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SHORT COMMUNICATION

Comparison of the portion size and frequency of consumption of 156 foods across seven European countries: insights from the Food4ME study

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There are no standardised serving/portion sizes defined for foods consumed in the European Union (EU). Typical serving sizes can deviate significantly from the 100 g/100 ml labelling specification required by the EU legislation. Where the nutritional value of a portion is specified, the portion size is determined by the manufacturers. Our objective was to investigate the potential for standardising portion sizes for specific foods, thereby ensuring complementarity across countries. We compared portion size for 156 food items measured using a food frequency questionnaire across the seven countries participating in the Food4me study. The probability of consuming a food and the frequency of consumption differed across countries for 93% and 58% of the foods, respectively. However, the individual country mean portion size differed from the average across countries in only 16% of comparisons. Thus, although dietary choices vary markedly across countries, there is much less variation in portion sizes. Our results highlight the potential for standardisation of portion sizes on nutrition labels in the EU.

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INTRODUCTION

Nutrition labelling has been promoted by the World Health Organization (WHO) as a major public health strategy.[1] This emphasises the importance of accurate, standardised and coherent information to inform consumers and facilitate healthy food choices. In the European Union (EU), nutrition labelling requires nutritional information to be given per 100 g/100 ml. This allows direct comparison of the nutritional value of different food products. However, in addition to the mandatory 100 g/ml, the manufacturers may also give nutrition information in a typical serving size, which is not specified by the EU and determined by the manufacturers. Article 33 of EU regulation no. 1169/2011 (of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, 2011) permits, in addition to the form of expression per 100 g or per 100 ml, expression on a per portion basis or per consumption unit, provided that the portion or the unit used is quantified on the label, and that the number of portions or units contained in the package is stated.

As yet there are no standardised serving/portion sizes defined for different groups of food products at the EU level. The RACC (reference amounts customarily consumed) defines the portion size in the United States. RACCs were established by regulation in 1993 in response to the Nutrition Labelling and Education Act and represent the amount of food customarily consumed per eating occasion (21 CFR 101.12—Reference amounts customarily consumed per eating occasion, 1993). They were primarily derived from the 1977–1978 and the 1987–1988 Nationwide Food Consumption Surveys conducted by the US Department of Agriculture. However, diets vary considerably across the EU, and little is known about the intercountry variability in portion size.

MATERIALS AND METHODS

The Food4me study is a multicentre, web-based, proof-of-principle study of personalised nutrition. The Food4me study design and measurement methods are described in Celis-Morales *et al.*[2] The aim of the study was to determine whether providing more personalised dietary advice can lead to greater health outcomes compared with conventional population-based advice. Habitual dietary intake was quantified using an online food frequency questionnaire (FFQ), where participants were asked to select the frequency of intake and the portion size they usually consume of 156 food items. For each food item, the 25th, 50th and 75th percentiles of daily intake were estimated from the 2008–2010 National Adult Nutrition Survey database,[3] and classified as small, medium and large portion sizes, respectively. To accommodate variability in portion size across populations, options for portion

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sizes above, below and in-between these classes were also provided, yielding seven categories (vs, s, s–m, m, m–l, l, vl). The categories were then converted back to g per day, based on the original percentiles and interclass midpoints. Forster *et al.*[4] and Fallaize *et al.*[5] describe the development of the Food4me food frequency questionnaire and the data collection protocol. Within this study, data were collected on the portion sizes (g per day) and frequencies of consumption (number portions per day) and of 156 foods, measured on 1480 participants in seven European countries (Germany, $n = 208$; Greece, $n = 210$; Ireland, $n = 217$; Netherlands, $n = 220$; Poland, $n = 204$; Spain, $n = 214$; United Kingdom, $n = 207$). The objective of this study was to assess whether there is substantial variation in portion size across the seven countries.

The analysis of frequency of consumption was complicated by a large number of zero values (non-consumers) for many food items. Frequency of consumption was thus analysed in two stages. First, by defining a dichotomous response (non-consumer = 0, consumer = 1), the probability of being a consumer/non-consumer of a food was compared across countries using a logistic regression model, including age and sex as covariates. Conditional on an individual being a consumer of the food (zeros excluded), the median frequency of consumption (number of portions per day) was then compared across countries using a Kruskal–Wallis test. Mean portion size (g per day) was compared among countries for each food item using a generalised linear mixed model, with age and sex as covariates. To adjust for multiple comparisons (156 tests), *P*-values were compared with the Bonferroni-adjusted significance level ($\alpha = 0.05/156$).

In addition, the mean portion size for each food in each country was compared with a weighted average across the seven countries, using linear contrasts. A population-weighted average was calculated using 2013 population statistics for the seven countries from EuroStat (http://ec.europa.eu/eurostat/). A full table of mean portion sizes, probability of consumption and frequency of consumption for all 156 foods, along with *P*-values for tests of difference across countries, is available in online Supplementary Material (Supplementary Table S1). A summary of the results of the tests of significance for a difference in portion size are presented in Table 1. For illustrative purposes, the mean portion size and frequency of consumption are presented in Figure 1 for brown sliced bread, cereals, chicken and white pasta. These were the foods with the highest probability of consumption within their food groups. Correlation between frequency of consumption and portion size was estimated using the Spearman's rank correlation coefficient. Models were fitted using the GENMOD, NPAR1WAY and GLM procedures in SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

Table 1. Summary of tests of significance of a difference in portion size across the seven countries

Food group	*Overall difference*	*Individual country differences*
Alcohol	0/5 (0%)	2/35 (6%)
Bread and savoury biscuits	4/8 (50%)	12/54 (22%)
Cereals	3/4 (75%)	5/28 (18%)
Dairy products	4/15 (27%)	8/103 (8%)
Drinks	7/10 (70%)	14/69 (20%)
Egg	1/1 (100%)	4/7 (57%)
Fats and spreads	1/7 (14%)	3/44 (7%)
Fruit	2/12 (17%)	4/84 (5%)
Meat and fish	13/24 (54%)	34/164 (21%)
Potatoes, rice and pasta	9/12 (75%)	20/80 (25%)
Soups, sauces and condiments	0/10 (0%)	3/66 (5%)
Sweets and snacks	6/20 (30%)	18/126 (14%)
Vegetables	16/28 (7%)	39/195 (20%)
Overall	66/156 (42%)	166/1055 (16%)

The overall difference tests whether there is a significant difference in the mean portion size across all countries (single test per food). The individual countries difference tests whether the mean for each country differs significantly from the population-weighted average across countries. All tests are Bonferroni-adjusted for multiple comparisons. The mean portion sizes and *P*-values for the tests for all 156 foods are detailed in Supplementary Table S1.

RESULTS

Diet choices differed significantly across countries, both in terms of the foods selected (probability that an individual consumes a food differed for 93% of food items) and in the frequency with which the food items were selected (frequency of consumption differed for 58% of the foods) (Supplementary Table S1a and Figure 1). This confirms substantial variation in dietary selection across Europe. There was an overall significant difference across countries in the mean portion size for 66 of the foods (42%). The food groups with the greatest differences were cereals, potatoes, rice and pasta, and meat and fish. The food groups with the fewest differences were soups, sauces and condiments, fats and spreads, and fruits. When the mean portion sizes in each country were compared individually to the population-weighted mean across the seven countries, there were significant differences in only 15.7% of foods (Table 1). This indicates that although the overall test for difference across countries might be significant, the mean portion size for an individual country might only differ from the population-weighted average across countries for a small number of the countries. For example, the overall test for a difference across countries was significant for brown sliced bread (Supplementary Table S1a, $P < 0.001$). However, when the individual country means are assessed, this difference is driven by a single country (Figure 1). In addition, whereas some differences were found to be statistically significant, this does not automatically imply a relevant difference in terms of portions, and the effect sizes differed across foods. The differences between the country means and the population-weighted mean resulted in a change in portion category in only 7.7% of comparisons. (Supplementary Table S1a). The portion size selected was significantly correlated with the frequency of consumption for 17% of foods (positively for 25 foods and negatively for 2 foods).

DISCUSSION

Appropriate portion size reference amounts are preferred by consumers and are of importance for the effective presentation of nutritional information. A survey conducted by the Food Safety Authority of Ireland[6] found that 61% of consumers preferred nutrient values stated per portion size, compared with 31% of consumers that preferred nutrient values stated per 100 g/100 ml. A systematic review of nutrition labels[7] suggests that many consumers have difficulty with the quantitative information presented on labels, especially with respect to serving sizes or other forms of reference information on the label. They concluded that nutrition labels that require calculations with respect to nutrient amounts and serving sizes are confusing to many consumers, particularly those with lower education and literacy skills. Raats *et al.*[8] found that across three food categories, consumers do factor reference amount into their judgements of healthfulness.

The analysis presented here suggests that although diet choices (frequency of consumption of foods) vary substantially across countries, there was no difference between the individual country mean portion size and the average across countries in 84% of comparisons. Although the data are limited to seven European countries, the results from this study are encouraging for the

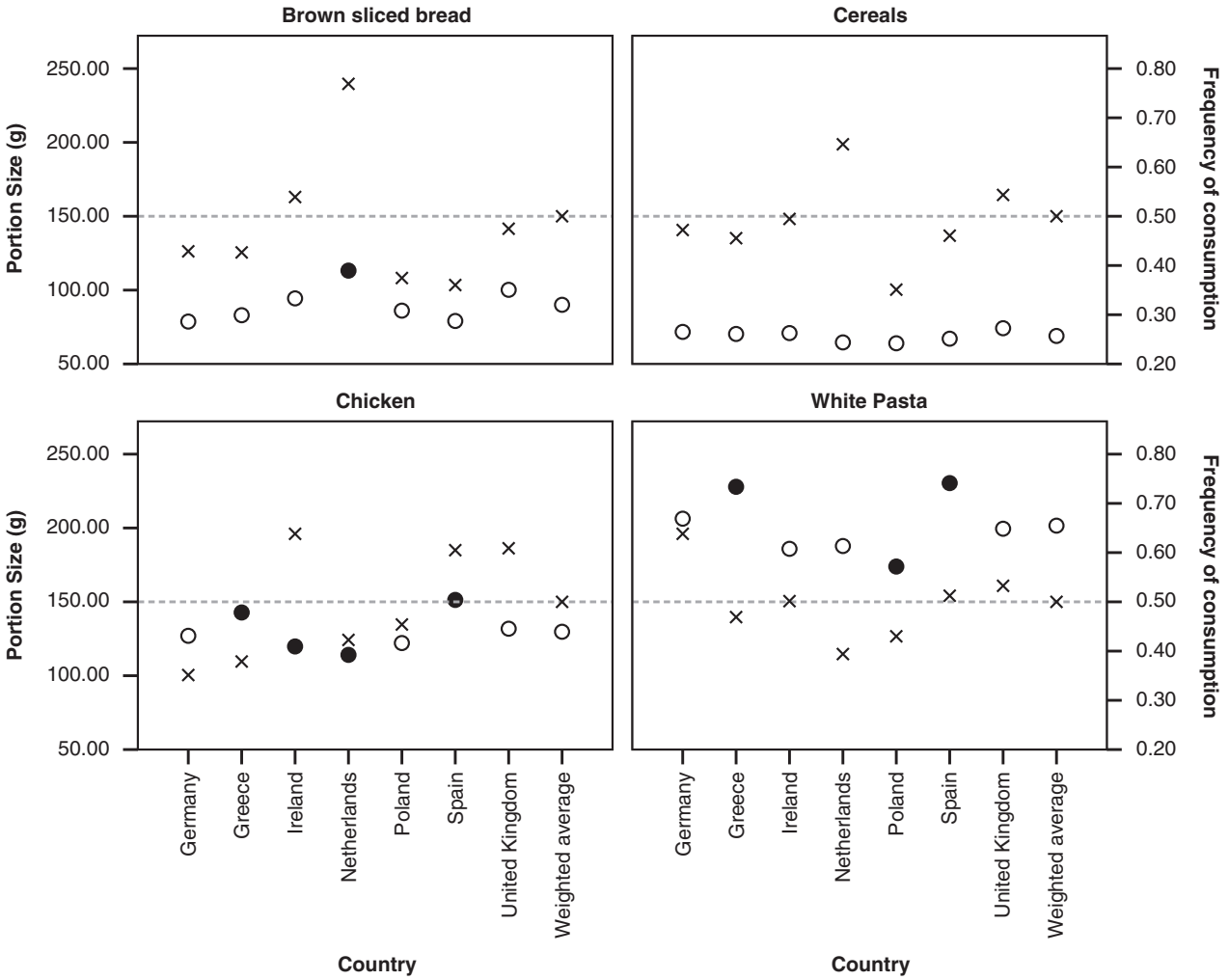

Figure 1. Mean portion size (g) per food item (○) and frequency of consumption (×) for each of the seven countries and the population-weighted average. Where the mean portion size for a country differs significantly from the population-weighted average, the marker is filled. Frequency of consumption is presented as the proportion of values above the median frequency. If frequency of consumption were the same across all countries, you would expect that for each country, 50% of values would be above the median. The dotted line reflects the null hypothesis of no difference. The higher the proportion of values above the median, the higher the frequency of consumption of that food.

potential use of standardised portion sizes on nutrition labels in the EU. This points to the need for further research and the establishment of an EU-wide database of portion sizes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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