revisited. In all-you-care-to-eat dining environments, consumers pay a fixed fee for entry; the quantity of food selected is not directly linked to its cost. Research by Just and Wansink (2011) suggests some consumers will work to extract the full value of their entry fee ("get their money's worth"), even to a point that is beyond optimal. In the event that consumers perceive the fixed meal fee to be too expensive, they may take – and waste – more food (Just and Wansink, 2011). Potential adjustments to the pricing strategy could be to adopt an a la carte

menu where consumers pay for the foods selected; similarly, a pay by weight strategy could be adopted. In both cases, there is a more direct (and salient) link between food quantity and food cost, which should motivate more thoughtful food choice behavior.

The sheer number of food choices may also influence the amount of food waste generated. The treatment dining facility in the present study, for example, offered many more choices than the comparison site, which likely contributed to higher waste averages overall (before or after the education campaign). Mirosa, Loh, and Spence (2016) acknowledge that reducing choice offerings could reduce waste and overconsumption, yet for many diners, choice is intrinsically valuable (Just and Swigert, 2016). Removing choices may result in decreased satisfaction with the dining facility and force consumers to look for other alternatives – an outcome that college/university dining facilities cannot afford as their survival depends on students purchasing meal plans.

Rather than limiting food choices, dining facilities may want to explore changes in how these items are served. In many all-you-care-to-eat venues, including the dining facilities in the present study, items are self-served. Research has clearly indicated consumers' knowledge of proper portioning is weak (e.g., Bryant and Dundes, 2006; Schwartz and Byrd-Bredbenner, 2006; Wansink and van Ittersum, 2007), so a self-serve environment may result in over-serving and, ultimately, increased waste. Foodservice managers interested in reducing waste may consider hiring additional staff to serve food items to diners. This will not stop consumers from taking multiple trips through the serving line, but it should prevent the "stockpiling" of food items that often results in waste. Another option would be to pre-portion food items when possible. Freedman and Brochado (2010) experimented with reducing the portion size of a pre-portioned item, French fries, and found that the smaller portion size significantly reduced waste.

Finally, in some cases, consumers may serve themselves appropriate portion sizes but still generate food waste because the food item did not meet their taste expectations. This waste is hard to avoid if the consumer has no prior experience with the food item and/or the dining establishment. One potential solution is to offer samples so consumers can determine their liking or disliking of a dish before taking a full serving.

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Figure 1. Sample Food Waste Posters (Displayed in Student Seating Area of Treatment Dining Facility)

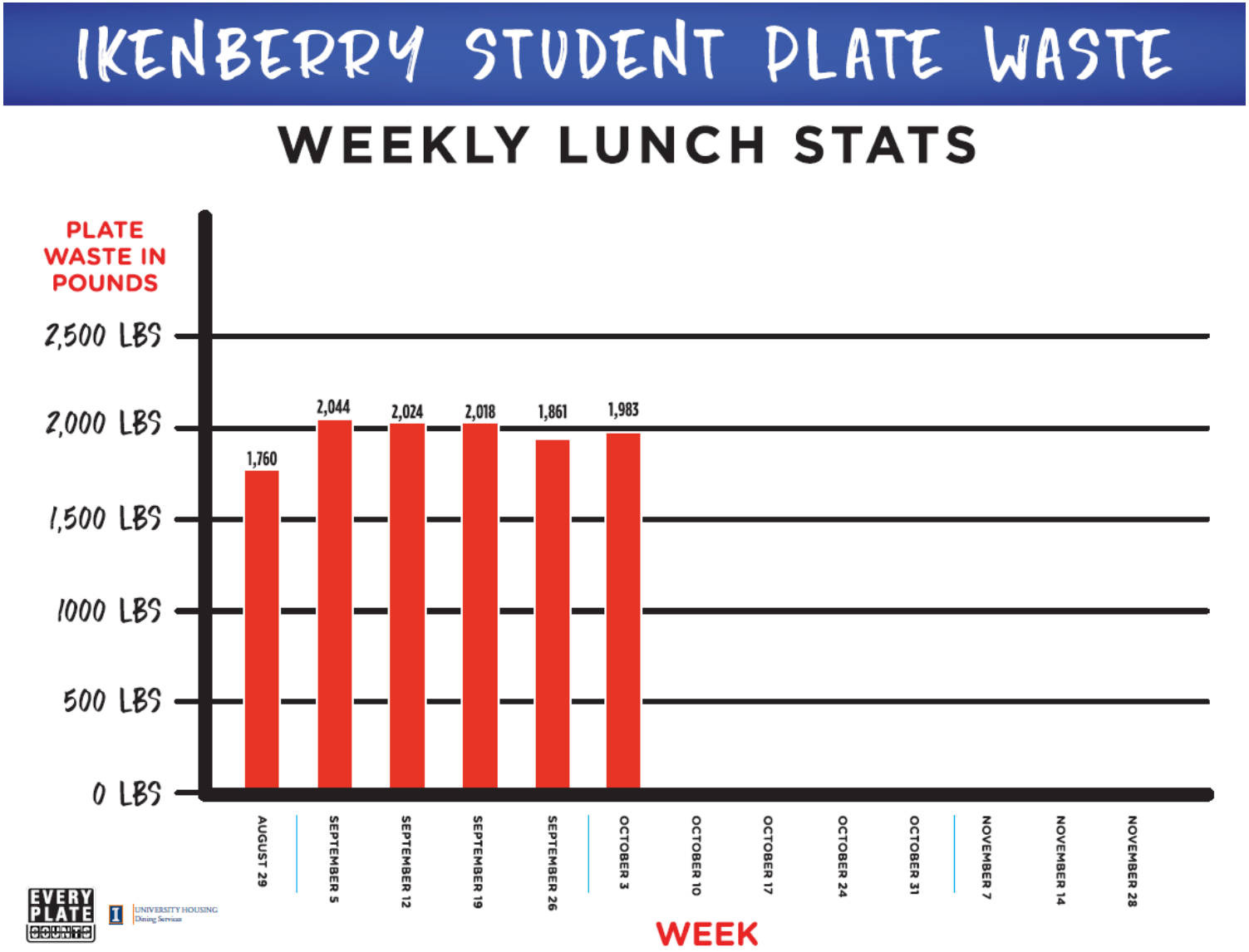

Figure 2. Wall Graphic of Weekly Food Waste (Posted Next to Dish Drop-off Area in Treatment Dining Facility)

Figure 3. Student Call to Action Message (Posted at Dining Hall Entry Points and Throughout Serving Area in Treatment Dining Facility)

Figure 4. Sample Napkin Inserts (Displayed in Student Seating Area in Treatment Dining Facility)

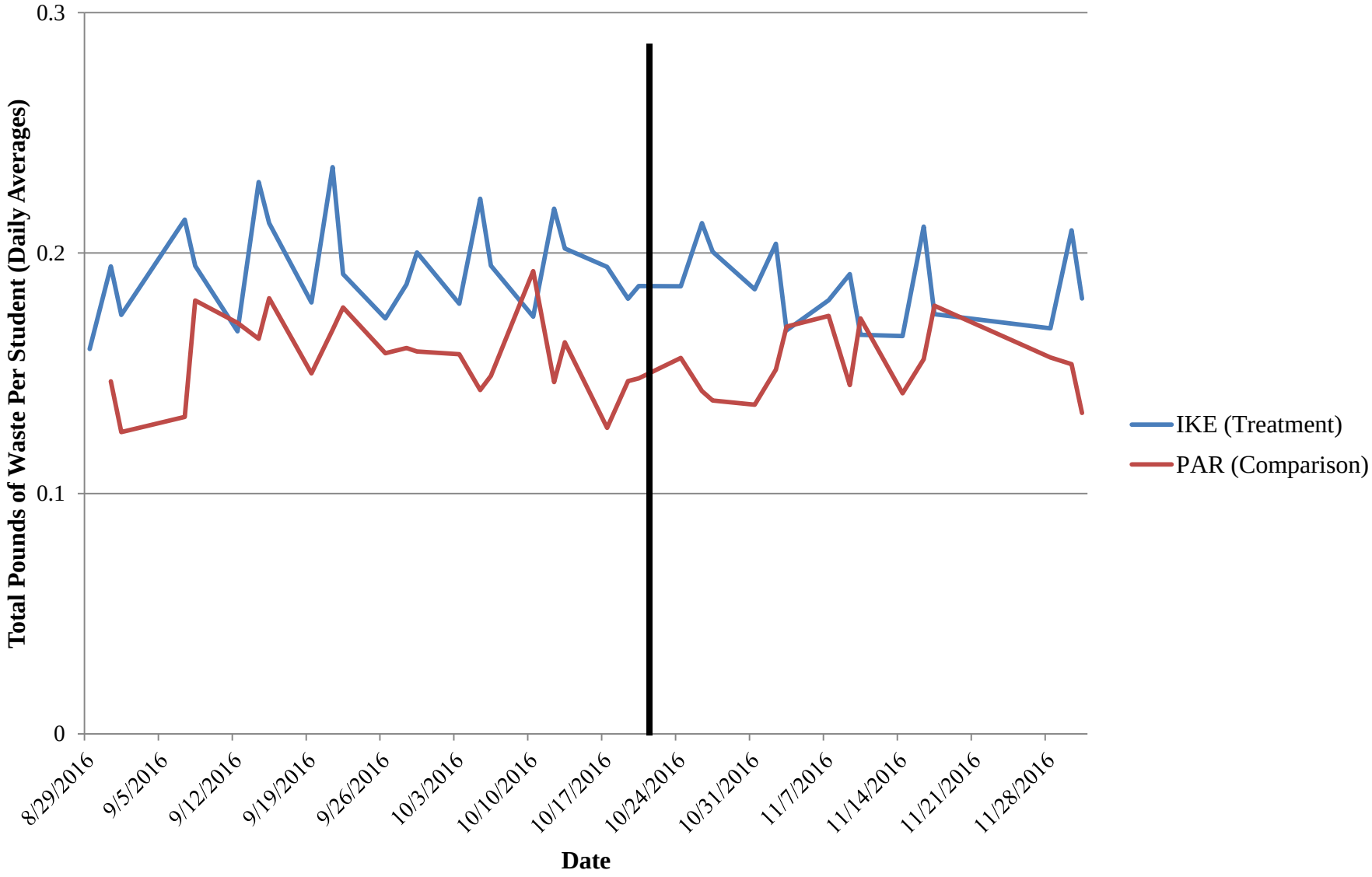

Figure 5. Total Pounds of Waste per Student over Time (Daily Averages)

Note: Black vertical line indicates the beginning of the educational campaign.

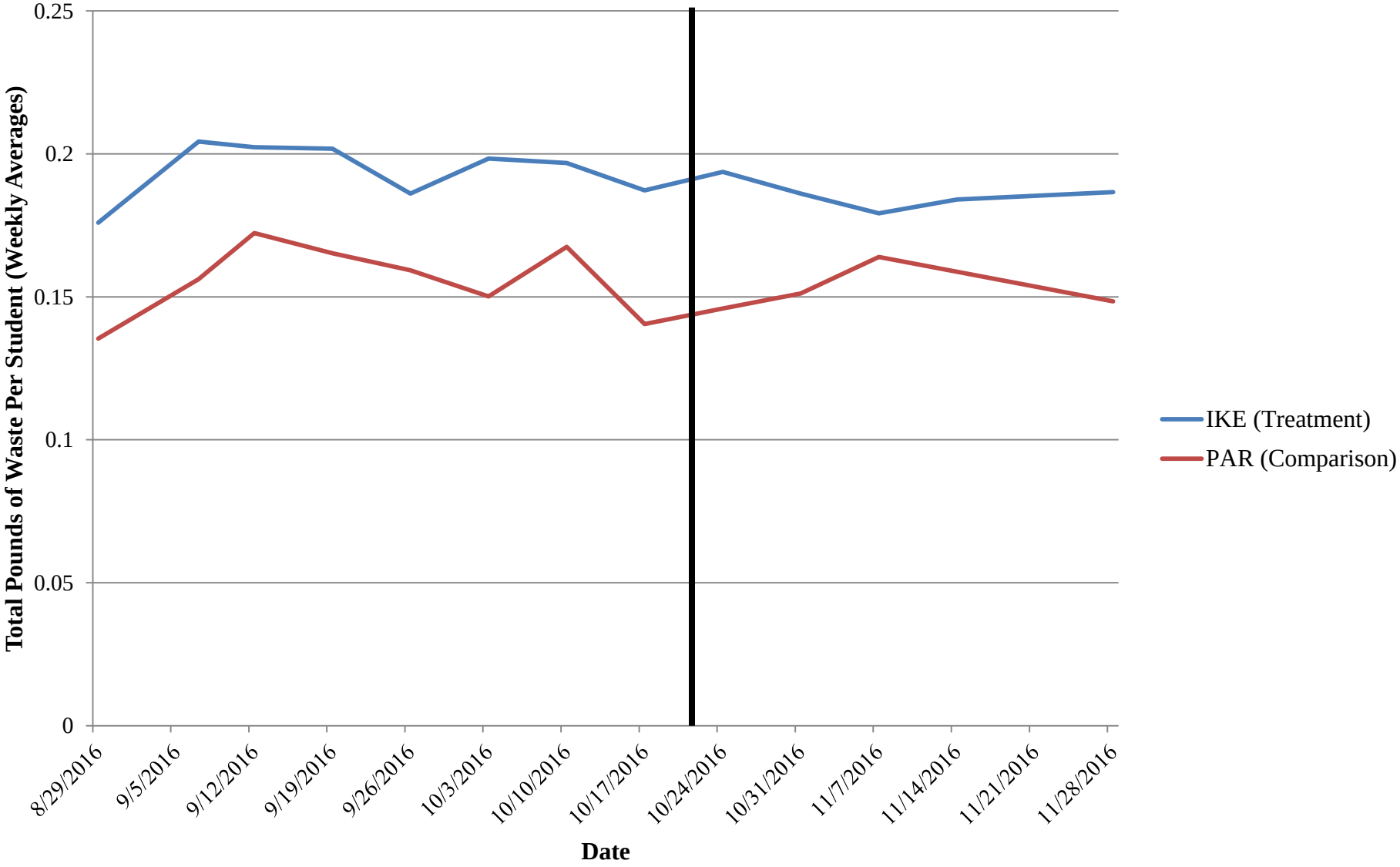

Figure 6. Total Pounds of Waste per Student over Time (Weekly Averages)

Note: Black vertical line indicates the beginning of the educational campaign.

Table 1. Average Pounds of Waste per Student Pre- and Post-Campaign by Dining Facility

	Dining Facility	
	IKE (Treatment)	PAR (Comparison)
Pre-Education Campaign		
Protein Waste per Student	0.038	0.032
Fruit/Vegetable Waste per Student	0.038	0.035
Other Waste per Student	0.118	0.090
Total Waste per Student	0.195	0.157
Post-Education Campaign		
Protein Waste per Student	0.039	0.027
Fruit/Vegetable Waste per Student	0.039	0.035
Other Waste per Student	0.109	0.091
Total Waste per Student	0.187	0.153

Table 2. OLS Regression Estimates for Total Pounds of Waste per Student (WPS)
(Dependent Variable: [WPS in treatment site – WPS in comparison site])

	Specification	
Variable	Model 1	Model 2
Intercept	0.039** (0.006)	0.031** (0.009)
PostEdu[a]	-0.006 (0.009)	-0.005 (0.007)
Monday[b]		-0.007 (0.009)
Wednesday[b]		0.029** (0.008)
MenuWk1[c]		0.004 (0.010)
MenuWk2[c]		0.004 (0.010)
MenuWk3[c]		-0.011 (0.010)
R-squared	0.011	0.450

Note: Standard errors are in parentheses.
**Denotes significance at the 1% level
[a]Effect relative to pre-education campaign
[b]Effect relative to Thursday
[c]Effect relative to Week 4 in the 4-week menu cycle