THE IMPACT OF A PORTION PLATE ON PLATE WASTE IN A UNIVERSITY DINING HALL

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ABSTRACT

University dining facilities generate nearly 3.6 million tons of waste annually with 10-20% estimated as food. The study's purpose was to determine the impact of portion plates on reducing plate waste in a university dining hall. Data were collected in a Midwestern university in two phases. Phase 1 utilized normal service plates, while Phase 2 introduced the choice of a portion plate. Results showed a reduction in edible and aggregate plate waste per person from Phase 1 to Phase 2. Participants who utilized portion plates reported a greater awareness of their food choices and intentionally chose less food while dining.

Keywords: Portion Plate, Plate Waste, University Dining Hall, Sustainability

INTRODUCTION

Food waste is an important concern as the annual amount of food eligible for human consumption that is wasted globally is approximated to be 1.3 billion tons. This estimate roughly equates to one third the total amount of food produced for humans annually (Food and Agriculture Organization [FAO], 2018). According to the United States Department of Agriculture (USDA), the United States contributes nearly 30 to 40 percent food waste from the general food supply, which results in an estimated 133 billion pounds and $161 billion worth of waste annually (USDA, n.d.). This considerable percentage of food is wasted before it even reaches the retail or consumer level of consumption (Buzby et al., 2014). Accordingly, in 2017, the Environmental Protection Agency (EPA) estimated that there was 22 percent food placed into landfills and combustion facilities (EPA, 2019).

Furthermore, landfills generate approximately 20 percent of the total methane gas production which negatively affects climate change and the environment (EPA, 2019). In order to help reduce the large amount of food waste within the United States, in 2015, the EPA and the USDA created the 2030 Food Loss and Waste Reduction Goal, stated to decrease food loss and waste by 50 percent over the subsequent 15 years (EPA, 2019).

To further illustrate the significance of elevated levels of food waste, it has been estimated that the energy represented by the wasted food in the United States is around 150 trillion kilocalories per year, which can be broken down to 1,400 kilocalories per person per day (Hall et al., 2009). This analysis has significant implications due to the fact that the United States currently has more than 37 million food insecure individuals and minimal efforts at food recovery and redistribution (Feeding America, n.d.). Continued levels of uncontrolled food waste will have increasingly negative ramifications for the economy, environment, and society.

According to the National Center for Education Statistics, as of 2016 there were approximately 4,500 degree-granting institutions (United States Department of Education, National Center for Education Statistics, 2019). College and university dining facilities contribute to waste by generating nearly 3.6 million tons of waste per year with 10-20% estimated to be food (Whitehair & Shanklin, 2013). With the ever-growing dialogue revolving around sustainability, foodservice operation managers have discussed approaches to implement sustainable practices into their facilities. A study conducted by Kwon et al. (2012) indicated that many foodservice managers were motivated to implement sustainability methods in their operations because of financial and environmental benefits, however they lacked the resources to implement more serious processes.

It was found by Chen et al. (2010) that recent practices of composting and trayless dining have been implemented into food service facilities and have received positive feedback. When twenty-five Aramark facilities removed trays from their food service operations, there was a reported reduction of 11,505 pounds of food waste, estimated to be 1.2 – 1.8 ounces per person per meal (Aramark Higher Education, 2008). Sodexo food services pulled trays from their dining facilities and propagated similar results. Sodexo approximated that around 200 gallons of water per 1,000 meals would be saved with the removal of trays; at one million meals per day served by the company, it totaled around 200,000 gallons of unused water (Sodexo, 2008).

At an another all-you-can-eat buffet-style dining facility, there was a 25 percent reduction in plate waste using education and awareness alone, however, when trayless dining was implemented in addition to the education, waste reduction increased to 54 percent, indicating the additional benefit of going trayless (Kim & Freedman, 2010). Furthermore, Thiagarajah and Getty (2013) found a significant mean decrease in food waste of 0.81 ounces per person after going trayless. In addition, Sarjahani et al. (2009) also indicated a significant reduction of 1,726 pounds of edible food waste when trays were removed. Reasons for the reduction of food waste given by Whitehair and Shanklin (2013) included students being more aware and focused while making food choices, thus eliminating the wandering around and grazing as previously noted prior to going trayless. Overall, the literature supported the technique of going trayless in food service operations as a primary method of reducing consumer-level plate waste.

One alternative to reduce food waste is the exploration of visual cues and their effects on food waste. A study conducted by Huerta et al. (2014) found that when compared to taste and odor, visual cues of food had the most significant brain stimulation within the higher-order visual cortex rather than traditional locations of food-appetite

regulation, indicating a complex and multi-faceted reaction to food visuals. Considering the visual system produces stronger brain responses in relation to food than taste and odor, anti-waste methods that focus on utilizing visual cues may yield superior results than other methods. A study conducted by Whitehair et al. (2013) researched the basis of the Elaboration Likelihood Model, which illustrates two methods to persuasion: the peripheral route and the central route. The primary difference between these two routes is dependent on how much thinking is required to process the information presented. The peripheral route occurs quicker and requires less thinking to understand the message, while the central route requires thinking about personal influence when processing the information. The researchers utilized a prompt-type message to represent the peripheral route because the message could be gathered via one quick glance over. A feedback message represented the central route because it contained more personal information of significance and required more thought to understand the message. It was found that the prompt-type message led to a 15 percent reduction in food waste in addition to influencing the student's behaviors toward food waste, indicating that in this instance of promoting awareness of sustainability, visual cues utilizing the peripheral route to persuasion demonstrated superior results (Whitehair et al., 2013).

Portion size is an applicable visual cue that may be related to food waste. A study conducted by Freedman and Brochado (2010) found that decreasing the portion size of a single food item resulted in decreased consumption, and subsequently the plate waste of that food item. A threshold of reduced portion size was identified as still being acceptable to consumers and that also decreased consumption and plate waste. A similar study investigated by Vermote et al. (2018) found that a 20 percent reduction in portion size led to a significant 66.4 percent decrease of plate waste. Both studies indicated that a reduction and awareness of portion size led to significant reductions in food waste, indicating the connection between portion size and plate waste. Furthermore, a study conducted by Berkowitz et al. (2015) found that even the simple addition of reduced portion size entrées resulted in decreased plate waste. A significant decrease in plate waste was found when both normal and reduced-size options were available, indicating that consumer awareness increased with the presence of more than one portion size to choose from (Berkowitz et al., 2015).

A concept commonly studied in weight management and obesity research is the use of a portion control plate. A study conducted by Kesman et al. (2011) found that individuals who used the portion control plate had significantly greater weight loss when compared to the control group with normal service plates. Another study by Pedersen et al. (2007) discovered that patients who received portion control interventions had greater success at weight loss when compared to those receiving standard care. Overall, the past literature suggests that portion plates have a significant impact on weight loss due to the increased awareness brought to portion sizes during consumption.

Although the aforementioned studies researched the connection between portioning and consumption, there is a paucity of research evaluating the effects of the portion plate on plate waste. Based upon this dearth of literature, the purpose of this study was to determine if introducing the option of a portion plate in a university dining facility would impact consumer plate waste in that facility. The objectives of this research study were 1) to determine the effectiveness of a portion plate on reducing plate waste in a university dining facility, 2) gain insight into potential contributors of plate waste from the consumer perspective, and 3) pilot test a potential implementation strategy for reducing waste in a university setting.

METHODOLOGY

Study Design
The study was approved by the Institutional Review Board (IRB) at Bradley University, the Committee on the Use of Human Subjects in Research. Permission to use an on-campus residential dining hall at a mid-sized private Midwestern university for data collection was obtained from the General Manager of Dining Services at the university. Approximately 400 students dined at the dining hall between the dinner hours of 5:00 p.m. and 8:00 p.m. each evening during the regular academic year. The dining hall utilized an all-you-can-eat, self-serve, buffet-style of meal service. Data collection occurred in two phases: Phase 1 and Phase 2. Baseline data for Phase 1 was collected using the regular service plates the dining hall owned, including a large 10 ¼ in. service plate. During Phase 2, diners had the choice of using either the regular large 10 ¼ in. service plate offered by the dining hall or a 10 ¼ in. diameter Chinet Paper Dinnerware 3-Compartment Plate (Chinet, De Soto, Kansas), hereafter referred to as a portion plate. Each diner had full autonomy in choosing which plate option they preferred. The decision to continue offering the regular plates along with the portion plates in Phase 2 was based upon guidance from the General Manager of Dining Services. The General Manager emphasized that customer satisfaction in the dining hall was imperative and that diners should have their choice of plates (regular or portion) during Phase 2. Data collection for Phase 2 occurred exactly 28 days after Phase 1, on the same day of the week (Wednesday), using the same menu. The dining hall used a cycle menu that repeated every 28 days, which ensured that menu items were kept consistent. Waste was collected and measured from plates only, with food from bowls and cups omitted. This was to determine if the implementation of the portion plate would alter the amount of plate waste generated.

Participants
Participants were recruited using a convenience sampling of students that had a campus meal plan at the university and who dined at the residential dining hall. Criteria for inclusion in the study were specified on the cover page of the survey instrument; it was required that students be currently enrolled at the university and 18 years of age or older to participate in the research study. Exclusion criteria for the study comprised any non-student person or person under the age of 18.

Survey Instrument Development
Survey questionnaires were developed for Phase 1 and Phase 2 to examine the constructs of this research and were based on pertinent questions from the literature. Survey questions were identical for both Phase 1 and Phase 2, with two additional questions included in Phase 2 to assess participants' feedback while using a portion plate. The survey instruments assessed participants' knowledge and beliefs regarding food/plate waste, sustainability, along with demographic information. The instruments were pilot tested among 25 university students and modifications were made based on relevant feedback. Modifications include grammatical changes and the inclusion of graduate students in the demographics question. This step was taken to ensure that the survey instruments had high content validity for primary data collection. The final version of the survey instruments included demographics questions; questions regarding knowledge or attitude towards nutrition, sustainability, and plate waste; and behavior-related questions related to food selection. For both Phase 1 and Phase 2, participants were invited to write their institution email address on a tear-away slip at the bottom of the completed

survey to be entered into a drawing for gift certificates. Participants detached the emails slips when they submitted their surveys and the slips were stored separately from the completed surveys, which helped protect the confidentiality of survey responses.

Phase 1 Data Collection Procedure

Phase 1 data were collected under normal conditions of the dining hall. All regular service plates were utilized and no portion plates were available for use. Research volunteers were stationed at the entrance doors to the dining hall and offered surveys to diners as they entered. Participants completed the surveys as they ate and submitted them to the research volunteers stationed at the exit doors to the dining hall. A total of 201 (53.6% of all diners) usable surveys were included in data analysis. Surveys were excluded from data analysis if there was missing or incorrect data such as two or more answers filled in for single-answer questions, or surveys that had multiple questions not completed. Plate waste for all diners (n = 375) was collected and discarded into one of two bins in the dish room. One bin was designated for edible plate waste. Edible plate waste in this study included any food item that was still edible (i.e. left-over noodles, sauce, chicken vegetables, etc.). A second bin was designated for inedible plate waste only, including but not limited to: napkins, condiment packaging, and inedible rinds and skins from fresh fruits. Waste bins were weighed during the data collection time frame by the primary researcher at the convenience of the dining hall kitchen employees so as to not disrupt the flow of work and service. Waste from the bins were recorded in ounces of edible and inedible waste.

Phase 2 Data Collection Procedure

Phase 2 data collection introduced the option of using a portion plate for participants. Research volunteers were stationed at the entrance doors to the dining hall and offered a portion plate and survey to diners as they entered. Each portion plate that was distributed automatically came with an accompanying survey instrument that participants were instructed to complete. Participants completed the surveys as they ate and submitted them to the research volunteers stationed at the exit doors to the dining hall. Regular service plates were still available for diners who declined the portion plate option. Diners declining the portion plate option did not receive a survey and thus were not participants in Phase 2 of this study. A total of 278 (61.4% of all diners) usable surveys were included in data analysis. Surveys were excluded from data analysis if there was missing or incorrect data. Plate waste for all diners (n = 453) was collected and discarded into one of two bins in the dish room (edible and inedible plate waste), with waste collection and record-keeping mirroring Phase 1. Plate waste was removed from the portion plates and the portion plates were discarded separately. The weight of the discarded portion plates was not included in the data analysis.

Measurements

Survey instruments were administered to participants and collected by research volunteers. Plate waste was measured as aggregate, edible, and inedible waste. Weight measurements were taken throughout the data collection time period and performed by the primary researcher using a digital food scale.

Data Analysis

Data were analyzed using the SPSS Statistics version 25 (International Business Machines [IBM] Corporation, Armonk, New York). Statistical tests used included descriptive statistics and One Way Analysis of Variance (ANOVA) for the survey instruments. Chi-Square tests were used to measure differences in demographic data. Statistical significance was measured at the $p \leq .05$ level.

RESULTS AND DISCUSSION

Participants

During Phase 1 of data collection, a total of 375 diners ate at the facility during the hours of 5:00 p.m. and 8:00 p.m. Of the 375 total diners, 201 (53.6%) participants (56% females and 44% males) ranging in education level from freshman to graduate students completed the survey instrument (Table 1). During Phase 2, a total of 453 diners ate at the facility between the hours of 5:00 p.m. and 8:00 p.m. Of the 453 total diners, 278 (61.4%) participants (56% females and 44% males) ranging in education level from freshman to graduate students completed the survey instrument. According to Dillman (2014), based on a population of around 400, a sample size of 196 responses was desired for survey data collection. Therefore, sample sizes for Phase 1 (n = 201) and Phase 2 (n = 278) both met this threshold.

Plate Waste

Plate waste was analyzed by aggregate, edible, and inedible plate waste ounces per person. Aggregate waste included both edible and inedible waste from diners. Results indicated that both mean aggregate waste per person and mean edible waste per person decreased as a result of the use of the portion plate intervention during Phase 2.

Mean aggregate waste per person from Phase 1 equaled 3.11 ounces and 2.75 ounces from Phase 2, indicating a reduction in total waste as a direct result of the intervention (Figure 1). It was also noted that the mean amount of edible waste per person decreased from 2.82 ounces per person in Phase 1 to 2.38 ounces per person in Phase 2. There was a very small increase in the mean inedible waste from Phase 1 to Phase 2 from 0.29 ounces per person to 0.37 ounces per person. A possible explanation is that this could have been attributed to slight variances in the foodservice system inputs, transformations, or outputs during Phase 1 and Phase 2. For example, providing cut cantaloupe with or without the rinds removed, differences in condiment packaging, or the availability of seasonal fresh fruit.
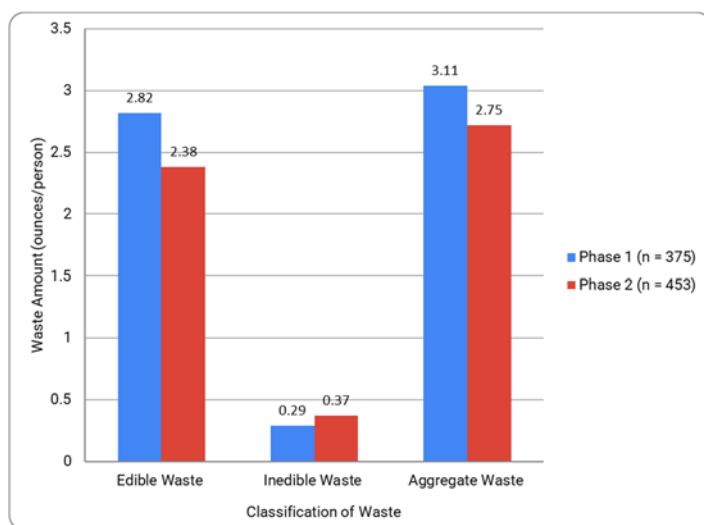
Figure 1: *Comparison of edible, inedible, and aggregate waste per person of diners in a residential dining hall.*

Note: Data collection occurred in two phases: Phase 1 and Phase 2. Phase 2 data collection occurred exactly 28 days after Phase 1, using the same menu. Data for Phase 1 was collected from 375 diners using the regular service plates the dining hall owned, including a large 10 ¼ in. service plate. During Phase 2, 453 diners had the choice of using either the regular large 10 ¼ in. service plate offered by the dining hall or a 10 ¼ in. diameter portion plate.

Survey Instrument

There were no significant differences between the demographics of students in Phase 1 and Phase 2. Identical percentages of female and male students were identified in Phase 1 and Phase 2, $c^2(1, N = 479) = 0.01$, $p = .93$ (Table 1). Likewise, the percentages of each education level were markedly similar, $c^2(4, N = 479) = 5.45$, $p = .24$, along with frequency of dining, $c^2(3, N = 479) = 0.41$, $p = .94$, concluding that there were no significant differences in demographics of participants in either phase of the study.

For both Phase 1 (Table 2) and Phase 2 (Table 3) , the average frequency of dining for males was reported to be five to six times per week, while it was reported for females to be three to four times per week. When comparing gender to the frequency of dining of Phase 1 survey participants, it was found that males dined more frequently at the dining halls than females ($p < .001$) . Results from the Phase 2 survey also showed that males were likely to dine more frequently than females ($p = .015$). When asked about typically finishing all the food on their plates, males indicated they were more likely to typically finish their food than females in both Phase 1 ($p < .001$) and Phase 2 ($p = .003$).

Two additional questions were included in the Phase 2 survey to assess participants' perceptions or behaviors while using a portion plate. The first additional question asked participants about the perceived awareness of their food choices while using a portion plate (Table 4). About half of the participants (52.2%, n = 145) stated that the awareness of their food choices did not change, while 46% (n = 128) indicated that they became more aware of their food choices. Only 1.8% (n = 5) of participants thought they had become less aware of their food choices while using a portion plate. When excluding the participants that indicated that the awareness of their food choices did not change (n = 145), 96.2% (n = 128) thought they had become more aware of their food choices, while only 3.8% (n = 5) thought they had become less aware of their food choices while using a portion plate. This is an important finding, which shows that using portion plates could potentially be a useful tool in promoting food awareness to diners.

The second question included in the Phase 2 survey asked participants about the perceived effect of the use of the portion plate on their actual food choices (Table 5). About half of the participants (49.6%, n = 138) stated that their food choices stayed the same, while 44.6% (n = 124) indicated that they had chosen less food. Only 5.8% (n = 16) of participants responded that they had chosen more food while using a portion plate. When excluding the participants that indicated that their food choices stayed the same (n = 138), 88.6% (n = 124) indicated that they had chosen less food, while only 11.4% (n = 16)

Table 1. Participant Demographics from Phase 1 Survey and Phase 2 Survey		
Characteristics of Participants	**Phase 1 (n = 201)**	**Phase 2 (n = 278)**
Gender		
Female	112 (56%)	156 (56%)
Male	89 (44%)	122 (44%)
University Level of Education		
Freshman	119 (59%)	192 (69%)
Sophomore	52 (26%)	57 (21%)
Junior	15 (7%)	15 (5%)
Senior	12 (6%)	10 (4%)
Graduate Student	3 (2%)	4 (1%)
Dining Frequency Per Week		
1-2 times	34 (17%)	51 (18%)
3-4 times	60 (30%)	78 (28%)
5-6 times	55 (27%)	73 (27%)
7 or more times	52 (26%)	76 (27%)

thought they had chosen more food while using a portion plate. This is also an important finding, which shows that portion plates could potentially be used to help reduce plate waste.

In both Phase 1 (Table 6) and Phase 2 (Table 7), participants were asked if they had previously taken a sustainability course. This data was compared with participants' awareness of food waste impact on the environment, economy, and society, as well as participants' awareness of their own contributions to plate waste. Results for both Phase 1 and Phase 2 showed that participants who had taken a sustainability course were more aware of the impact of food waste in the environment, economy, and society than participants who had not taken a sustainability course. Furthermore, participants in both Phase 1 and Phase 2 who had taken a sustainability course were more aware of their own contributions to plate waste than participants who had not taken a sustainability course. It is interesting to note that in Phase 2, responses regarding the awareness of the impact of food waste in the environment, economy; and society and participants' awareness of their own contributions to plate waste were statically significant ($F = 7.60$, $p = .006$; and $F = 4.57$, $p = .033$, respectively), but were not statistically significant in Phase 1. A possible explanation for this could be that the addition of portion plate usage in Phase 2 could have increased participants' awareness to sustainability issues, such as the overall impact of food waste on society, as well as their own personal plate waste.

The purpose of this study was to determine if introducing the option of a portion plate in a university dining facility would impact consumer plate waste generated in that facility. Prior studies

Table 2: Participants' Frequency of Dining and Finishing Food on their Plate during Phase 1 (n = 201)					
	Males n = 89	**Females n = 112**	**Total n = 201**		
Survey Question	**M (SD)**	**M (SD)**	**M (SD)**	**F (1,199)**	**P***
How many times a week do you typically eat dinner at the dining hall? 1. 1-2 times 2. 3-4 times 3. 5-6 times 4. 7 or more times	2.92 (0.99)	2.38 (1.03)	2.62 (1.05)	13.91	< .001
Do you typically finish all the food on your plate? 1. Always 2. Often 3. Sometimes 4. Never	1.87 (0.69)	2.26 (0.71)	2.08 (0.73)	15.63	< .001

* Indicates statistical significance at $p \leq .05$.

Table 3. Participants' Frequency of Dining and Finishing Food on Their Plate during Phase 2 (n = 278)					
Survey Question	Males n = 122 M (SD)	Females n = 156 M (SD)	Total n = 278 M (SD)	F (1,199)	P*

How many times a week do you typically eat dinner at the dining hall?
  1. 1-2 times
  2. 3-4 times
  3. 5-6 times
  4. 7 or more times
	2.80 (1.04)	2.49 (1.08)	2.63 (1.07)	6.05	.015

Do you typically finish all the food on your plate?
  1. Always
  2. Often
  3. Sometimes
  4. Never
	1.99 (0.66)	2.24 (0.71)	2.13 (0.70)	9.09	.003

* Indicates statistical significance at $p \leq .05$.

conducted on food waste management and portion control help to elucidate the results from this study. In regards to students' awareness of sustainability issues, Whitehair et al. (2013) found that providing a simple prompt-type message, with a statement to not waste food, resulted in a 15% reduction of food waste in residential dining facilities. The provision of a portion plate could also be viewed as a simple prompt that may provide students with a visual cue to be more aware of their food choices.

A study by Kwon et al. (2010) indicated that foodservice operators in dining facilities were supportive of programs to assist them in sustainable management of food waste. The study also found that there was a need to focus on reducing barriers to encourage foodservice operators to implement sustainable food waste programs in their dining operations. The initial cost of replacing existing service plates with portion plates might be perceived as a financial barrier to a foodservice operator. However, a reduction in plate waste achieved by implementing portion plates in a foodservice operation could be both cost-effective and environmentally sound.

Berkowitz et al. (2015) found a significant decrease in plate waste when both normal-sized and reduced-size entrée options were offered. This parallels the findings of this study, in which both normal plates and portion plates were offered to diners. This is an important observation, because if a foodservice operator chose to offer both portion plates and regular plates to diners, then a reduction in food waste might still likely be the result, as was found in this study.

Freedman and Brochado (2010) found that reducing the portion size of French fries offered in individual paper bags in an all-you-can-eat dining operation had beneficial effects. This included a reduction in plate waste, decreased food production, and overall food cost savings, which could potentially be realized by purchasing portion plates for use in residential dining facilities. A study by Kesman et al. (2011) described weight loss amidst obese patients who participated in a portion control plate intervention within a general medicine practice setting. Portion plates could be beneficial to students for weight loss in a dining hall setting, in addition to reducing plate waste and food waste costs.

CONCLUSIONS AND APPLICATIONS

The study addressed various factors associated with food waste including a) the effects of a portion plate intervention on reducing plate waste in a university dining facility, b) insight into potential contributors of plate waste from the consumer perspective, and c) a pilot test of a potential implementation strategy for reducing waste in a university setting.

The use of a portion plate in a university dining facility may help reduce the amount of plate waste generated by that facility. The results from this study found that on average, the amount of edible food waste per person decreased when using a portion plate. This is important for foodservice operators to consider from a long-term strategic perspective. An investment in portion plates could help to decrease the amount of food chosen by students in a residential dining facility, which would then not subsequently be wasted. Once implemented, portion plates would constantly and continually help with reducing the amount of food needing to be produced and also in decreasing the volume of food waste requiring disposal. Not only would this have a positive impact on the environment, but it would also help to reduce the costs associated with food preparation and solid waste management methods.

In this study, students' awareness of food choices increased and students made more deliberate food choices while using the portion plate. However, not all students may wish to dine using a portion plate, and the option to use a regular plate could be related to students' perceptions of customer satisfaction. Thus, a gradual implementation of portion plates into a dining facility could be performed over time. Foodservice operators could determine the popularity of the portion plate option by tracking the type of plates returned to the dishroom; the edible food waste could be measured as well. During the initial introduction of the portion plates, a simple, prompt-like message or information flyer could help to communicate the reasons for offering portion plates to diners.

It is not surprising that students who had taken a sustainability course were more aware of their own contributions to plate waste than participants who had not taken a sustainability course. Sustainability is important to the current generation of students (Generation Z);

Table 4. Participants' Perceived Awareness of Their Food Choices with the Portioned Plate during Phase 2 (n = 278)			
Participants	Became more aware of food choices	Became less aware of food choices	Awareness of food choices did not change.
Males (n = 122)	52 (42.6%)	1 (0.8%)	69 (56.6%)
Females (n = 156)	76 (48.7%)	4 (2.6%)	76 (48.7%)
Total (n = 278)	128 (46%)	5 (1.8%)	145 (52.2%)

Note: Participants were asked: "*Circle the answer that best describes your level of awareness of your food choices with the portioned plate.*" Participants were given the options of: a) I became more aware of my food choices, b) I became less aware of my food choices, and c) my awareness of my food choices did not change.

Table 5. Participants' Perceived Effect of Using a Portioned Plate on Their Food Choices during Phase 2 (n = 278)			
Participants	Chose more food	Chose less food	Food choices stayed the same
Males (n = 122)	8 (6.6%)	49 (40.2%)	65 (53.3%)
Females (n = 156)	8 (5.1%)	75 (48.1%)	73 (46.8%)
Total (n = 278)	16 (5.8%)	124 (44.6%)	138 (49.6%)

Note: Participants were asked: "*Choose the best option regarding the portioned plate effect on your food choices.*" Participants were given the options of: a) chose more food, b) chose less food, and c) food choices stayed the same.

input regarding sustainable practices in dining facilities could be solicited from students and then used to develop or update sustainability practices in a foodservice operation, including the management of plate waste. Besides a sustainability class, education about sustainability can also come from dining operators themselves, by providing useful materials to students, holding focus groups, or discussing green initiatives at dining advisory meetings with students. Participation in professional organizations can assist foodservice operators by providing access to current and innovative information about sustainability methods that could be implemented in their operations.

The methodology from this study could be applied to other colleges and universities. Disposable portion plates could initially be evaluated to see if they were effective in reducing plate waste in a given foodservice operation. If effective, a cost-benefit analysis could then be conducted to compare the cost of portion plates versus the economic benefits associated with reducing wasted food. One potential benefit for students through better portion control could be better weight control; this could also assist in mitigation of the general societal issue of obesity. Yet other benefits for the environment could be reduced greenhouse gas emissions from food waste sent to landfills, decreased energy costs, and less water waste generated by the dining facility.

Limitations of the study included a sample collected in one mid-sized private Midwestern university; therefore, the results from the intervention cannot necessarily be generalized to a different setting. The data were collected at only two points in time; therefore, the lack of replications was a limitation. Future studies focused on the use of a portion plate could attempt to implement the portion plate intervention in other types of foodservice operations or in other geographic locations with larger sample sizes. Additionally, long-term effects of the use of portion plates could be researched by increasing the number of intervention replications, coupled with an extended data collection time period of six months or longer.

There was practical significance to the study as it was determined that the use of a portion plate decreased the amount of food taken and subsequently wasted in a residential dining hall at a mid-sized university. Findings are in line with the EPA and USDA Food Loss and Waste Reduction Goal of decreasing food waste by the year 2030 and represent a small, yet meaningful step towards developing more sustainable practices in university settings. Sustainability practices such as those measured in this study demonstrate practical application to help reduce the impact of food waste in onsite foodservice operations such as university dining halls.

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Table 6. Participants' Awareness of Food Waste in the Environment, Economy, and Society and Their Own Contributions to Plate Waste Compared with having Previously Taken a Sustainability Course in Phase 1					
Survey Question	Total n = 201 M (SD)	Sustainability Course (Yes) n = 33 M (SD)	Sustainability Course (No) n = 168 M (SD)	$F_{(1,199)}$	P*
To what extent are you aware of the impact of food waste in the environment, economy, and society? 1. Fully aware 2. Somewhat aware 3. Somewhat unaware 4. Fully unaware	2.07 (0.82)	1.88 (0.74)	2.11 (0.83)	2.18	.142
To what extent are you aware of your own contributions to plate waste? 1. Fully aware 2. Somewhat aware 3. Somewhat unaware 4. Fully unaware	1.76 (0.76)	1.63 (0.55)	1.78 (0.79)	0.99	.322

* Indicates statistical significance at $p \leq .05$.

Table 7. Participants' Awareness of Food Waste in the Environment, Economy, and Society and Their Own Contributions to Plate Waste Compared with having Previously Taken a Sustainability Course in Phase 2

Survey Question	Total n = 278 M (SD)	Sustainability Course (Yes) n = 30 M (SD)	Sustainability Course (No) n = 248 M (SD)	F (1,276)	P*
To what extent are you aware of the impact of food waste in the environment, economy, and society?	1.99 (0.76)	1.63 (0.61)	2.03 (0.76)	7.60	.006
1. Fully aware					
2. Somewhat aware					
3. Somewhat unaware					
4. Fully unaware					
To what extent are you aware of your own contributions to plate waste?	1.85 (0.76)	1.57 (0.57)	1.88 (0.78)	4.57	.033
1. Fully aware					
2. Somewhat aware					
3. Somewhat unaware					
4. Fully unaware					

Data are represented as M(SD).

* Indicates statistical significance at p ≤ .05.

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