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RESEARCH ISSUES: THE FOOD ENVIRONMENT AND OBESITY

Portion Size and Obesity[1–3]

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ABSTRACT

Portion size is a key environmental driver of energy intake, and larger-than-appropriate portion sizes could increase the risk of weight gain. Multiple acute, well-controlled laboratory studies, supported by data from free-living settings, demonstrated that portion size has a powerful and proportionate effect on the amount of food consumed. Of particular importance is that bouts of overeating associated with large portions are sustained and not followed by a compensatory reduction in energy intake. The positive effect of portion size on energy intake was demonstrated for different types of foods and beverages, and is particularly pronounced with energy-dense foods. The predisposition to overeat in response to large portions is pervasive and occurs regardless of demographic characteristics, such as socioeconomic status, age, body mass index, and sex. Secular trends toward greater availability of large portions, coupled with value-size pricing, effectively distorted consumption norms and perceptions of what is an appropriate amount to eat. Nevertheless, although a direct causal link between portion size and obesity remains to be established, advice to moderate portion sizes, especially of energy-dense foods, is presently the cornerstone of most weight management advice. Although many strategies have been proposed to counteract the deleterious effects of portion size, there are few data indicating which are likely to be acceptable in the medium- to long term. Further research is urgently needed to establish what types of interventions targeted at portion size are likely to be effective, in what settings, and among which target groups. *Adv Nutr 2014;5:829–834.*

Portion Size—The Issue

It is only comparatively recently that the contribution made by larger portion sizes to promoting overeating and obesity has been the subject of intense investigation. The trend toward increasing portion sizes started in the late 1970s and has been accelerating ever since. This is most apparent and best documented in the United States, where portion sizes of numerous food products, especially those of high energy density, are increasing in restaurants and fast food establishments (1–4). More extensive analyses of nationally representative dietary data in the United States also confirmed this trend, not only for out-of-home eating, but also for in-home consumption by adults (5,6) and children (7). In comparison, there is a paucity of trend data on portion size in Europe. Limited data from Denmark (8), the Netherlands (9), and the United Kingdom (10,11) suggest that trends in portion size are mirroring those observed in the United States, although portion sizes tend to be larger overall in the United States (12). Data from the United Kingdom show that although the portion sizes of many traditional products generally remain constant, the range of portion sizes has been extended for many food products, including those sold in fast food establishments (11).

Exposure to large portion sizes is now routine and driven by value-size pricing, and both effectively distorted consumption norms and perceptions of what is an appropriate amount to eat. The predisposition to overeat in response to large portions appears to be a ubiquitous phenomenon and occurs irrespective of current weight status in children and adults, sex, and/or degree of dietary restraint or disinhibited eating behavior (13–17). Even by 2 y of age, children may no longer be immune to the intake-enhancing effects of large portion sizes (18).

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Given that portion size trends coincided with the increasing prevalence of obesity in both the United States and Europe, it has been speculated that they are causally connected. Analysis of cross-sectional population-level data in the United States indeed confirmed that, over the past 3 decades, the observed increase in energy intakes of both children >2 y of age and adults was largely driven by a combination of increased eating frequency and portion size (7,19). Although these observational data cannot establish causality, they highlight the complexity of establishing a direct causal link between portion size and obesity, given that energy intakes are a function of not only the portion size of food, but also its energy density and the frequency of food and beverage consumption, among other factors (19). With these caveats in mind, the purpose of this review is to evaluate the impact of portion size manipulations on energy intake and weight management in both children and adults.

Portion Size—Critical Review of All Substantive Relevant Perspectives

The overwhelming majority of studies manipulating portion size were acute, single-eating occasion studies, with only one-quarter of studies investigating the impact of portion size on overall food intake for 24 h or longer. Studies were conducted in a number of settings, including the laboratory and more naturalistic settings, e.g., in buffet-style restaurants and cinemas, and also included a variety of foods such as amorphous foods, pre-packaged snacks, single unit foods, and beverages. A positive effect on energy intake was demonstrated in most, but not all, studies. Moreover, in general, consumers tend to eat proportionally more as portion size increases.

Acute studies (<24 h)

Increasing the portion size of snacks. Snack foods have the potential to promote energy intake, because many are of high energy density and may therefore potentiate the effect of increasing portion size (20,21).

In total, 9 studies focused on manipulating the portion size of snacks. Of these, one-third showed that increasing the portion size of a snack food by 100% will result in a 35–80% increase in adults' snack energy intake (22–24). In the presence of visual cues, such as larger bowls and serving scoops, it appears that adults will serve themselves more of an energy-dense snack (25,26). Preschool children also appear to be influenced by similar environmental cues (27). Alternatively, reducing the package unit size of various snack foods, although not effective for reducing short-term energy intake (22), reduced energy intake from snacks over periods of 7 d or longer in adults (28,29). In addition to increasing consumer awareness of portion size (29), portion-controlled or segmented packs of snack foods were a useful means of reducing food intake in overweight adults (30) and undergraduate students (31). However, in 1 study, the opposite effect was observed among restrained eaters (32).

Overall, although these snacking studies show that increased portion sizes can increase intake in the short term, the conclusions are limited by the heterogeneous study designs used, and no definitive statements can be made about their efficacy for weight management in the longer term.

Increasing the portion size of a meal. The positive and proportionate effect of increasing portion size on energy intake at a single meal was documented extensively and conclusively in adults (33–42). Five studies showed that by increasing the portion size of amorphous and single unit foods by 50%, energy intake increased by 10–40% (33–36,41), and when increased by 100%, the response was a 30–55% increase in food energy intake (34,36,37). A major limitation of such studies, however, is that the majority were conducted in an unrealistic laboratory setting where, at times, subjects were eating in isolation (34,37,38,40,42). Only 3 studies replicated the effect in the more naturalistic settings of buffet-style restaurants and cafeterias (33,35,39). Interestingly, in a much earlier study, Edelman et al. (43) failed to show an effect of increasing the portion size of a pasta meal on subsequent intake, although eating in isolation did significantly reduce intake.

To date, only 5 studies have been conducted in children to assess their responsiveness to increasing portion sizes. In these studies, doubling the portion size of a macaroni and cheese entree resulted in a 10–40% increase in energy intake (44–47), whereas a 4-fold increase in entree portion size increased the total meal energy intake by 61% (48). These observations were first reported in 5-y-old preschool children, but not in younger 3-y-old children (44). Subsequent studies demonstrated significant positive effects of larger portion sizes on intake in children as young as age 2 y (45–48). Moreover, portion size and energy density have additive effects in promoting energy intake (46). These studies, albeit limited in number, suggest that from an early age, children are susceptible to portion size cues.

Although these acute studies provide supportive evidence that individuals will immediately respond to increasing portion sizes by eating more, they give no indication whether the effects would be sustained, or indeed compensated for, at future eating occasions.

Increasing portion size over 24 h and longer

In an attempt to resolve these issues, studies that manipulated portion sizes over 24 h or longer in adults demonstrated that in most, but not all, cases, the positive effect of portion size on food intake is sustained.

However, the evidence for a compensation effect (i.e., down regulation of the amount of food consumed as a consequence of eating larger portions) in children and adults on subsequent food intake in the short term is equivocal (34,38,41,42,47,49). A previous study showed that the energy intake of adults is more tightly regulated over 24 h compared with that at individual eating occasions (50), which

may help to explain inconsistencies in short-term studies. Indeed, all 7 crossover-designed studies carried out in the longer term (2 d to 1 mo) showed no evidence of compensation of intakes in adults (22,29,51–55).

As noted with the single meal studies, the change in energy intake appears to be proportionate to the change in portion size, with 25–100% changes in the latter resulting in a change in mean daily energy intake of adults of between 10% and 25%. Although the longer-term effects of increasing portion size are attenuated relative to those observed in the acute studies, the results tend to be more consistent between studies. Of note, in the 3 studies conducted over 2–4 d (51–53), men were more responsive to the portion size effect compared with women. Over 11 d, however, the opposite effect was observed (54). No studies to date have explored the longer-term effect of portion size manipulation on food or energy intake in children.

Reducing food portion sizes

There is now substantial and robust evidence that increasing portion sizes positively affects energy intake, at least in the short term, with an additional and independent effect from energy density also apparent in both children and adults (34,46,56). Remarkably, there is virtually no evidence that unequivocally demonstrates the effectiveness of reduced portion sizes on reducing energy intakes.

In terms of food unit size, 4 studies in adult subjects showed that subpackaging or reduced food unit size can reduce food intake (29,30,39,57). However, others suggested that such a strategy could have the reverse effect, because self-control mechanisms are not triggered (58). Moreover, the effect does not appear to extend to amorphous foods offered as small bite-sized portions for all meals over 24 h (56).

With respect to meals, Rolls et al. (59) showed that offering adults a large portion of a low-energy–dense first course resulted in reduced energy intake during the second course. More recently, this finding was also demonstrated in children aged 3–5 y (60,61). In another study, a 25% reduction in portion sizes over 2 d resulted in a 10% decrease in ad libitum consumption and energy intake by adults (53). In the only acute studies investigating the impact of reduced portion sizes in children, although no change in energy intake was observed when the portion size of the entree decreased by 25% (47), an effect was apparent when a wider range of age-appropriate portion sizes was considered (48). Although these studies are a useful addition to the debate, it is unclear whether these effects would be maintained in the medium- to long term under free-living conditions. Further studies in children are also required to assess their responsiveness to reduced portion sizes in the medium- to long-term.

Portion size as a strategy for weight management

A range of observational studies in children and adults have associated increasing portion size with both overweight and obesity (30,43,62–67), as well as weight gain (51,55). Not surprisingly, these studies concluded that addressing portion size may be an effective tool for weight management. However, given that these conclusions are based on cross-sectional analyses, it is unclear whether the observed associations between portion size and adiposity are causal or associative only.

The use of meal replacement products and portion-controlled entrees for effective weight loss is well documented (68,69) and, given the extensive range of evidence that now exists linking increased portion sizes to increased energy intake, it is astonishing that only 2 of the intervention studies discussed in the present review assessed body weight changes during portion size manipulation. The first, by Jeffery et al. (55), observed a non-significant increase in body weight after employees were provided with a 50% larger lunch for 1 mo. Although the authors acknowledged that the change may have failed to reach significance because of the small sample size, it could also be that, by manipulating only 1 meal throughout the intervention period, the portion size effect was too small to result in weight change. In the second, shorter-term study by Kelly et al. (51), a significant mean increase in body weight was observed after larger portions at all eating occasions were served to men and women over a 4-d fully residential period. Unfortunately, these studies cannot be taken as proof of causality, because both are not without their limitations, most notably in that they do not reflect eating in a free-living context. Although undoubtedly challenging to carry out, longer-term studies in both laboratory and free-living contexts are clearly needed to definitively establish a causal link between increased portion sizes and obesity.

Portion Size—Proposed Future Research Agenda

Despite pervasive commercial trends toward large portions, there is surprisingly little compelling evidence that these are causally linked to obesity. Nevertheless, the totality and strength of the evidence provide sufficient evidence for the design and implementation of multifaceted interventions to effectively moderate the effects of portion size distortion. Many consumers are not unaware that portion sizes of a range of foods have been getting overly large, but perceive that self-regulation of portion size, particularly in relation to out-of-home eating and snacking, is extremely challenging and a major obstacle in weight management and healthy eating strategies.

Consumer behavior in relation to portion size is a complex and evolving area of research. Although consumers may be amenable to portion size interventions, these must be tempered with the caution that they are only going to be feasible and acceptable if palatability and convenience are not compromised, and value for money and individual freedom of choice are guaranteed. If education messages are to resonate with consumers, it is imperative that these are underpinned by a more informed evidence base about consumer

attitudes, beliefs, and behaviors toward portion size than has hitherto been the case. Although not a definitive list, some of the key communication challenges that need to be addressed include the following: food portion size selection remains largely unaligned to energy and nutrient needs; there is a perception that the portion size concept is only relevant to dieters and those with special dietary needs; the ability of consumers to estimate how much they have consumed is poor, particularly for larger portion sizes; the amounts of food selected for consumption are frequently based on immediate considerations; portion size advice is not well used by consumers because it is seen as unrealistic and lacking credibility; portion size consumption norms and expectations vary with eating context, e.g., eating out-of-home, snacks, shared foods, indulgent foods, and healthy options; and there is distrust for the motives of any food industry initiatives in the area of portion size (70,71).

Empowering consumers through education to manage portion sizes more appropriately critically depends on identifying and promoting best practice communications that are nonprescriptive, engaging, credible, and subtle, i.e., not necessarily guided by health-related considerations. Although portion size labeling has the potential to help consumers select more appropriate portion sizes, any meaningful dialogue with consumers is currently impeded by the lack of a transparent and consistent message with regard to terms such as portion size, serving size, and reference portion, and lack of clarity about the intended purpose (comparative vs. aid to appropriate portion size selection) of that guidance. In addition, the most effective and accessible portion size aids and communication formats for portion size selection and behavioral strategies for managing portion sizes should also be a priority.

However, without addressing the environmental contexts in which consumers make portion size selection and consumption decisions, educational initiatives on their own are likely to have very limited efficacy in changing portion size behaviors. Detailed behavioral research is needed to fully comprehend the motivations and expectations behind portion choice decisions in a variety of eating contexts and how these affect each another. In particular, given that out-of-home eating and snacking have been identified by consumers as posing the greatest obstacles to portion size regulation, a better understanding of the drivers of consumption behavior in the myriad out-of-home and in-home eating scenarios is needed to ensure that any guidance on portion-size control is not naively based on a "1 size fits all" context, and thereby is more likely to be endorsed by consumers.

To date, there has been little research to establish the most feasible and effective interventions and policies to counteract the deleterious impact of portion size. A number of intuitively promising interventions, such as increasing the range of portion sizes available (72–74), reducing the portion size of high-energy–dense foods together with encouraging the consumption of low-energy–dense foods to facilitate reduction in energy intakes without undue and unwelcome restriction on the amounts consumed (13,21), portion size labeling (75–78), and proportional pricing strategies (5,74,75,79), have been proposed but there is little empiric evidence to indicate how effective these might be in the medium- to long term. Although there is some evidence that consumers particularly favor a larger variety of portion sizes as a strategy for managing portion sizes (71), the impact of this greater choice on purchasing and eating behavior in the typical environments in which they are consumed is far from clear. This issue merits further investigation, especially in relation to small portions, subpackaged food products, including single-serving and calorie-counted packs, and foods perceived as "healthier" (e.g., fat-reduced products), to assess if they can deliver the anticipated benefits or, alternatively, act as a license to eat more, and more often.

In conclusion, although it may never be possible to establish a direct causal link between large portion sizes and obesity, advice to moderate portion sizes, especially of energy-dense foods, is presently the cornerstone of most weight-management advice. However, the challenge of getting consumers to follow such advice is formidable given their chronic exposure to large portion sizes and distorted consumption norms and perceptions, together with consumer unwillingness to compromise on value for money, taste, and convenience. Generating the evidence base on which intervention strategies hold the most promise in terms of acceptability and efficacy will not be achieved by short-term highly focused interventions. The evidence needed will only be generated through the development of a well-articulated research framework that systematically tests the interactions between individual, socio-cultural, economic, environmental, and political influences on portion size selection and consumption behaviors.

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