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Serving size guidance for consumers: is it effective?*

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Larger portion sizes (PS) may be inciting over-eating and contributing to obesity rates. Currently, there is a paucity of data on the effectiveness of serving size (SS) guidance. The aims of the present review are to evaluate SS guidance; the understanding, usability and acceptability of such guidance, its impact on consumers and potential barriers to its uptake. A sample of worldwide SS guidance schemes (*n* 87) were identified using targeted and untargeted searches, overall these were found to communicate various inconsistent and often conflicting messages about PS selection. The available data suggest that consumers have difficulty in understanding terms such as 'portion size' and 'serving size', as these tend to be used interchangeably. In addition, discrepancies between recommended SS and those present on food labels add to the confusion. Consumers generally understand and visualise SS best when expressed in terms of household measures rather than actual weights. Only a limited number of studies have examined the direct impact of SS guidance on consumer behaviour with equivocal results. Although consumers recognise that guidance on selecting SS would be helpful, they are often unwilling to act on such guidance. The challenge of achieving consumer adherence to SS guidance is formidable due to several barriers including chronic exposure to larger PS, distorted consumption norms and perceptions, the habit of 'cleaning one's plate' and language barriers for ethnic minorities. In conclusion, the impact of SS guidance on consumers merits further investigation to ensure that future guidance resonates with consumers by being more understandable, usable and acceptable.

Food portion size: Food serving size: Dietary guidelines: Obesity

In recent years, the impact of larger portion sizes (PS) on energy intake and obesity has been the focus of extensive research. This is not surprising given that approximately two-thirds of adults in the UK and Ireland are currently either overweight or obese[1–3]. The latest predictions estimate that if present trends continue there will be an additional eleven million obese people in the UK by 2030 compared with 2010[4]. The impact of food PS has been well documented in the US[5,6] where PS have increased in parallel with obesity[7] since the late 1970s[8]. The prevalence of larger PS is evident both within and outside of the home[9], particularly for foods of high-energy density[10], and in both adults[11–14] and adolescents[15], especially in those with a higher BMI[16–19]. Limited data from Europe demonstrate broadly similar trends to the US[20]; although, in the US, PS of fast food in particular are larger than those in Europe[21]. In the UK, while the PS of some foods such as ready meals and fast food[22,23] have increased, the PS of other foods have remained constant, albeit, there is a wider range of PS available[24]. In the present economic climate, larger PS may incite over-eating because they are often regarded as good value for money[25,26], but this has also contributed to a distorted perception of appropriate PS.

A number of short-term studies have shown that serving larger PS of snacks[27,28], sugar-sweetened drinks[29] and

Abbreviations: GOV, government; HCP, health care professional; PS, portion size; SS, serving size.

*The authors dedicate this article to the memory of their colleague Professor Julie Wallace (7 April 1971–7 February 2012).

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individual meals[19,30–33] led to an increased energy intake. For example, participants consumed more popcorn when presented with a large serving compared with a medium serving, even though they reported that it tasted stale[34]. Of concern, participants failed to compensate for the increased intake at subsequent meals[14,35]. The effect of larger PS has also been reflected in longer-term studies of varying length, from 2 d to 1 month[11,14,35–37]. In one study, males and females gained an average of 0·9 (SD 1·1) kg and 0·6 (SD 0·6) kg, respectively, in response to modest increases in PS over 4 d[37]. On the other hand, serving smaller PS[38–40], single serve packets[41] or smaller packaged foods[42,43] have been associated with a reduced energy intake. Collectively, this evidence demonstrates that advising people solely about food selection is not enough; the challenge is to also help consumers appreciate the significance of the quantity of the food they consume.

In the UK, there is an absence of national serving size (SS) guidance which has led to public confusion[44]. The UK food guide, 'The Eatwell Plate'[45], illustrates the recommended proportions of each food group. For example, it advises the consumption of at least two servings of fish weekly[45], but does not attempt to quantify the SS of the fish. In contrast, other national guides provide more comprehensive guidance about SS, e.g. the Canadian Food Guide[46] gives specific examples of SS from each food group, gives recommendations on the number of daily servings, accounts for individual needs and includes composite dishes. In the UK, the lack of national quantitative recommendations has inevitably resulted in a plethora of schemes from various groups including non-government (GOV) organisations, health care professionals (HCP) and industry, communicating inconsistent guidance on SS, which is often conflicting and misleading. It is imperative that universally agreed definitions of both PS and SS are established and communicated effectively to the consumer. Furthermore, SS of particular foods can vary according to GOV recommendations or market place sizes[47,48] or consumer perceptions of a SS[49–51]. Not surprisingly, consumers are confused by the inconsistent guidance that may limit their ability to actually implement such advice[48]. Nonetheless, there is a paucity of comprehensive data on consumer understanding of SS guidance[52]. Therefore, the objectives of the present research were firstly to evaluate SS guidance schemes and secondly to review the published literature on the effectiveness of SS guidance, i.e. consumer understanding, usability and acceptability of SS guidance, its impact on consumer behaviour and potential barriers to its uptake.

For the purposes of this review, definitions of PS and SS were based on those recently cited in the UK[52], i.e. PS is the amount of food intended to be consumed by an individual in a single eating occasion and SS is the quantity recommended to be consumed in a single eating occasion.

Methods

Identifying serving size guidance schemes

Targeted and untargeted internet searches were conducted for national and international GOV, non-GOV organisations, HCP and food industry recommendations on SS. Details of each scheme were collated under the following headings: scheme developer and/or owner; date developed; country; rationale; basis of information; present status (e.g. being used, under review and in draft); applicable foods/exemptions; target audience; main information; graphical format; context; ease of use and clarity; consideration of individual needs; terminology; and the number of daily/weekly SS. In some instances, it was not possible to collect complete data under each heading for all schemes, e.g. some schemes were not available in English, albeit, their graphical format was still recorded.

Ease of use and clarity were rated using a scoring system based on factors cited as being important to consumers[48]. Maximum scores that could be allocated for each attribute are shown in brackets: visual graphical format/design (1); use of descriptors, e.g. tools or household measures (1); inclusion of all food groups (0·5) and composite foods (0·5); guidance on frequency of consumption (0·5) and individual needs (0·5) and practicality and conciseness (1). A total score out of five was calculated, and schemes were classified as poor (score 0–1·5), average (score 2–3·5) and excellent (score 4–5) in terms of ease of use and clarity. In addition, a sub-sample of schemes was scored independently by two researchers to within 0·5 of the initial scores.

Assessing the effectiveness of serving size guidance schemes

A search for the appropriate literature was conducted using the online electronic database 'Web of Knowledge: Web of Science with Conference Proceedings' together with manual searches of reference lists. The following broad search terms (food PS) or (food serv* size) were employed for papers published between 1970 and February 2012. This resulted in a total of 2333 papers, which were refined by relevant subject areas resulting in 949 papers prior to exclusion. Initially, papers were included/excluded based on the relevance of the information in their abstracts; where necessary the full text was consulted. The majority of studies were excluded because their primary focus was either to validate dietary assessment methods such as FFQ or evaluate adherence to dietary guidelines[53]. Only studies that were available in English and investigating the general adult population (i.e. ≥ 18 years) were included. Studies specifically dealing with children were excluded as different parameters apply, e.g. nutrient requirements. This resulted in a final total of 108 papers for inclusion in the present review. The papers identified were evaluated with respect to: consumer understanding, impact, acceptability, usability and potential barriers. The papers were interpreted using NVivo qualitative data analysis software version 9 (QSR International Pty Ltd)[54].

Identifying serving size guidance schemes

A total sample of eighty-seven national and international GOV (*n* 49), non-GOV organisations (*n* 14), industry (*n* 12) and HCP (*n* 12) SS guidance schemes were identified.

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Table 1. Overview of national and international serving size (SS) guidance schemes

	Number of guidance schemes*				
	GOV	NGO	HCP	Industry	Total
Graphical format					
Pyramid	18	2	0	0	20
Plate	8	0	3	3	14
Other	23	11	9	8	51
Terminology					
Portion	11	7	8	7	33
Serving	10	2	0	1	13
Combination of terms	10	3	3	4	20
Other	9	2	1	0	12
Ease of use and clarity					
Poor	11	8	4	4	27
Average	21	4	7	6	38
Excellent	7	1	1	1	10
Advice on no. of daily/weekly servings					
Yes	17	3	5	3	28
No	11	5	4	8	28
Sometimes/vague	8	5	3	1	17
Total daily amount	6	0	0	0	6
Account for individual needs					
Yes	16	2	5	3	26
No	18	9	7	8	42
Sometimes/vague	6	2	0	1	9

GOV, government; NGO, non-GOV organisation; HCP, health care professional.
*It was not possible to collect complete data for all eighty-seven schemes, therefore, the total number of schemes from each source varies depending on the aspect of the guidance being considered.

The information in the schemes was communicated with the aid of various graphical formats. Table 1 shows that GOV schemes most consistently favoured the pyramid format; however, the plate and other formats, such as the rainbow, flag, house and spinning top were also used. The Food Pyramid used in Ireland[55] was adapted from the US 'My Pyramid'[56], the latter being recently replaced with 'My Plate'[57]: a meal-based approach similar to the UK 'Eatwell Plate'[45] but with additional SS information. The majority of non-GOV organisations, HCP and industry schemes adopted other formats to demonstrate appropriate SS, including food photographs, information sheets and visual aids such as the palm of the hand. A lack of consistent terminology was apparent (Table 1) with some schemes utilising the term 'portion size' or 'serving size', whereas others used a combination of terms without distinguishing between them, e.g. PS and SS, or other terms such as 'units' or 'amounts'. The US has moved away from SS and PS and now uses 'amounts' in the most recent recommendations[58]. In relation to the ratings for ease of use and clarity, the majority of guidance schemes were rated either 'average' (score 2–3·5 out of 5) or 'poor'. Only ten (13%) schemes were rated 'excellent' for their quantitative advice. A considerable number of schemes from all sources did not provide any advice on the number of servings that should be consumed daily or weekly, whereas others provided only vague and/or inconsistent information, e.g. advising on the frequency of some food groups but not others. Individual needs such as sex and age were not considered by many of the schemes although some made a vague attempt, e.g. by stating that pregnant or lactating women need more servings.

GOV schemes were generally based on either typical SS for appropriate nutrient intake or PS from food consumption survey data. However, a number of schemes did not specify the basis of their SS. One food industry scheme based SS on a combination of GOV recommendations, food consumption survey data, the Food Standard Agency Food PS book[59] and manufacturers labelling information. Table 2 provides some examples of the variations which are evident in the industry recommended SS. For example, an 'average' SS of a potato varied from a small baked potato to a large potato. Moreover, it is clear that none of the schemes shown in Table 2 used the medium SS of cereal (30 g) currently recommended by the Food Standard Agency[59]. GOV PS guidance schemes were mainly developed to translate nutrient-based recommendations into food-based dietary guidance. However, while most schemes did not specify their underlying rationale, a number of HCP schemes were specifically developed to reduce disease risk, e.g. World Cancer Research Fund[60]. Overall, schemes were generally developed to communicate a healthy balanced diet, weight management, dietary assessment or as a guide for caterers. A large proportion (*n* 22; 25%) of schemes did not specify their target audience. Where this was specified, GOV schemes were generally designed for adults and children >2 years, or in some instances >5 years. HCP schemes were sometimes more specific, e.g. they could be aimed at diabetics, cancer patients or overweight and obese individuals. The context in which the SS guidance should be applied was usually not stated, but generally the information was applicable to eating at home or away from home contexts. Most schemes gave SS information for the major food groups including meat, grains, dairy and fruit and vegetables. In the majority of schemes, SS of high-energy dense foods such as fats, oils and confectionery were not quantified; rather it was advised that those food groups be consumed in small amounts or 'sparingly'. Most schemes did not provide SS guidance for composite foods such as lasagne or casseroles.

In summary, the wide range of formats currently employed has the potential to present conflicting and often ambiguous information to consumers about SS. It is clear that a consistent rationale for such communications needs to be set in place to allow for the provision of more comprehensive guidance in future.

Assessing the effectiveness of serving size guidance schemes

As SS guidance is highly variable, consumer understanding, acceptability and use are pivotal to its success. The following sections outline the effectiveness of SS guidance.

Consumer understanding

Understanding can be considered in two ways: objectively; interpreting something as it was intended to be, or

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Table 2. Examples of variations in UK industry* portion size (PS) guidance

Food type	Recommended serving sizes		
Yogurt	Four fluid oz.	150 g small pot	125 g average pot
Potato	Small baked potato	One medium potato	One large potato
Pasta	4–5 oz. (cooked)	75 g mug (dried)	One cup
Flake-type cereal†	1/3 soup bowl	40 g	35–40 g

*Tesco, Marks & Spencer, Sainsburys, Waitrose and Boots Web MD.
†Recommended average 30 g (medium portion).[59]

subjectively; believing that you understand something[61]. Although, 78% of Australian consumers said they understood what constituted a SS of vegetables (subjective understanding), only 14% identified that this was equivalent to half a cup (objective understanding)[62]. Consumers generally have a poor understanding of SS guidance[50,63]. There are three main areas where this is particularly evident: terminology; units of measurement; and consumer perceptions *v.* recommendations.

Terminology. A major obstacle in developing dietary guidelines has been the confusion associated with the terminology used[64]. Consumers have difficulty in understanding the terms PS and SS[48,53] as these tend to be used interchangeably, even within the same scheme[50,52]. Table 3 provides an overview of various cited definitions of PS and SS. These terms are sometimes believed to have the same meaning: the amount of food eaten at a single eating occasion[50] or one sitting[48]. In fact, in a US study, few consumers were aware that their PS could represent more than one SS[50]. PS can be the amount of food offered in a restaurant, or on a label or plate[68]. Phrases associated with the term PS have been reported as 'daily allowance', 'restriction', 'enough for one person' and the weight of food in grams[73].

The majority of the definitions listed in Table 3 can be loosely translated as PS being the amount of food consumed at a single eating occasion, and SS being the amount that is recommended. However, evidence from the most recent European-wide consumer research is not in accord with these definitions[71]. It is imperative that there are universally agreed definitions of both PS and SS established and communicated effectively to the consumer. As mentioned earlier, this review utilises definitions of PS and SS that were recently cited in the UK[52] (i.e. PS is the amount of food intended to be consumed by an individual in a single eating occasion and SS is the quantity recommended to be consumed in a single eating occasion), in order to provide a basis for comparison with future research.

Units of measurement. Various units of measurement are used in SS guidance to convey what constitutes an appropriate SS including weight (e.g. grams or ounces), household measures (e.g. cup), units (e.g. one piece of fruit), a fraction or slice (e.g. slice of bread) or proportions of a plate. Statements such as 'a balanced diet'[53], advising to consume 'more' of something[74] or terms such as small/medium/large may be too ambiguous and subjective[75]. Consumers interpreted SS to be the amount suitable to fulfil daily nutrient requirements rather than that appropriate to have a satiating effect. The authors suggested communicating SS in specific gram weights[70]. However, consumers reportedly find it difficult to adapt from the imperial system to the metric system, particularly those over 45 years, while others show no knowledge of either approach[73]. Furthermore, weights can be difficult to understand, especially for cereals, unless the SS can be related to a common object or household measure[73]. Indeed, consumers generally understand amounts expressed in terms of household measures and units better than specific weights, e.g. the cup as a measure for fruit and vegetables[50,53,62]. In addition, household measures used in conjunction with specific food examples, i.e. one cup of oatmeal (one serving of grains), reportedly helps to 'visualise' amounts[50]. However, care must be taken to ensure consumers fully understand the differences between household measures. For example, a group of UK consumers speculated that a tablespoon was: 'three dessert spoons', 'probably one ounce', or 'is it a dessert spoon or a soup spoon?'[73].

Given that few consumers actually weigh their food[73], SS guidance using household measures with food examples may be most appropriate, with the caveat that consumers need to understand the type of the household measure in question.

Consumer perceptions v. *recommendations.* Consumer understanding of appropriate SS can show little correspondence with actual recommendations[16,48,69,76–79]. With respect to specific foods, consumers estimated SS of pasta, breakfast cereals, meat and rice to be larger than recommended[49,50,69,73], while SS of banana were estimated with ease[77]. In contrast, salad items[69] and mashed potato[49] were estimated to be smaller than the recommended SS. A UK study found that none of the GOV or HCP SS guides under consideration correlated with a group of normal and overweight men's perceptions[51]. However, appropriate PS can vary considerably depending on age and sex[80], therefore it is imperative that recommended SS consider the variable needs of the whole population.

Recommended SS often bears little resemblance to consumers' habitual eating patterns. For instance, in Ireland, one slice of bread equates to one serving; however, people are most likely to consume two slices in a sandwich or two slices of toast at one eating occasion. Consequently, efforts are being made to improve advice so that it resonates better with consumers[81], in a manner similar to Australian guidelines[82]. In the US and the UK, self-reported PS of ethnic minority groups were often multiple times the recommended SS[83,84]. These larger habitual PS can easily promote a distorted view of recommendations,

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Table 3. Definitions of portion size (PS) and serving size (SS) as cited in the literature

References	PS definition	SS definition
Hogbin *et al.*[65]	The amount of a specific food an individual eats for dinner, snack or other eating occasion ... can be bigger or smaller than servings	A specific amount of food that contains the nutrients listed on the label ... generally reflects the amount and individual might reasonably consume each eating occasion
The Dietary Guidelines Alliance[66]	The amount they actually eat	What is 'recommended' they eat
National Heart, Lung and Blood Institute[67]	The amount of a specific food you choose to eat for dinner, snack or other eating occasion – can be bigger or smaller than the recommended food servings	A unit of measure used to describe the amount of food recommended from each food group
Britten *et al.*[50]	'Portion' and 'serving' had the same meaning – the amount eaten on a single eating occasion	
Division of Nutrition and Physical Activity[68]	PS is the amount of a single food item served in a single eating occasion, such as a meal or a snack	A standardised unit of measuring foods, e.g. a cup or ounce used in dietary guidance
Schwartz & Byrd-Bredbenner[69]	The quantity of a food the participant would consume on one eating occasion	
Anderson *et al.*[48]	Terms 'food PS' or 'SS' may refer to the amount of an individual food consumed at one sitting	
Institute of Grocery Distribution[52]*	The amount of food intended to be consumed by an individual in a single eating occasion, e.g. single serve prepared meals	The quantity recommended to be consumed in a single eating occasion as defined by the manufacturer
Institute of Grocery Distribution[63]	PS – sufficient food for a meal or eating occasion/amount of food on one's plate (consumer understanding)	
Ueland *et al.*[70]	'Standardised index of the nutritional content of a food/meal, rather than as an index by which to estimate personal food intake' (consumer understanding)	
US Department of Agriculture[58]	The amount of a food served or consumed in one eating occasion. A portion is not a standardised amount, and the amount considered to be a portion is subjective and varies	A standardised amount of a food such as a cup or an ounce, used in providing information about a food within a food group, such as in dietary guidance
European Food Information Council[71]	The amount a person should be eating or drinking in one sitting, rather than what they are likely to consume	
Waitrose[72]	A portion is how much you should eat, e.g. 80 g of fruit or vegetables is one portion and contributes to one of your five a day	A SS on pack is guidance as to how many people a particular food might serve, e.g. 'this steak and ale pie serves three'. A single SS in some cases equates to one portion, e.g. a yogurt pot

*The definitions of PS and SS used in this review.

causing over-estimated SS of various foods[79]. Industry are also urged to use realistic SS[85] since manipulation of SS to make the nutritional content appear more favourable may be misleading for many consumers[86].

Foods that have been identified as being the most difficult for consumers to select appropriate PS include: starchy foods (rice, pasta, breakfast cereals and potatoes), meat, fats, cheese, alcohol and foods sold loose or in multi-serve packs[63]. Composite dishes also add to the confusion. Although consumers understood that composite dishes such as pizza could account for servings from more than one food group, they were unsure why a range of servings were recommended[50]. While the '5-a-day' campaign for fruit and vegetables is widely promoted, consumers found it difficult to understand what constitutes a SS of fruit or vegetables[62,73,87]. When more guidance was available to increase consumer awareness of fruit and vegetable SS their consumption of this food group increased considerably[88].

Overall, it is apparent that recommendations may need to be reconsidered to be more reflective of consumers' perceptions of SS and their habitual PS, in order to be more meaningful. Particular consideration and perhaps additional education may be needed for some foods.

Impact. The impact of SS aids and training has mainly been evaluated in the context of dietary assessment. Relatively few studies have assessed their direct impact on consumer SS estimation and selection[48] (*n* 17) and these are summarised in Table 4. Although the majority of these studies have reported a reduced error in SS estimation or a

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Table 4. Impact of serving size guidance

References	Details of SS guidance	Subject characteristics	Country	Impact
Bolland *et al.*[89]	10 min group training – household measures and food models (solids & liquids)	*n* 42 (F) college students	US	Positive*
Yuhas *et al.*[90]	10 min group training – food models (solid, liquid and amorphous foods)	*n* 145 (M and F) students	US	Positive
Weber *et al.*[91]	1 h SS training for solid, liquid and amorphous foods	*n* 66 (F) adults	US	Positive
Brown & Ole[92]	2D and 3D aids, e.g. 1 cup of milk	*n* 380 (M and F) students	US	Positive
Venter *et al.*[93]	Photographs of SS of commonly eaten foods	*n* 169 (M and F) adults	South Africa	Positive
Byrd-Bredbenner & Schwartz[94]	2D and 3D aids, e.g. golf ball	*n* 113	US	Positive
Ayala[88]	Computer and group training	*n* 76 (F) adults	US	Positive
Martin *et al.*[95]	Energy calculation training system	*n* 44 (M and F) adults	US	Positive
Colapinto & Malaviarachchi[96]	Interactive F&V SS display in grocery store	*n* 201 (81 % F) adults	US	Positive
Ollberding *et al.*[97]	SS labelling	*n* 4454 (M and F) adults	US	Positive
Tavelli *et al.*[102]	Food guide pyramid	*n* 346 nutrition students	US	Negative†
Riley *et al.*[103]	Computer tutorial	*n* 7 adults	US	Negative
Ashfield-Watt *et al.*[98]	F&V 5-a-day – household measures and food photographs	*n* 269 (M and F) adults	UK	None‡
Ueland *et al.*[70]	Lunch labelled as 0·5/1/1·5 servings	*n* 33 (M and F) adults	Norway	None
Vermeer *et al.*[99]	Proportional pricing – cafeteria and fast-food	*n* 291 (M and F) adults	US	None
Kothe & Mullan[100]	F&V SS – online questionnaire	*n* 106 (79 % F) adults	Australia	None
Vermeer *et al.*[101]	Soft drinks labelled 0·8–3 servings	*n* 89 adults	Netherlands	None

SS, serving size; min, minutes; F, female; M, male; F&V, fruit and vegetables.
*Reduced the error in SS estimation, i.e. closer to recommended or reference size, or resulted in a more favourable nutrient intake.
†Under or over-estimation of SS.
‡No change in SS estimation.

more favourable nutrient intake (positive impact), these effects were only measured in the short term and usually in the laboratory setting[88–97]. A follow-up study conducted 3 months after initial training about SS showed that the immediate positive impact had not been maintained[96]. Some studies showed that SS guidance had no impact[70,98–101] and others resulted in under- or over-estimation of SS (negative impact)[102,103]. These equivocal results cannot be explained by the different methods of communicating SS information, e.g. computer based and food labelling *v.* SS aids, because each of these methods could have either positive, negative or no impact depending on the study. Group training using food models and other aids appears to be the most consistently effective method, albeit in the short term only. The majority of these studies were carried out in the US. Moreover, there have been no long-term or intervention studies on the impact of SS guidance on weight management[68].

Awareness of SS guidance does not necessarily result in its implementation[104]. For instance, the current 5-a-day campaign for fruit and vegetables is well known by the public, but there is little evidence of its effectiveness[74]. A UK study demonstrated that guidance on SS estimation of fruit and vegetables using household measures and food photographs as aids had no effect on PS selection[98]. There is some evidence to suggest that portion control tools may be effective for aiding weight-loss in the clinical setting[105–107], but further work is needed to evaluate the impact of SS guidance in the general population[48].

In the US, dietary guidelines are revised every 5 years, but there is no mandate to evaluate their impact[108], nor is this compulsory in the UK or Ireland. More support is clearly needed to aid the implementation and evaluation of guidance[109]. Even when information on SS is available, consumers still tend to inaccurately assess their PS[68]. A positive impact is more likely if consumers are aware that the change is important for their health[110].

Acceptability. In general, consumers tend to be interested and recognise that SS guidance may be helpful, but do not always consider it relevant to them personally[26,111], and the idea that 'one size does not fit all' has been evident since the 1980s[112].

It would appear that consumers will only consult SS guidance when they feel intervention is required, e.g. when aiming for weight loss[53,73,110,111]. Furthermore, SS guidance is reportedly more accepted by consumers for main meals and foods such as rice and pasta, but is generally not considered for snack foods, drinks or staples like bread and milk[73]. Acceptability also appears to be dependent on sex, socio-economic status, level of interest in the diet and the perceived credibility of the source[25,26,48,66,73,111,113].

There is evidence that consumers were not inclined to implement SS guidance even when they were aware of it[66]. Indeed, only half of UK consumers reported that they would use serving demarcations on food labels[73]. Negative connotations were associated with measuring SS as it was considered time consuming, impeded the enjoyment of meal time, and could be frowned upon by others[114]. Consumers are generally amenable to tools and household measures as guides to SS[73] and the provision of computer-based SS information is generally well accepted by

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younger groups, e.g. students[88,115,116]. Although proportional pricing strategies were considered to be unattractive for large households[26], consumers were reportedly most receptive to pricing strategies, SS labelling and the provision of a larger range of SS[26,99]. However, despite being viewed as acceptable, pricing strategies had no effect on PS selection[117].

The available data suggest that SS guidance should be simple, non-prescriptive, consistent, practical and flexible in order to be accepted by consumers[73,111]. Ultimately, the uptake of any recommendation about SS is unlikely unless they are both realistic and achievable[118].

Usability. As previously discussed, consumers have difficulty comprehending incoherent and contradictory advice[50] available from various sources, each with different perspectives[119]. For example in the US, the inconsistencies between SS from the Pyramid[120] (half a cup of cooked pasta) and the Nutrition Facts label on food packaging (1 cup cooked pasta)[121], add to consumer confusion[50]. Labelling SS for products from the grains group can vary considerably[121]. US market-place PS were found to be larger than those recommended[8,47], e.g. cookies were seven times bigger, while cooked pasta was almost five times the recommended SS[8]. Moreover, reference SS for food labels were derived from food consumption surveys conducted between 1977–78 and 1987–88[122]. In Australia, SS for snacks varied greatly (18–100 g), while the SS for drinks frequently did not correspond to the size of the container[123]. Furthermore, SS of some own brand foods such as ready meals and pizza were significantly smaller than their market brand equivalents[124]. In Europe, there are no regulations or clarification of SS on labels[48]. A comparison of the recommended UK medium PS[59] with food label SS demonstrated several inconsistencies, e.g. the average SS for a medium slice of steak pie is 120 g but this ranges between 138 and 300 g on food labels[48] making it difficult to compare products. On the other hand, UK consumers thought SS on front-of-pack labels helped them make quick comparisons between the nutritional composition of foods[86].

Recommended SS of foods within the same food group should also be nutritionally comparable to enable consumers to exchange foods. For instance, a SS of rice should be comparable in terms of energy content with an SS of pasta. In the present Irish dietary guidelines, there is a wide range in energy content between SS of bread, cereals and potato ranging from 314 to 1046 kJ (75–250 kcal), although these were deemed to be equivalent[49]. In theory, this limits the consumer's ability to effectively use SS in the intended way, although efforts have been made to rectify this issue[125].

Foods labelled as containing multiple servings can be problematic. An entire packet of a food product is often eaten oblivious to the fact that it contained several servings[68] and unless the whole pack contained just a single SS consumers were confused about how to interpret the nutrition information[73]. Details of the number of servings in packaged amorphous foods, demarcations of individual SS on packets of foods such as rice and butter, and individually packaged SS can be useful[73]. Despite this less than a quarter of consumers use food labels to aid their estimation of PS[63]. With regard to the elderly, some may not be able to remember SS recommendations that would limit their ability to follow them[126].

Food photographs[127], household measures and other practical tools can be useful in PS estimation although these have mainly been investigated with respect to their use in dietary assessment[48]. Photographs and food models can help the consumers to visualise their typical PS but they may not be useful for composite dishes, e.g. sauce covering meat or rice in a meal, making it difficult to interpret PS of the individual food items on the plate[128].

Another issue is that SS guidance does not always consider the types and amounts of foods typically eaten by ethnic minorities[83,84]. 'The plate model' was considered useful, but concerns have been expressed about the large proportion of vegetables recommended because of the customary addition of fats and oils to vegetables by some ethnic groups. For example, a typical PS of vegetable soup for a British–African–Carribean group (which was more than double that of the Caucasian population in the UK) could contain up to 25 g of fat[84]. A Canadian study conveyed that the 'hand jive' method (e.g. using the palm of the hand to estimate a serving of protein) was too vague and difficult to remember for immigrants from South Asia, who found themselves thinking of SS in terms of household measures[111]. Consequently, such tools may need special consideration of the traditions and language of ethnic minority groups[114]. Further research is needed to assess the validity and relevance of SS tools and aids such as food photographs and household measures for ethnic minority groups[129].

Potential barriers. The potential barriers to the uptake of SS guidance have been widely documented in the literature. There are various environmental factors that can act as potential barriers to the implementation of SS guidance both within and outside of the home, such as package size[63,130], eating food in units[131], poor nutrition knowledge[63], value for money[26,73,101,118], irregular eating patterns[63], time constraints[48,50,53,132], taste[132], social interactions/distractions[133,134], food cue exposure[135] (especially in unrestrained eaters)[136], language barriers[114] and literacy and numeracy skills[137,138]. Larger plates have been linked to larger PS[133], although manipulation of plate size does not affect food or energy intake[139,140]. One of the main reasons for failing to adhere to such guidance is consumer habit and experience[48,66,73,141]. The tradition of 'cleaning one's plate'[66,73,142] occurs at over 91 % of meals[143] with just over half of consumers admitting to this when eating out[73]. Consumers have been found to ignore SS guidance when eating outside of the home[66], albeit they considered the home to be the most challenging setting in which to control their PS[63].

The adoption of SS guidance is difficult in a culture where larger PS have become 'the norm'[26,48,101] and recommended SS are perceived as being too small[26]. Consumers are generally oblivious to the fact that these consumption norms coupled with the underestimation of energy content in large PS can often result in consumption beyond their needs[144]. Another obstacle to adopting SS guidance is the increasing concern about

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avoiding food wastage[26,63,66,101]. Lack of consideration for PS has also been attributed to hunger and satiety cues[26,73,101,114,132,143,145–151]. Approximately a fifth of consumers eat what is on their plate until they feel full[73]. Hunger has been typically shown to cause an increase in PS[73,152]. However, PS estimates of a range of foods and beverages were reported to be significantly smaller under hungry compared with full conditions[51]. PS has also been shown to correlate with food liking and familiarity, and larger PS were estimated for foods expected to be less satiating[77].

Consumers are sceptical of labelled SS as they feel the recommended SS may be manipulated by manufacturers to mislead them[86]. The 'health-halo' effect associated with low-fat foods may also lead consumers to disregard SS information[10,153]. The so-called healthier options may not be as satisfying and may lead to an increased consumption[73]. In addition, the food industry is reluctant to reduce SS as this would increase packaging costs and consumers could perceive it as a strategy to increase profits[99]. Marketing techniques such as product naming, reduced cost, labelling and presentation can make the larger portions more appealing[99].

Health professionals have also identified barriers to providing SS advice, i.e. determining the level of details required in SS guidance communications, conflicting information in the media (especially for carbohydrates), and the absence of national quantitative guidance[48].

Summary of overall findings

There are many aspects of SS guidance which must be evaluated in order to effectively promote consumer understanding, acceptability and usability, and to subsequently enhance the impact of such communications. In particular, efforts should be made to rectify the potential barriers to the uptake of SS guidance. In addition, the paucity of SS information on composite dishes which constitute the majority of eating occasions should be addressed. Further research on the long-term impact of SS guidance is necessary[48] to ensure the efficacy and improvement of such communications and tools. The focus to date has been on translating the science, but little work has been done to evaluate the effectiveness of the guidance on consumers[109]. This is a gap that must be addressed in order to provide clear, consistent guidance for consumers about SS, which is both meaningful and easily understood. Policy-makers need to be much more aware than hitherto of how well their guidance is being communicated, i.e. how consumers are interpreting or potentially misinterpreting this information, in order to improve their advice.

Conclusion

The present review has shown that the SS guidance currently in place in many countries has been, by and large, ineffective, mainly caused by the large degree of inconsistencies and the resulting consumer confusion. Priority needs to be given to this issue due to the fact that expanding food PS is a major environmental factor implicated in the increasing prevalence of obesity among children and adults.

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