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Note: A corrigendum has been published:

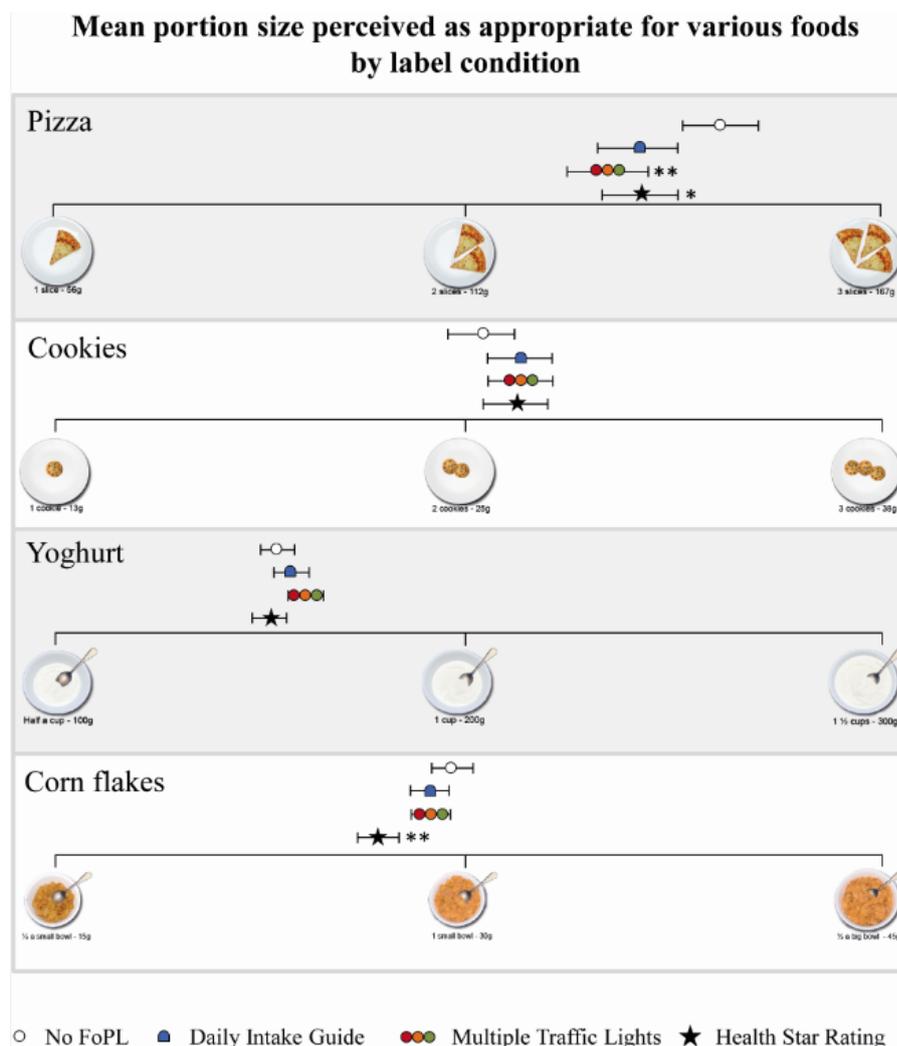
ORIGINAL TEXT (page 2778, Results)

Significantly smaller portion sizes were selected when the HSR was present compared with no FOP label on pizzas (mean_{NoFOPLabel}=2.64 slices, SE_{NoFOPLabel}= 0.09 v. mean_{HSR}=2.44 slices, SE_{HSR}=0.09 slices, P =0.013) and cornflakes (mean_{NoFOPLabel}=198 g, SE_{NoFOPLabel}=5 g v. mean_{HSR}=180 g, SE_{HSR}=5g, P=0.001).

CORRECTION

Significantly smaller portion sizes were selected when the HSR was present compared with no FOP label on pizzas (mean_{NoFOPLabel}=2.64 slices, SE_{NoFOPLabel}= 0.09 v. mean_{HSR}=2.44 slices, SE_{HSR}=0.09 slices, P =0.013) and cornflakes (mean_{NoFOPLabel}= 29.7 g SE_{NoFOPLabel}= .75 g, mean_{HSR} = 27 g SE_{HSR}= .75 g, P=0.001).

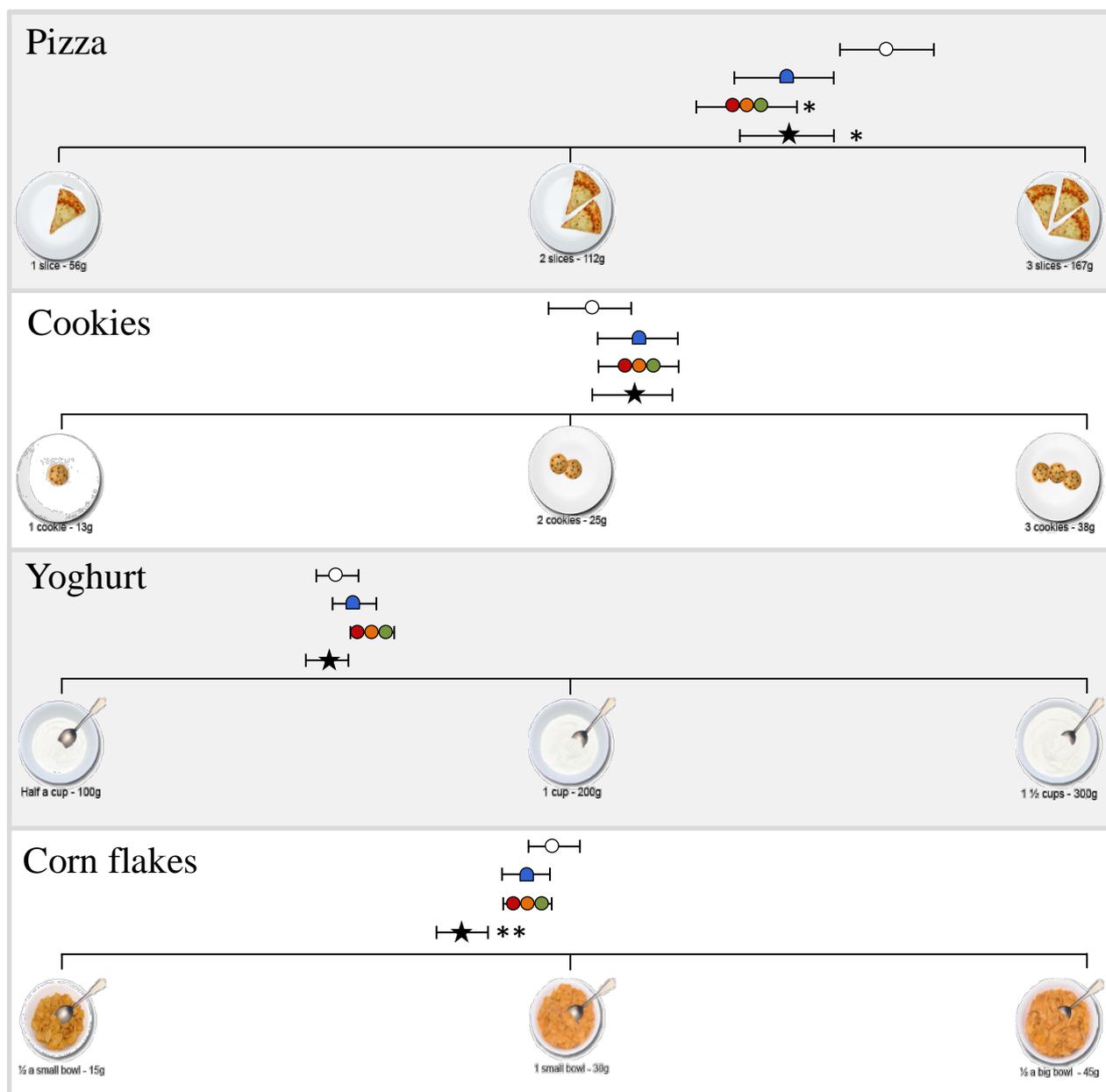
ORIGINAL TEXT (page 2779, Results)



CORRECTION

Figure 2 has been updated so that one asterisk is shown next to the MTL for pizza.

Mean portion size perceived as appropriate for various foods by label condition



○ No FoPL ■ Daily Intake Guide ●●● Multiple Traffic Lights ★ Health Star Rating

CAN FRONT-OF-PACK LABELS INFLUENCE PORTION SIZE JUDGEMENTS FOR UNHEALTHY FOODS?

ABSTRACT

Objective: By clearly conveying the healthiness of a food, front-of-pack labels (FoPL) have the potential to influence the portion size considered appropriate for consumption. This study examined the how the Daily Intake Guide (DIG), Multiple Traffic Lights (MTL), and Health Star Rating (HSR) FoPLs affect judgements of appropriate portion sizes of unhealthy foods compared to when no FoPL is present.

Design: Respondents viewed mock packages of unhealthy variations of pizzas, cookies, yoghurts, and cornflakes featuring the DIG, MTL, HSR, or no FoPL and indicated the portion size they believed should be eaten of each food on a single occasion.

Setting: The survey was completed on the respondent's personal computer.

Subjects: A total of 1,505 Australian adults provided 4,166 ratings across 192 mock packages relating to four product categories: pizza, yoghurt, corn flakes, and cookies.

Results: Compared to no FoPL, the HSR resulted in a small but significant reduction in the portion size selected as appropriate for consumption of pizzas and cornflakes ($p < .05$). The MTL resulted in smaller portions of cornflakes being selected compared to no FoPL ($p < .05$).

Conclusions: Respondents perceived smaller portion sizes as appropriate for some, but not all, of the foods tested when FoPLs with more interpretative formats (HSR, MTL) appeared on-pack compared to no FoPL. No effect was found for the less interpretive FoPL (the DIG). Interpretive FoPLs may have the potential to influence portion size judgements, albeit at modest levels.

Keywords: Food label, portion size, daily intake, traffic light, health star

INTRODUCTION

Substantial increases globally over the last 40 years in the proportion of people who are overweight or obese have been partially attributed to larger portions of food being more readily available and more widely consumed⁽¹⁻³⁾. Reducing portion sizes, particularly for unhealthy foods, may thus be an effective way to decrease total energy intake at the population level^(4,5). However, little is known about how to achieve this, and much of the research on portion sizes has focused on energy intake when a person is served food by a third party⁽⁶⁻⁹⁾. The limited research on self-serve portions suggests people are poor at judging appropriate portion sizes⁽¹⁰⁾ and tend to serve larger portions than would be consistent with dietary guidelines^(1,2,11).

Awareness of the adverse nutritional profiles of foods may prompt consumption of smaller portions. This is particularly important for unhealthy foods because reducing portions can have a large effect on overall energy intake^(4,12). Front-of-pack labels (FoPLs) that offer a simplified summary of a food's nutritional value are one way to provide this information. Consumers generally attend to FoPLs more than other sources of on-pack nutrition information⁽¹³⁾ and FoPLs can increase the accuracy of product healthiness judgements⁽¹⁴⁾.

FoPLs that provide nutrient-level information with little interpretation, such as the Daily Intake Guide (DIG), are reportedly difficult for consumers to interpret⁽¹⁵⁻¹⁷⁾. Providing an interpretation of nutrient information (e.g., by using colours and/or text to indicate high, medium, and low levels of nutrients, as seen in the Multiple Traffic Lights (MTL) system) increases understanding^(18,19), but can still require consumers to integrate multiple points of information⁽¹⁷⁾. Some FoPLs provide an interpretation of the *overall* nutritional value of a food via a graded summary system. For example, the Australian and New Zealand Health Star Rating (HSR), introduced in 2014, rates products on a scale from 0.5-5 stars and details the amounts of key nutrients per 100g. FoPLs such as this may be easy for a wide range of consumers to understand since they offer information at a glance^(14,17).

A recent review reported mixed findings from a number of studies examining whether the MTL, GDA, or labels containing only serving size information reduced, increased, or did not affect consumption⁽²⁰⁾. Another recent study of young adults tested the effect of two label types (an energy only label and the HSR) and found no significant differences in participants'

food selection behaviours⁽²¹⁾. More studies testing a wider range of FoPLs in more diverse samples are needed to assess whether FoPLs can influence portion sizes, particularly for unhealthy variants of commonly consumed foods. As such, the aim of this study was to assess how FoPLs that differ according to interpretive content affect the portion size that is deemed appropriate for consumption of unhealthy foods. Previous research with Australian consumers has found that the HSR and the MTL, are easier to understand than the DIG^(17,22). It was hypothesised that, compared to no FoPL, smaller portions would be considered appropriate when more interpretive FoPLs (HSR and MTL) were applied to unhealthy foods while a less interpretive FoPL (the DIG) would not result in smaller portion sizes being considered appropriate.

METHOD

The data analysed herein were collected as part of a larger study ($n=2,058$) assessing adults' and children's perceptions of packaged foods. Various food packaging attributes for four product categories (pizza, yoghurt, corn flakes, and cookies) were manipulated and fully crossed (to ensure no association between any of the independent variables⁽²³⁾) and each participant was randomly presented with eight unique mock packages (from a suite of 576 that included healthy and unhealthy variants) to view and rate individually. This paper reports on data relating to adults' portion size judgements for the 192 unhealthy mock packages tested as part of the larger study. The focus on unhealthy products reflects the particular importance of portion size decisions for these types of products^(4,12). Ethics clearance was obtained from a University Human Research Ethics Committee.

Sample

An online survey was completed by Australian respondents recruited through an ISO accredited web panel provider (PureProfile). Recruitment quotas were set relating to age, gender, and postcode-based socioeconomic status (SES) categories, with respondents further screened to ensure they regularly consumed at least two of the four foods shown in the survey. The present paper reports findings for the $n=1,505$ adults who provided portion size estimates for unhealthy mock packages in the main study. These respondents had an equal gender split, a skew towards those from low SES neighbourhoods (48%) to reflect the higher

level of diet-related conditions among this group^(24,25), and 16-17% of the sample in each of the following age categories: 18-25 years, 26-35 years, 36-45 years, 46-55 years, 56-65 years, 66 + years. Across all participants, the 192 mock packages showing unhealthy varieties of foods were rated a total of 4,166 times.

Stimuli

The mock packages were created by a graphic designer to feature the DIG, the MTL, the HSR or no FoPL. The specific product categories were chosen because they tend to be frequently purchased⁽²⁶⁾, exhibit large differences in healthiness⁽²⁷⁾, and consumers often attend to the nutrition information on these foods⁽¹³⁾. The nutritional profiles for the products were based on unhealthy versions available in the Australian marketplace. Figure 1 shows the FoPLs used on the mock packages and their nutrient profiles. The serving sizes listed in the DIG and MTL (the HSR does not specify serving size) were the same across these FoPLs within food type and were based on serving sizes commonly used by manufacturers of these foods.

Procedure

The survey began with demographic questions to assess respondents' eligibility to participate based on the quotas. Respondents indicated the frequency with which they bought and consumed each food. They then rated the mock packages on various dimensions and could view the Nutrition Information Panel by clicking a link below the pack image. Immediately after viewing each package, respondents were shown a new screen with images of different portion sizes of the product sourced from an online image database⁽²⁸⁾ and asked "If you were going to eat this product, how much should you eat at one time?". Text appeared below each image describing the portion size in grams accompanied by a graphic illustrating an intuitive measurement. For pizzas and cookies, eight options (depicting 1-8 slices of pizza and 1-8 cookies) were shown and scored from 1-8. For yoghurts and cornflakes, four options (depicting 100g, 200g, 300g, and 400g servings and 15g, 30g, 45g, and 60g servings) were shown and scored from 1-4. Fewer options were provided for yoghurt and cornflakes because they are amorphous foods⁽²⁹⁾ with no defined shape or standard unit of measurement, and thus it is difficult to pictorially convey small graduations in portion size. In all instances,

respondents could select a “no amount” option of the serving size images if they thought the food should not be eaten at all.

Analyses

To ensure the results were relevant to those who would consume the product, data from respondents who indicated in the pre-screening that they never ate a particular food were excluded from analyses (7% of all observations). Two tailed chi square analyses were run comparing the frequency of ‘no amount’ responses in each FoPL condition with the no FoPL condition. The dataset was then split according to food type and responses where a serving size greater than ‘no amount’ were chosen were analysed using linear mixed effects models with FoPL condition as the fixed effect, respondent ID as the random effect, age, gender, SES, and Body Mass Index as covariates. These demographic variables were included as covariates (as per previous research)^(30–34) to better understand the effects of FoPLs after demographics were taken into account. This was followed with planned comparisons of the DIG, MTL, and HSR conditions to the no FoPL condition.

RESULTS

There was a significantly smaller proportion of respondents indicating that no amount of the product should be eaten in the no FoPL condition (9%) compared to the DIG (12%, $p=0.04$), MTL (13%, $p=0.033$), and HSR (15%, $p=0.001$). Figure 2 presents the mean portion sizes perceived to be appropriate for each food type depending on the FoPL used. A small but significant main effect of FoPL on portion size was found for pizzas ($F(3,193.9)=2.80$, $p=0.041$) and cornflakes ($F(3,336.6)=3.80$, $p=0.010$). Significantly smaller portion sizes were selected when the HSR was present compared to no FoPL on pizzas ($M_{\text{No FoPL}}=2.64$ slices, $SE_{\text{No FoPL}}=0.09$ versus $M_{\text{HSR}}=2.44$ slices, $SE_{\text{No FoPL}}=0.09$ slices, $p=0.013$) and cornflakes ($M_{\text{No FoPL}}=198\text{g}$, $SE_{\text{No FoPL}}=5\text{g}$ versus $M_{\text{HSR}}=180\text{g}$, $SE_{\text{No FoPL}}=5\text{g}$, $p=0.001$). The MTL only led to smaller portion sizes being selected for pizzas ($M_{\text{No FoPL}}=2.64$ slices, $SE_{\text{No FoPL}}=0.09$ slices versus $M_{\text{MTL}}=2.36$ slices, $SE_{\text{No FoPL}}=0.10$ slices, $p=0.043$) compared to no FoPL. Given that a 1 point difference in portion size on the scale was represented by 1 slice of pizza (645kJ) and 15g of cornflakes (244kJ), the average differences reported above are equivalent to a decrease of 44-129kJ per serving with the HSR (for cornflakes and pizzas respectively) and 181kJ with

the MTL (for pizzas). Across all foods, the portion sizes selected with a DIG present were not significantly different to those selected when no FoPL was present. No significant differences were found between the no FoPL and FoPL conditions for the cookies or yoghurts.

DISCUSSION

Across all FoPL conditions tested in the present study, significantly more respondents indicated that they should consume no amount of the unhealthy products compared to the no FoPL condition. This suggests that consumers were more aware that the foods were unhealthy when the FoPLs were shown. Among those who did express a desire to consume some amount of the product, self-reported appropriate portion size estimates varied for some products (cornflakes and pizzas) across different FoPL conditions. Respondents may have attended more to the nutrition information when selecting the appropriate portion size for these foods. This outcome is consistent with past research showing that people are less likely to consult FoPLs on yoghurt and confectionary than ready meals and breakfast cereals⁽¹³⁾, and can be reluctant to use FoPLs on discretionary products⁽¹⁷⁾.

Although respondents were more likely to report that they should eat no amount of unhealthy food across all FoPLs, this effect was stronger among the interpretive FoPLs (the HSR and MTL) and only these FoPLs resulted in smaller portion sizes being selected for some foods compared to the no FoPL condition. Difficulty interpreting the nutrient-level information in the DIG^(14,15,17,35) may have hindered some respondents when estimating how much less of the product they should consume. The smaller portion sizes selected for pizzas and cornflakes when the HSR was present support the idea that an easy to understand summary of nutrition information is a more effective prompt than less interpretive nutrition information in guiding consumers to lower their perceptions of how much of an unhealthy product they should consume. While the differences were small (i.e., 44-181kJ), when aggregated across many eating situations and many consumers they may constitute meaningful differences at the population level.

The amount of food considered appropriate to eat will be determined to a large extent by individual level factors such as age, gender, and general appetite. These demographic factors were accounted for as covariates in the model. One limitation of this study was the focus on

self-reported estimates of appropriate portion sizes of foods rather than measuring actual selected portion sizes. Real-life consumption behaviors are complex and can also be influenced by factors such as package size, health claims, perceived healthiness, and the type of food being consumed⁽³⁶⁻³⁹⁾. Nevertheless, these findings offer a foundation on which future research can build to better assess the effects of FoPLs on consumption patterns.

To conclude, the results of the present study suggest that more interpretive FoPLs may have the potential to favourably influence portion size judgements for unhealthy foods, albeit at modest levels. Efforts to encourage individuals to reduce their servings of unhealthy foods may usefully instruct consumers to use FoPLs as a guide when estimating appropriate portion sizes, as well as utilizing other forms of nutrition education to optimise outcomes.

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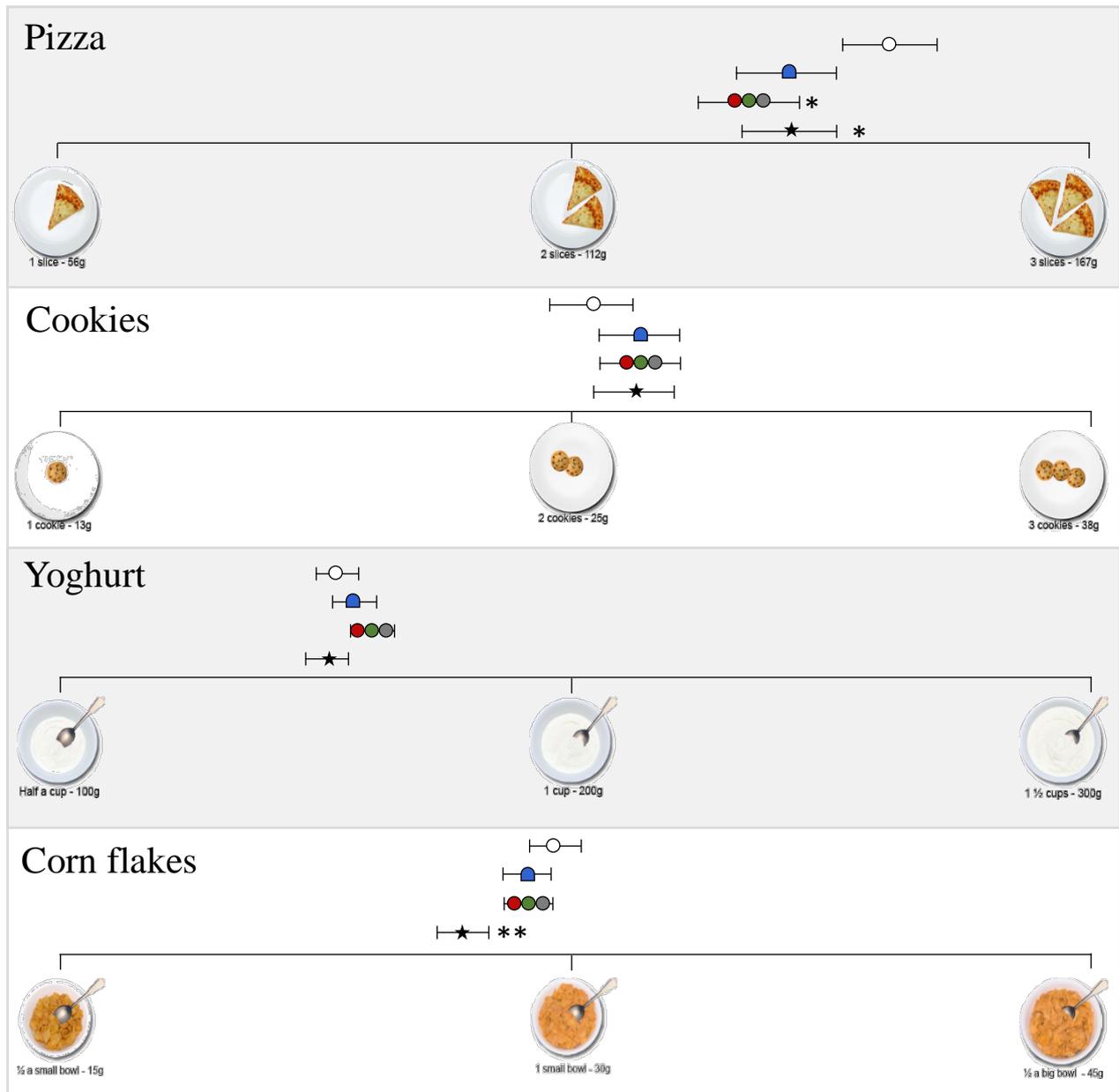
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		Food type			
		Cookies	Corn flakes	Pizza	Yoghurt
Label condition	No Label				
	Daily Intake Guide				
	Multiple Traffic Lights				
	Health Star Rating				
Nutrient profile (100g)	Energy (kJ)	2010	1630	1147	536
	Fat, total (g)	20	<0.1	18	6.9
	Fat, saturated (g)	10.3	0.1	10.2	4
	Sugars (g)	36.7	24	6.5	10
	Sodium (mg)	265	725	850	46

Figure 1. Front of pack labels used on each food type by label condition

Mean portion size perceived as appropriate for various foods by label condition



○ No FoPL ■ Daily Intake Guide ●● Multiple Traffic Lights ★ Health Star Rating

Figure 2. Mean portion size perceived as appropriate for each individual food type. Note: the pizza and cookies data were scored on an 8-point scale while the yoghurt and cornflakes data were scored on a 4-point scale. Significant differences from the no FoPL condition are indicated by * $p < .05$ and ** $p < .01$. Error bars were calculated from standard error of the mean.