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ORIGINAL ARTICLE

Portion-size preference as a function of individuals' body mass index

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Summary

Objective

Large portions of food are often blamed for rising rates of obesity. We tested the possibility that people who are heavier may tend to select or prefer larger portions than do people who are lighter.

Methods

Participants (total $N = 798$) were asked to choose between a small and larger portion of pasta for a hypothetical meal (Studies 1, 2 and 4), to indicate their ideal portion from a range of portion-size options (Study 2), or to select their preferred portion size from each of 28 portion pairs (Study 3).

Results

Across all studies, there were no significant differences between heavier and lighter participants in their portion-size selection (effect sizes ranged from $d = -0.06$ to 0.33). The pattern was the same regardless of whether we grouped participants as having a body mass index (BMI) <25 vs. ≥ 25, as having a BMI of <30 vs. ≥ 30, or treated BMI as a continuous predictor.

Conclusions

Given the lack of association between BMI and portion-size preference, we suggest that factors other than portion size, such as differences in meal frequency, food type, plate clearing or compensation at subsequent meals, may need to be considered in order to explain the increasing prevalence of obesity.

Keywords: Food choice, obesity, overweight, portion size.

Introduction

Increasing portion size has received considerable attention in recent years, with many authors suggesting that larger portion sizes are one of the main contributors to excess energy intake, weight gain and even obesity (1–4). There is indeed substantial evidence that larger portions lead to greater energy intake (5). However, Herman and colleagues recently examined the role of large portions in the increasing prevalence of overweight and obesity in the last few decades, commonly referred to as the 'obesity epidemic', and concluded that the evidence indicting large portions is not particularly compelling (6). Although some studies indicate that people who are heavier tend to eat larger portions (7), other studies find no difference between heavier and leaner people in the size of the portions that they consume (8). Further complicating the picture is the fact that 'large portions' sometimes refer to the amount consumed (irrespective of how much was initially selected or served) (9), whereas at other times 'large portions' refer to the amount selected or served (irrespective of how much is consumed) (10). When large portions are blamed for increasing levels of obesity, what is usually meant is that increasingly large portions are being made available to people, with greater intake as a consequence. Can larger portions account for the increase in the prevalence of obesity over the past few decades?

Considerable evidence suggests that when larger portions are served, people tend to eat more, but this effect appears to be uniform across different body mass index (BMI) levels (10–12). In fact, a recent meta-analysis indicated that, if anything, individuals with higher BMIs are *less* responsive to larger portions (5). Furthermore, epidemiological evidence suggests that it is specifically those who are already high in BMI who have displayed the greatest weight increases over time (13). These two facts together pose a conundrum for the view that larger portions are responsible for the rise in the prevalence of obesity. One would need to argue that people who are overweight or obese are not simply responding to the same secular increase in portion sizes that everyone else is responding to (14,15), but rather that they are disproportionately likely to *select* larger portions in the first place. In other words, it might not be that people who are heavier eat more of a given (large) portion than do people who are lighter, but rather that they choose larger portions to begin with. If it is the case that there is a tendency for people who are heavier to select larger portions and for people who are lighter to select smaller portions, then it becomes increasingly difficult to blame large portions for the increase in obesity; more of the blame would appear to accrue to individuals who choose larger portions from an array of available portions.

There is scant evidence pertaining to the question of whether people with higher BMIs select larger portions. A few studies have found that people who are heavier select larger amounts of food when they are self-selecting their portion size (16,17), but other studies have found no difference as a function of BMI (18). Furthermore, self-selecting portion sizes differs from a real-world context in which individuals are choosing between two or more fixed portion sizes (such as when ordering in a restaurant or when ordering from a menu online). One 40-year-old field study of 68 fast-food restaurant patrons indicated that participants who were obese ordered larger portions than did participants who were not obese (19), but we have been unable to find any other studies examining this particular question. The present set of studies was designed to explore whether people with higher BMIs (in the overweight category, BMI $\geq$ 25; or in the obese category, BMI $\geq$ 30) would select larger portions than would people with lower BMIs (BMI $<$ 25). We examined this question in four online samples totalling 798 participants, who were asked to select larger or smaller portions for a hypothetical meal.

Study 1

Participants completed an online portion-size choice task. They were asked to imagine that they were being served a portion of pasta for lunch and to indicate whether they preferred the small portion or the large portion.

Method

Participants

Participants were 128 women residing in the USA who were recruited online via the Amazon Mechanical Turk website and were reimbursed $1.00 for their participation. Their mean age was 25.83 years (SD = 3.22) and their mean BMI (kg/m^2) was 25.35 (SD = 6.16). Fifty-nine percent (n = 75) had a BMI $<$ 25; 41% (n = 58) had a BMI $\geq$ 25; and 17% (n = 21) had a BMI $\geq$ 30. With regard to ethnicity, 77.2% were Caucasian, 11.0% were African-American, 6.3% were Asian, 3.9% were Hispanic and 1.6% identified as 'other'. All studies were approved by the university's human research ethics committee.

Materials and procedure

Participants signed up for a study on 'hunger and food perception'. After providing informed consent, they were instructed to imagine that they were just about to have lunch and to think about how hungry they typically are at lunch time, and how much they typically feel like eating for lunch. Participants were then shown an image of a small portion of pasta and a large portion of pasta (with the accompanying labels 'small' and 'large') side-by-side, and were asked to choose which one they would prefer for lunch. Pasta was used as the target food in all studies because it is a food that is familiar to most people, and one that we assumed would be eaten regularly and at least moderately well-liked (assumptions that were confirmed by participants' ratings; Table 1). The small

Table 1 Mean (SD) liking and frequency of eating pasta for each study

	Study 1	Study 2	Study 3	Study 4
Liking of pasta	73.64 (25.74)	65.60 (28.94)	64.56 (28.45)	72.89 (23.81)
Frequency of eating pasta	3.69 (0.90)	3.64 (0.97)	3.63 (0.87)	3.70 (0.86)

For liking of pasta, participants made ratings on a visual analogue scale anchored by 0 (not at all) and 100 (very much). For frequency of eating pasta, response options were 1 = Never, 2 = Less than once a month, 3 = Once a month, 4 = Once a week, 5 = A few times a week, 6 = Once a day.

portion of pasta consisted of 238 g of pasta and tomato sauce, which is equivalent to approximately two standard servings of pasta, or 1/3 of recommended daily carbohydrate intake (20); the large portion consisted of 477 g of pasta and tomato sauce, which is equivalent to approximately four standard servings of pasta, or 2/3 of recommended daily carbohydrate intake. The portions were presented on a placemat with cutlery and a glass of water in the picture to provide a reference point for the bowl size (21) (Figure 1). After choosing their preferred portion size and completing some unrelated measures, participants rated their hunger level on a visual analogue scale from 0 (*not at all*) to 100 (*extremely*) and indicated the number of hours since they last ate. They also rated how much they generally liked pasta with tomato sauce on a visual analogue scale from 0 (*not at all*) to 100 (*very much*) and indicated how frequently they eat pasta on a six-point scale ranging from 1 (*never*) to 6 (*once a day*). Hunger, hours since previous meal, liking of pasta and frequency of eating pasta were all examined as potential covariates. Finally, participants provided their age, ethnicity, and height and weight (which were used to calculate their BMI).

Results and discussion

A chi-square analysis was used to determine whether the proportion of participants selecting the small vs. large portion varied as a function of their BMI category. A somewhat greater proportion of participants who were overweight (37.7%) chose the large portion than did participants who were not overweight (22.7%), but this difference was not statistically significant, χ^2 (1, $N = 128$) $= 3.43$, $p = 0.06$, Cohen's $d = 0.33$. Repeating the analysis by grouping participants as obese (BMI ≥ 30) vs. non-obese (BMI < 30) showed the same pattern of results ($p = 0.12$, Cohen's $d = 0.28$). Similarly, including BMI as a continuous measure in a logistic regression analysis showed no significant association between BMI and portion choice (whether or not hunger, hours since last meal, liking of pasta and frequency of eating pasta were included as covariates; $ps > 0.07$). Thus, Study 1 did not find strong evidence that individuals who are overweight are more likely to choose larger portions than are those who are not overweight.

Study 2

The aim of Study 2 was to provide a more thorough examination of whether choice of portion size varied according to participants' weight status. The choice task used in Study 1 was expanded to include multiple different presentation formats, and participants also completed an additional measure of portion-size preference in which they selected their preferred portion from a broader range of portion sizes.

Method

Participants

Participants were 293 women residing in the USA who were recruited online via the Amazon Mechanical Turk website and were reimbursed $1.00 for their participation. Their mean age was 25.81 years ($SD = 2.99$), and their mean BMI was 25.47 ($SD = 6.51$). Fifty-seven percent ($n = 168$) had a BMI < 25; 43% ($n = 125$) had a BMI ≥ 25; and 19% ($n = 55$) had a BMI ≥ 30. With regards to ethnicity, 77.1% were Caucasian, 10.6% were African-American, 4.8% were Hispanic, 6.1% were Asian and 1.3% identified as 'other'.

Materials and procedure

The materials and procedure were identical to Study 1 with two exceptions:

1 Two new choice formats were added to the *image + label* format used in Study 1. In the *image only*

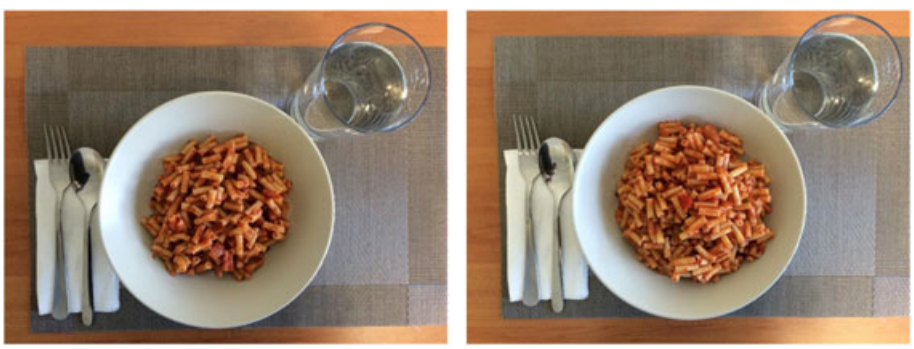

Figure 1 Small portion (238 g) and large portion (477 g) of pasta.

condition, participants were shown unlabelled images of the small and large portions and were asked to choose which one they would prefer for lunch. In the *label only* condition, participants read that 'small' and 'large' portion options were available, and were asked to choose which one they would prefer for lunch, without seeing images of the portions.

2 As an additional measure of ideal portion size, participants were also shown an array of eight different portions of pasta ranging from 119 to 953 g (representing 1–8 standard servings) and were asked to select the portion that they would eat in order to feel comfortably full.

Results and discussion

A chi-square analysis was conducted to determine whether the proportion of participants selecting the small vs. large portion varied as a function of their BMI category. As in Study 1, a somewhat greater proportion of participants who were overweight (36.0%) chose the large portion than did participants who were not overweight (29.8%), but this difference was not statistically significant, $\chi^2(1, N = 293) = 1.27$, $p = 0.26$, Cohen's $d = 0.13$. The same pattern of results emerged if we examined each of the choice formats separately (Table 2). The same pattern also emerged if we grouped participants as obese vs. non-obese ($p = 0.96$, Cohen's $d = 0.02$). There was also no significant association between BMI and portion choice if we conducted a logistic regression with BMI as a continuous measure (whether or not we included hunger, hours since last meal, liking of pasta and frequency of eating pasta as covariates; $ps > 0.13$).

We next conducted a *t*-test to determine whether there were any BMI-group differences in ideal portion size. Participants who were overweight reported an ideal portion size ($M = 373.82$ g, $SD = 172.23$) that was slightly, but not significantly, larger than the ideal portion size reported by participants who were not overweight ($M = 340.51$ g, $SD = 174.26$), $t(291) = 1.63$, $p = 0.11$, $d = 0.19$. Again, the pattern was the same if we grouped participants as obese vs. non-obese ($p = 0.12$, Cohen's $d = 0.24$), and there was no significant correlation between BMI as a continuous measure and ideal portion size ($r = 0.10$, $p = 0.09$).

Table 2 Proportion of participants who selected the large portion in Study 2, separately by choice format

	Overweight (%)	Non-overweight (%)	χ^2	*p*
Image only	50.0	31.3	3.43	0.06
Label only	22.4	27.4	0.36	0.55
Image + label	31.0	36.7	0.28	0.59

Overall, using a broader range of choice formats (image only, label only or image + label), as well as assessing ideal portion size in a continuous rather than dichotomous fashion, the results of this study are consistent with those of Study 1 in that they failed to provide any evidence that individuals who are overweight reliably choose or prefer larger portions.

Study 3

Study 3 sought to build on the previous studies by generating a more reliable and sensitive estimate of participants' portion-size preference.

Method

Participants

Participants were 104 women residing in the USA who were recruited online via the Amazon Mechanical Turk website and were reimbursed $1.00 for their participation. Their mean age was 26.11 years ($SD = 2.85$), and their mean BMI was 24.74 ($SD = 6.70$). Sixty-four percent ($n = 66$) had a BMI < 25; 36% ($n = 38$) had a BMI ≥ 25; and 15% ($n = 16$) had a BMI ≥ 30. With regards to ethnicity, 84.6% were Caucasian, 7.7% were African-American, 4.8% were Hispanic, 1.0% were Asian and 2.0% identified as 'other'.

Materials and procedure

This study used a forced-choice task in which participants were shown pairs of portion size images and were asked to indicate which portion from the pair they would prefer to eat for lunch. The same eight portion sizes used for the continuous measure in Study 2 were used in this study. Pairs of images were created by combining each portion size with every other portion size (1–2, 1–3, 1–4, …,7–8), resulting in 28 pairs in total. Order of presentation of the 28 pairs was randomized, and the position of the larger portion (left or right) was randomized within each pair. Participants' preferred portion size was defined as the portion size that they selected most frequently across all 28 decisions. In cases where participants selected more than one portion with equal frequency, their preferred portion was calculated as the mean of the values. Participants then completed all the same control and demographic measures as in the previous two studies.

Results and discussion

A *t*-test indicated that participants who were overweight preferred a portion size ($M = 427.46$ g, $SD = 215.13$) that was somewhat larger than the portion size preferred by participants who were not overweight ($M = 369.80$ g, $SD = 219.20$). However, this difference was not statistically significant, $t(102) = 1.30$, $p = 0.20$, $d = 0.27$. Controlling for hunger, hours since last meal, liking of pasta and frequency of eating pasta had no bearing on the results. Furthermore, grouping participants as obese vs. non-obese showed the same pattern of results ($p = 0.09$, $d = 0.51$), and there was no significant correlation between BMI as a continuous variable and preferred portion size ($r = 0.12$, $p = 0.21$). Thus, the results of Study 3 were consistent with Studies 1 and 2, finding insufficient evidence to suggest that there is a difference in portion-size preference according to BMI classification.

Study 4

Participants from Studies 1–3 were involved in a larger project on eating behaviours among young women. Because the first three studies focused exclusively on women, Study 4 examined the relationship between BMI and portion-size choice in men.

Method

Participants

Participants were 273 men residing in the USA who were recruited online via the Amazon Mechanical Turk website and were reimbursed $1.00 for their participation. Their mean age was 32.29 years ($SD = 9.88$), and their mean BMI was 26.25 ($SD = 5.55$). Forty-nine percent ($n = 133$) had a BMI < 25; 51% ($n = 140$) had a BMI ≥ 25; and 21% ($n = 57$) had a BMI ≥ 30. With regards to ethnicity, 76.6% were Caucasian, 3.7% were African-American, 6.2% were Hispanic, 12.1% were Asian, and 1.4% identified as “other”.

Method

The method for Study 4 was identical to that of Study 1.

Results and discussion

A chi-square analysis was used to determine whether the proportion of participants selecting the small vs. large portion varied as a function of their BMI category. Participants who were overweight (60.0%) and participants who were not overweight (63.2%) were equally likely to choose the large portion, χ^2 (1, $N = 273$) $= 0.29$, $p = 0.59$, Cohen’s $d = -0.06$. Repeating the analysis by grouping participants as obese vs. non-obese showed the same pattern of results ($p = 0.56$, Cohen’s $d = 0.07$). Similarly, including BMI as a continuous measure in a logistic regression analysis showed no significant association between BMI and portion choice (whether or not hunger, hours since last meal, liking of pasta and frequency of eating pasta were included as covariates; $ps > 0.81$). Thus, consistent with the previous studies, Study 4 found no evidence that individuals who are overweight select larger portions than do individuals who are not overweight.

General discussion

In four separate samples, totaling nearly 800 respondents and using different methodologies, we found no significant differences in selection of larger portions as a function of BMI. That is, participants with higher BMIs did not select larger portions than did participants with lower BMIs. We should acknowledge that, in Studies 1–3, there was a slight tendency for the heavier female participants (more so than for lighter female participants) to select the large portion over the small portion in a forced-choice situation, or to select larger portions from an array. Although none of these differences was statistically significant, even small differences in the tendency to select larger portions could accumulate over time or occasions to contribute to weight gain in a practically significant way (22). It may be that future research tracking food choices on multiple occasions over a longer period would reveal differences between heavier and lighter individuals. Nonetheless, our data do not provide any strong indication that portion-size preferences vary as a function of participants’ BMI.

If portion size affects food intake to more or less the same degree across BMI (5,10), and if there are no differences in portion-size preference among people who are heavier and people who are lighter (as observed in the present studies), then other factors need to be considered in attempting to explain the connection between portion size and obesity. For example, rather than ordering larger portions, people with higher BMIs might eat more of what they order than do people with lower BMIs (23). It is also possible that people with higher BMIs select foods that are more calorically dense than do people with lower BMIs. However, some recent search suggests that the frequency of self-reported consumption of high-calorie indulgent foods does not differ across BMI classification (24). It might also be that people who are heavier are less likely to compensate for the increased intake that accompanies larger portions by self-regulating at subsequent

meals, although the limited available evidence suggests that BMI does not predict subsequent compensation (25). Another possibility, discussed by Herman *et al.*, (6) is that the increasing rates of obesity may be a matter of more frequent meals rather than of larger meals, so perhaps when we look at portion selection, we are looking in the wrong place. Of course, it may be that those more frequent meals are themselves also larger and higher in calories, compounding the problem of frequent snacking.

There are some limitations in the present study that should be noted. The fact that the choices made in these studies were hypothetical necessitates some caution in interpreting the results. In real-life portion-selection situations, the pattern might be different. For example, the hypothetical scenario meant that participants were choosing portions without paying for them. A validation study did find that portion-size decisions and actual purchasing behaviour were highly correlated with virtual purchasing (26). However, it is conceivable that if people were required to pay for their portions, they might choose larger portions on the grounds that larger portions often offer more value for the money (27). This economic consideration might be particularly forceful for less affluent people, who also tend to be heavier (28). Future research could address these questions in contexts where consumers pay for their food and can also assess the role of socioeconomic status in people's portion-size preferences in those contexts. Another limitation is that our studies included only one food (pasta). Although participants in all studies indicated that they regularly ate pasta (almost once per week), and generally like pasta (mean liking rating across all studies was 69/100), there could be differences in portion-size selection across different types of foods. Thus, it will be important to determine whether the observed pattern generalizes to other foods (e.g. high-calorie snack foods).

Conclusion

We found no compelling evidence that people who are heavier select larger portions than do people who are lighter. Given the lack of association between BMI and portion-size preference observed in the present studies, as well as evidence that portion size influences food intake uniformly across BMI levels (5,10), it is likely that other factors beyond portion-size selection would also be necessary to account for rising rates of obesity. It is also worth noting that choice of portion sizes is not always available in the real word and that, even when choice is available, a 'smaller' portion is not necessarily a 'small' portion (e.g. relative to nutritional needs). If the only portions available are moderately large or larger, we might well find the entire population becoming heavier, even while the heavier segment of the population becomes even heavier even faster.

Conflict of interest

No conflict of interest was declared.

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CPH conceived the research question. NMR and LRV designed the studies and collected the data. LRV analyzed the data. All authors were involved in writing the paper and had final approval of the submitted manuscript.

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