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Reducing Portion Size Reduces Food Intake and Plate Waste

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ABSTRACT

As portion size (PS) increases, so does food intake. The effect of decreasing PS on food intake in a non-laboratory setting is unknown. This 5-week study sought to determine if decreasing PS resulted in decreased intake of the same food, and if so, at what point further PS reductions might lack benefit. It also assessed effects of PS reduction on food production and waste in a university all-you-can-eat dining facility (DF). Subjects were primarily freshmen who regularly ate lunch at the DF, and self-selected French fries (FF) presented in individual paper bags, portioned originally at 88 g, and decreased ~15 g/wk for 3 weeks. Diners were covertly observed choosing 1 or more bags. Total FF production and plate waste (PW) were determined daily. Decreasing PS resulted in significant decreases in consumption per diner ($P < 0.05$) and PW ($P < 0.05$), and non-significant decreases in total FF consumption and production. PS was

positively correlated with consumption per diner (r = 0.897, P = 0.001) and PW (r = 0.852, P = 0.001), but inversely correlated with number of diners choosing ≥ 2 bags (r = -0.809, P = 0.003). Total FF production was positively correlated with PW (r = 0.728, P = 0.011). This study shows that reducing PS of a particular item in an all-you-can-eat environment results in reduced intake of that food for most individuals, and that reducing PS reduces PW and food production.

INTRODUCTION

Almost one-third of college students self-report BMIs ≥ 25 (1), with weight gain often beginning their first semester, and continuing through senior year (2). In this setting, unlimited access to all-you-can-eat buffets, and exposure to large portion sizes of energy dense food has been linked to weight gain (3). This is not surprising, considering increased portion size (PS) has been linked to increased energy intake (4-11). The only study to examine the effect of decreasing PS was conducted by Rolls et al. (12), who, in a laboratory setting, reported reducing PS resulted in reduced energy intake. To date, no studies have examined the effect of PS reduction in a non-laboratory setting. This study, conducted in an all-you-can-eat university dining facility (DF), examined whether students exposed to a smaller portion of an energy-dense food (e.g. French fries; FF), would decrease overall FF intake, and if so, how small the portion of FF could become before students noticed and adjusted their intake. It also examined whether decreasing PS led to decreased food production and FF plate waste (PW).

METHODS AND PROCEDURES

Participants were primarily freshmen (heretofore called diners) who ate lunch at the DF. The San Jose State University Institutional Review Board for human subjects approved this study.

To determine the test food, 1,475 freshmen with university meal plans received an email to participate in a 5-minute online survey (www.SurveyMonkey.com, Portland OR). After providing informed consent, frequency of lunchtime consumption of hamburgers, FF, pizza, soup, sandwiches, salad and fresh fruit was assessed. Although the most frequently consumed items were salad and fresh fruit, FF were chosen as the test food because they are an energy-dense food, 50% of respondents reported frequent consumption, they are available daily as a "self-serve" item, and are easily manipulated into different sized portions.

This 5-week quasi-experimental study took place every Monday, Wednesday and Friday during lunchtime (11:00 AM – 2:00 PM). One week prior to data collection, diners were acclimated to an 88 g portion (24 - 28 fries) size of FF (Lamb Weston CrispyCoat™ 5/16" Fries/Thin Regular Cut) presented for the first time in a 5.5" x 4.5" plain paper bag (Sysco Corporation). On the production side, deep-frying was carefully monitored to ensure consistent cooking time, temperature and final product weight. Student assistants portioned FF into bags. Each bag was weighed using a Salter Aquatronic Kitchen Scale (Model 3003), and placed in rows standing upright on a metal shelf, in a 12" x 20" x 2" stainless steel hotel pan. Diners were allowed to choose as many bags as they wanted.

Number of bags chosen by each diner was determined by a student assistant seated 20' from the serving line, who, pretending to read a book, clicked a hand-held counter each time a diner chose 2 bags at once, and tallied those who chose ≥ 3 at once. Plate waste was determined by student assistants who removed bags and uneaten FF from trays as they worked in the tray return area out of view of diners. All uneaten FF were placed into a bucket labeled "A" if assistants collected 1 bag from the diner's tray, a bucket labeled "B" if they collected 2 bags, and

a bucket labeled "C" for ≥ 3 bags. At 2:00 PM, the weight of discarded FF (corrected for ketchup) was determined using the same scale.

The intervention started the next week, and continued for 4 weeks. Portion size of FF started at 88 g (baseline) and decreased by 15 g (~4 fries) per week, ending at 44 g (12-15 fries). All procedures continued as described above. One week after the intervention, an intercept survey was conducted among diners to assess perception of PS change.

Data analysis

Total FF consumption was determined by subtracting PW from amount produced [PS (g) x number of bags filled]. Consumption per diner was determined by dividing total consumption by number of diners choosing FF. Total production was the dry weight of uncooked product. Plate waste was the sum of all uneaten FF collected from diners' trays. Amount of FF eaten per bag was determined by dividing total consumed by amount produced, and was determined for the entire sample, as well as those choosing 1 bag and 2 bags. Kruskal-Wallis test determined differences between PS and census count, number of diners choosing FF, total production, consumption (total and per diner) and PW. Pearson's correlation assessed the association between PS and consumption per diner, diners taking ≥ 2 bags, total production, and PW. Statistical analysis was conducted with SPSS (version 16.0; Chicago, IL). Statistical significance was set at $P < 0.05$.

RESULTS

During the intervention, 703 ±140 diners ate lunch in the DF. There was a non-significant increase in the total number of diners eating in the DF, and the total number choosing FF over the course of the intervention (Table 1). As PS decreased from 88 to 44 g, so did total FF production, consumption (total and per diner) and PW. There was a significant reduction in

consumption per diner ($\chi^2 = 8.24$, df = 3, $P < 0.05$) and PW (($\chi^2 = 8.19$, df = 3, $P < 0.05$). Portion size was negatively correlated with diners choosing $\geq$ 2 bags ($r = -0.809$, $P = 0.003$), but positively correlated with amount consumed per diner ($r = 0.897$, $P = 0.001$), and PW ($r = 0.852$, $p = 0.001$). Total FF production was positively correlated with PW ($r = 0.728$, $p = 0.011$). On average, all diners consumed 81.6% of the FF in their bags, regardless of PS. There was no significant difference in FF consumption between diners who chose 1 bag compared to diners who chose 2 bags (83.5 ± 4.6% vs. 79.6 ± 7.5%, respectively). The intercept survey, completed by 322 diners who consumed FF during the study period indicated 70% did not notice the change in PS.

Although reduction in PS was strongly negatively correlated with diners choosing $\geq$ 2 bags (e.g., as portion size decreased, more diners chose > 1 bag), closer examination revealed that as PS decreased, almost all diners benefited from the PS reduction. Observations of diners choosing bags revealed that 1 bag was taken by 87% of diners during week 1, 71% during week 2, 77% during week 3, and 51% during week 4**.** This indicates 84 - 90% of diners ate fewer FF when PS was decreased to 73 g and 58 g during weeks 2 and 3. This percentage includes all diners who chose 1 bag, and 13% of diners who originally chose 2 bags and continued to choose 2 bags, who were now getting smaller portions (146 g and 116 g rather than 176 g). The remaining 10 - 16% of diners who chose $\geq$ 1 bag did not benefit from PS reduction, but rather, increased intake over baseline. During week 4 (when portion size was 44 g), 51% of diners who chose 1 bag reduced their intake by 50% and benefited from PS reduction. The remaining 49% of diners chose between 2 and 5 bags. Assuming 13% of diners who originally chose 2 bags continued to choose 2 bags, all 13% would now be consuming less than at baseline (88 g rather than 176 g). Those who chose 2 bags, who originally chose 1 bag, would be consuming the

same amount as during baseline (88 g). Only those few diners (n = 31 in this study) who chose ≥ 3 bags rather than 1 bag would have increased their FF intake over baseline.

DISCUSSION

Using mixed dishes, and exposure to multiple meals over 2-days, Rolls et al. (12) reported a 25% reduction in PS resulted in a 10% reduction in energy intake. Using the same energy-dense food at one meal, the current study determined that PS could be lowered 17 - 34%, resulting in an equivalent decrease in energy intake, before being noticed by most diners, and that even a 50% reduction in portion size would still benefit most diners, effecting an overall 35% decrease in FF consumption per diner. Since ~20% of the FF in each bag were left uneaten, regardless of PS, overall caloric savings associated with decreased PS may be even greater. Interestingly, as PS decreased, diners chose more bags, but still only consumed about 80% of the FF in each bag.

This study was limited by the inability to record diners coming back through the serving line for a second bag, to determine if diners increased intake from other foods as a consequence of decreased FF intake, to control the menu which might have affected how many diners chose FF, and to determine potential effects that student assistants working in the DF might have had on diners' food intake and/or choices. Despite these limitations, decreasing PS was shown to benefit most diners, and have a potential beneficial effect on overall food costs and plate waste.

CONCLUSION

Considering nutrition education has limited efficacy in changing consumer behavior (13), efforts to institute environmental changes that focus on decreasing PS of energy-dense foods should be made (14). This study clearly indicates decreasing PS of an energy-dense food is not noticed by most diners in an all-you-can-eat environment, and therefore, can make a difference

in overall caloric intake. A 15 to 44 g reduction in PS of FF translates into ~50 to 150 kcals. Consumption of smaller portions of FF could add up to significant caloric savings in populations who frequently consume this item. Studies should examine whether decreasing PS of other foods has a similar effect, and what effect, if any, decreasing PS of one food has on subsequent intake of other foods. Since the effects of PS and energy density are additive (12), a potentially more significant environmental solution to excess caloric consumption in this setting would be provision of smaller portions of FF cooked in ways to decrease fat content (e.g. baked), as long as taste was not compromised. The overall savings in calories might be substantial if reducing PS of other energy-dense foods is shown to have a similar effect, and university food service workers decrease portion size of all such foods in this setting.

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DISCLOSURE STATEMENT

The authors declare no conflict of interest.

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Table 1. Effect of Portion Size on Total Production, Consumption, and Plate Waste of French Fries (FF)[a]

Portion Size[c] (g)	Census Count[b]	Number of Diners Choosing French Fries	Total Produced (g)	Total Consumed (g)	Consumption Per Diner (g)	Total Wasted (g)
88	668 ± 101	315 ± 88	44,727 ± 6,328	23,282 ± 4,227	74.3 ± 2.2	6,168 ± 265
73	680 ± 106	348 ± 62	42,299 ± 3,299	24,158 ± 2,698	71.4 ± 2.4	5,098 ± 250
58	725 ± 110	359 ± 144	37,033 ± 3,767	18,295 ± 4,794	53.0 ± 2.5	4,983 ± 283
44	728 ± 30	377 ± 74	35,150 ± 3,350	17,846 ± 1,318	52.2 ± 6.0	4,242 ± 90

[a] Data are presented as means ± standard deviations.

[b] Refers to number of diners who ate in the dining facility during that week.

[c] Portion size was positively correlated with consumption per diner and plate waste ($P = 0.001$) and total produced was positively correlated with PW ($P = 0.011$).