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The effect of nutrition labels on lunch buffet consumption: a real-life experiment

Terhi Junkkari
Seinäjoki University of Applied Sciences, Seinäjoki, Finland
Maija Kantola
School of Marketing and Communication, University of Vaasa, Vaasa, Finland
Leena Arjanne
Seinäjoki University of Applied Sciences, Seinäjoki, Finland
Harri Luomala
School of Marketing and Communication, University of Vaasa, Vaasa, Finland, and
Anu Hopia
Functional Foods Forum, University of Turku, Turku, Finland

Abstract

Purpose – This study aims to increase knowledge of the ability of nutrition labels to guide consumer choices in real-life environments.

Design/methodology/approach – Food consumption and plate waste data were collected from two self-service restaurants (SSR) with different customer groups over six observation days: three control and three intervention (with nutrition labelling) periods. Study Group 1 consisted of vocational school students, mostly late adolescents (N = 1,710), and Group 2 consisted of spa hotel customers, mostly elderly (N = 1,807). In the experimental restaurants, the same food was served to the buffets during the control and intervention periods.

Findings – The nutrition label in the lunch buffet guides customers to eat fewer main foods and salads and to select healthier choices. Increased consumption of taste enhancers (salt and ketchup) was observed in the study restaurants after nutritional labelling. Nutrition labelling was associated with a reduction in plate waste among the elderly, whereas the opposite was observed among adolescents.

Originality/value – The results provide public policymakers and marketers with a better understanding of the effects of nutrition labelling on consumer behaviour. Future studies should further evaluate the effects of nutrition labelling on the overall quality of customer diets and the complex environmental, social, and psychological factors affecting food choices and plate waste accumulation in various study groups.

Keywords Nutrition label, Self-service restaurant, Lunch buffet consumption, Plate waste

Paper type Research paper

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Since submission of this article, the following author(s) have updated their affiliation(s): Terhi Junkkari is a Doctoral Researcher at the Institute of Biomedicine, University of Turku, Turku, Finland.

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Introduction

The role of nutrition labelling in helping customers find healthy food alternatives and thus tackle the problems of obesity and dietary-related diseases, such as cardiovascular diseases and diabetes, is well-recognised. There are several ways to nudge customers towards better dietary choices, such as changing product placement, posting taste labelling, using front-of-package (FOP) nutrition labelling or different nutritional quality labelling, such as colour or energy information labelling (Temple *et al.*, 2010; Hunsberger *et al.*, 2015; Bucher *et al.*, 2016; Turnwald *et al.*, 2019; Thorndike *et al.*, 2019; Naicker *et al.*, 2021; Roy and Alassadi, 2021; Erdem, 2022). Generally, nudging methods are considered to guide consumer behaviour towards healthier choices by changing the environment and food choice architecture (Cadario and Chandon, 2020). The beneficial effects of both reductive and evaluative FOPs on food selection have been previously reported (Roseman *et al.*, 2018). FOPs have been shown to help consumers find healthier products, but their ability to nudge consumers towards healthier choices is limited (Ikonen *et al.*, 2020). First, individuals following healthier diets are more likely to seek nutritional labels for their products (Campos *et al.*, 2011). Product colour coding has been shown to improve the sales of healthy beverages, and this effect is enhanced by the choice architecture (Thorndike *et al.*, 2012). Earlier, Bucher *et al.* (2016) also reported a positive effect of product order or proximity on food consumption in various study groups, and the lunch line arrangement resulted in less consumption of unhealthy foods in school lunchroom (Hanks *et al.*, 2012). Also, Hunsberger *et al.* (2015) found that calorie labelling reduced calorie and fat consumption in children at middle school and helped them to choose healthier options. Similarly, Sinclair *et al.* (2014), Brown *et al.* (2018), and Robinson *et al.* (2023) concluded in their reviews that interpretive nutrition information, such as traffic light symbols and nutrition information on food labels, influences consumer behaviour towards fewer calories and healthier choices.

A recent review by Cesareo *et al.* (2022) concluded that approximately 77% of nudging studies conducted in university cafeterias reported significant beneficial effects on customer behaviour during nudging interventions. However, most studies have been conducted in the laboratory or in randomised or non-randomised field study environments with adults. Research has often focused on only one or a few products/product categories. Empirical studies measuring meal consumption in real-life customer environments (i.e. living lab experiments) in different age groups are in the minority (Bucher *et al.*, 2016; Cecchini and Warin, 2016; Sacco *et al.*, 2017; Brown *et al.*, 2018; Naicker *et al.*, 2021).

This study aimed to gain deeper insights into consumers' responses to nutrition labels in real-life settings and to examine whether the presence of a nutrition label affects the amount of food wasted on plates. The first aim of this study was to investigate the effects of *point-of-choice nutrition labelling on food choices in real-life customer environments* in different study groups. The nutrition label chosen for this study (Heart Symbol) is well known among Finnish consumers, as according to the survey of the Finnish Heart Association, 72% of men and 92% of women aged 15–64 years old reported being familiar with the symbol (Heart Symbol, 2023a). Heart Symbol is an evaluative, summary indicator nutrition label that recognises better choices in its product category concerning fat, salt, sugar and fibre content, but does not indicate less healthy options. Heart Symbol has been in the Finnish market since the beginning of the 2000s and has been used in both pre-packaged food products and food services (Lahti-Koski *et al.*, 2012). To our knowledge, no previous empirical study has measured the effect of point-of-choice nutrition labelling on lunch buffet food consumption of self-service restaurants (SSRs) among different customer groups with the same precision as in this study. We examined, for the first time, the effect of nutrition labelling on the consumption of various food categories and condiments measured by grams consumed per customer in different study groups.

The problem of excessive food waste in the food service industry is well-recognised (Silvennoinen *et al.*, 2019). As part of sustainability and climate action, the European Union is working to halve food waste by 2050 (European Commission, 2020). In the European Union, approximately 15% of food waste is generated in the food service sector (European Environment Agency, 2022). The effect of healthy lifestyles and the relationship between a healthy diet and food waste have been studied to some extent. Studies have shown that household consumption of healthy food is associated with increased food waste (Conrad *et al.*, 2018; Carrol *et al.*, 2020). However, a healthy lifestyle has been found to decrease food waste among millennial consumers (Savelli *et al.*, 2020). Also, recently Cao and Liu (2023) found that increasing awareness of healthy diets is associated with a reduction in household food waste, concluding that promoting healthy diets would generally reduce food waste at the household level. As the effect of nutrition labelling on food and plate waste in SSRs remains unclear, the second aim of this study was to evaluate the total amount of plate waste per customer, differences in the amount of plate waste, and effect of nutrition labels on the amount of plate waste in restaurants with different customer profiles.

Materials and methods

Study design and setting

The study was conducted in South Ostrobothnia, Finland, between February and May 2022, in two SSRs with different customer profiles: one vocational school restaurant (later referred to as SSR1) and one spa hotel restaurant (later referred to as SSR2). Approximately 80% of the customers in vocational school restaurant were young students from vocational schools and high schools, aged 16–19 years. The remaining customers were employees, primarily teachers. In spa hotel, most customers (over 70%) were pensioners in rehabilitation. The remaining 30% consisted of employees and a few families with children (Table 1). In Finland, school lunches are free of charge for students, and the menus served fulfil, on average, Finnish nutritional recommendations. Most students eat school lunches daily (The National

	Self-service restaurant 1 Vocational school restaurant	Self-service restaurant 2 Spa hotel restaurant
Lunch buffet details		
Lunch served daily	10.30 am–12.30 pm	11 am–1 pm
Customer profile	Approx. 80% of students are from high schools and vocational schools; the rest are customers and school employees	Approx. 65–70% are pensioners in spa rehabilitation, approx. 25–30% are adults, <5% are families with kids
Food consumption data collection (three days in each research week including Tues., Weds., Thurs.)		
Control period	Week 8/2022	Week 17/2022
Number of customers	704 (232, 217, 255)	972 (338, 315, 319)
Intervention (nutrition label) period	Week 13/2022	Week 19/2022
Number of customers	1,006 (364, 295, 347)	835 (303, 243, 289)

Note(s): Identical menus, meaning the same foods, were served in the study restaurants during both the control and intervention periods (see Supplementary Material for more information). For each research, the food intake over a span of three days was measured, and then divided by the total number of customers during that same period

Source(s): Authors' work

Table 1.
The study design and data collection procedures

Nutrition Council of Finland, 2014; Pellikka *et al.*, 2019). Generally, the SSR lunch concept is typical in Finland, as according to studies done before COVID-19 pandemic, 50–60% of working-age people eat warm lunches daily (Raulio, 2011; Holm *et al.*, 2019).

The research weeks were carefully selected to avoid confounding factors, such as public holidays, which could have affected the results. Experimental restaurants served identical menus in the serving lines (same food items in the same order; see Supplementary Material), both in the control and intervention (nutrition label) periods, on Tuesdays, Wednesdays, and Thursdays. The menus content differed in the research restaurants (see Supplementary Material). Altogether, there were six observation dates in both restaurants: three during the control periods and three during the intervention periods. During the intervention, point-of-choice nutrition labels (i.e. Heart Symbol stickers and placards; Figure 1 and Plate 1) were attached to all food items (including main courses, salads, milk/buttermilk and margarine) fulfilling the criteria for the Heart Symbol, which were based on Finnish nutritional recommendations (The National Nutrition Council of Finland, 2014; Heart Symbol, 2023b). For the main course, the nutrient contents of recipes with Heart Symbol foods were approved by experts from the Finnish Heart Association. For other side foods (such as green salads,

Note(s): Published with the permission of the Finnish Heart Association
Source(s): The Finnish Heart Association

Figure 1.
Heart Symbol®, indicating "better choice" in its product category (in Finnish and Swedish)

Note(s): In the serving line, products fulfilling the Heart Symbol® criteria were labelled with a Heart Symbol during the intervention period. Published with the permission of research restaurants

Source(s): Authors work

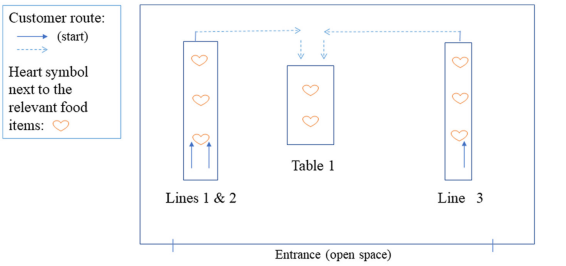
Plate 1.
Examples of salads and main courses in serving lines before opening hours

cucumber, and fat-free milk), the criteria were checked by researchers from Heart Symbol Internet pages, where foods that meet the Heart Symbol criteria are listed (e.g. criteria for fruits and vegetables, https://www.sydanmerkki.fi/en/criteria/vegetables-fruits-and-berries/). If the nutritional content of the product was unavailable, then a nutrition label was not attached. In this study, we refer to foods that met the criteria for Heart Symbol with "healthier foods" or "foods with a nutrition label" and other "less healthy foods" or "foods without a nutrition label." This study followed the guidelines of the Finnish National Board on Research Integrity and the Helsinki Declaration. According to the University of Vaasa Human Science Ethics Committee, no ethical review was required for this study (decision dated 21 January 2022).

At restaurants, two or three field researchers collected data on each research day, including at least one with a professional hospitality management background. The researchers were trained in the data collection methods, and a pilot research day in both research restaurants was organised before the study began. Field researchers manually collected food consumption data by pre-weighing foods using kitchen scales (with an accuracy of 1 g–10 kg) and recording each item offered on the buffet lines during lunchtime. This study measured the consumption of various buffet line food items, including main courses, salads, salad dressings, bread, spreads, milk/buttermilk, salt, and ketchup. To calculate the average consumption per customer during the study period, the total food intake over the three days was divided by the total number of customers in the same period. Leftovers from each food category in the service lines were considered when calculating the consumption. Additionally, the unseparated plate waste in total was collected and weighed at the end of the service. In this study, field researchers were integrated into the restaurant staff, and customers were not informed about the study to ensure a typical real-life setting. Therefore, the number of customers was calculated based on washed plates. During the experiment, 295–364 customers were served in SRR1 daily. In SSR2, the number of daily customers varied from 243 to 303 (Table 1).

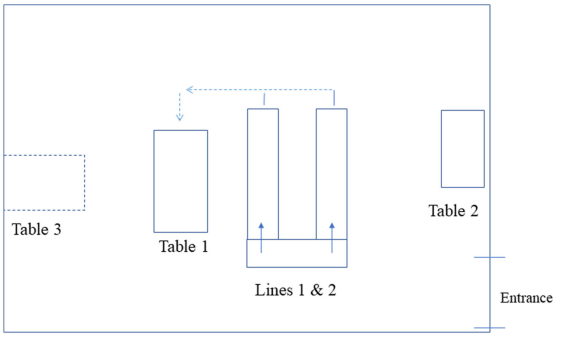
Serving lines and menus

Both experimental restaurants were operated in a self-serving buffet line model, in which customers choose and design their meals freely (Figures 2-4). In SSR1, there was one vegetarian and one meat or fish option with potatoes selected from the main courses at every lunch. The salad buffet options consisted mainly of fresh vegetables such as green salads, tomatoes, cucumbers, grated carrots, grated cabbage, and oil-based salad dressings. Rye, crispbread, and wholegrain bread were available each day, as were margarine (with an automatic dispenser machine, á ~5 g, Plate 2) and fat-free milk. In SSR1, desserts were not



Source(s): Authors' work

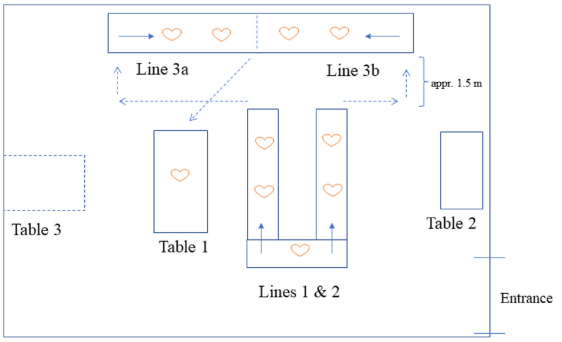
Figure 2.
Layout of vocational school self-service restaurant serving lines during control and intervention weeks



Lines 1 & 2: soup, salads and main courses (same foods in the same order in both lines)
Table 1: drinks, bread and spreads
Table 2: spice counter, salt and ketchup
Table 3: coffee and deserts – not included in the data collection

Source(s): Authors' work

Figure 3.
Layout of spa hotel self-service restaurant serving lines, control week



Lines 1 & 2: soup and salads (same foods in the same order in both lines)
Lines 3a & 3b: main courses (same foods in the same order in both lines)
Table 1: drinks, bread and spreads
Table 2: spice counter, salt and ketchup
Table 3: coffee and deserts – not included in the data collection

Source(s): Authors' work

Figure 4.
Layout of spa hotel self-service restaurant serving lines, intervention week

used. The SSR2 buffet lunch was more versatile; every lunch had warm meal options for vegetables, fish, and meat courses served with potatoes. The soup was served daily. The salad buffet consisted of several different fresh vegetables and salads with unhealthy nutrient contents, such as mayonnaise-based, pasta-based, and cheese-based salads. In the salad buffet, fresh vegetables (without dressing/mayonnaise) were placed at the beginning of the buffet line during both the control and intervention periods. Several kinds of bread, from rye to wheat bread, have been served, as well as various spreads and kinds of milk, with different fat contents and nutritional profiles. Desserts were included in SSR2; however, they were excluded from this study. Water consumption was not measured, because in both research restaurants, water was available from an automatic water dispenser without measurement possibilities. In February 2022, there were some restrictions on the number of customers in restaurants due to the COVID-19 pandemic, but these restrictions were loosened in the spring. Therefore, there were minor changes in the menu line order between the control and intervention studies for SSR2 (Figure 3 and Figure 4). For the full research menu, see Supplementary Material.

Note(s): Photo published with the restaurant's permission

Source(s): Authors' work

Plate 2.
The automatic margarine dispenser in the vocational school self-service restaurant

Data management and statistical analyses

Microsoft Excel (2016, Redmond, WA, USA) and IBM SPSS Statistics 28.0 (Armonk, NY, USA) were used for data management and analysis. Independent sample *t*-tests and two-sample tests for proportions were performed to compare consumption and waste accumulation changes during the control and intervention periods.

Results

The effect of point-of-choice nutrition labelling on food consumption

Main courses, salads, milk, bread and spreads: The mean consumption (g/customer) of measured food items in the control and intervention (nutrition label) periods is presented in Table 2. The mean consumption of main courses and salads was significantly lower in both SSR1 (main courses: $t = -5.83$, $p < 0.001$; salads: $t = -14.6$, $p < 0.001$) and SSR2 (main courses: $t = -3.11$, $p = 0.002$; salads: $t = -12.4$, $p < 0.001$) in the intervention period than in the control period. SSR1 customers increased their use of salad dressings (per 100 g of salad) during the intervention ($t = 36.9$, $p < 0.001$). In SSR2, the consumption of milk/buttermilk ($t = 3.90$, $p < 0.001$) and bread ($t = 18.5$, $p < 0.001$) increased after posting nutritional labels. However, the use of spreads (per 10 g of bread) decreased during the intervention in SSR2 ($t = -4.79$, $p < 0.001$). In contrast, in SSR1, the consumption of margarine per 10 g of bread increased significantly under nutrition label conditions ($t = 3.77$, $p < 0.001$). A deeper analysis revealed that in the SSR1, the relative consumption of rye bread (including crispbread) increased from 19% (7.3 g/customer of total bread consumption, 39.0 g/customer) to 52% (11.0 g/customer of total bread consumption, 21.3 g/customer) during the intervention ($z = 13.70$, $p < 0.001$, results not available in Table 2). This may have affected the higher consumption of margarine, assuming that more spread could have been used for drier types of bread, such as rye and crispbread, than whole grain bread. In SSR2, no differences were found in the relative consumption of the different bread types between the control and intervention periods ($z = 1.05$, $p = 0.293$).

Flavour enhancers (salt, ketchup, pickled cucumber): Compared with the control period, the use of salt increased during the intervention in SSR1 ($t = 24.6$, $p < 0.001$). After the nutrition label posting, SSR2 customers started independently looking for extra salt from other

Lunch buffet items	Control week N (SSR1) = 704 N (SSR2) = 972	Nutrition label week N (SSR1) = 1,006 N (SSR2) = 835	*t*-stat (*p*-value, summary independent *t*-test)
Salads			
SSR1[2]	84.3 (9.99)	74.6 (2.35)	*−14.6** (<0.001)
SSR2	143 (11.6)	127 (18.6)	*−12.4** (<0.001)
Salad dressing/100 g consumed salad			
SSRl[2]	8.4 (0.19)	10.1 (0.81)	*36.9** (<0.001)
SSR2	4.4 (1.69)	4.6 (1.25)	1.67 (0.097)
Main courses			
SSR1	343 (102)	299 (65.1)	*−5.83** (<0.001)
SSR2	279 (16.3)	271 (40.1)	*−3.11** (0.002)
Milk and buttermilk			
SSR1	88.5 (7.2)	89.8 (15.1)	1.37 (0.171)
SSR2	47.9 (5.0)	49.9 (7.2)	*3.90** (<0.001)
Bread, Karelian pies			
SSR1[3]	40.4 (49.7)	40.5 (57.0)	0.02 (0.982)
SSR2	15.4 (1.6)	21.4 (5.2)	*18.5** (<0.001)
Spreads/10 g consumed bread, Karelian pies			
SSR1[3]	1.6 (0.8)	1.9 (1.1)	*3.77** (<0.001)
SSR2	2.4 (0.32)	2.2 (0.63)	*−4.79** (<0.001)
Salt			
SSR1	0.010 (0.003)	0.023 (0.009)	*24.6** (<0.001)
SSR2[4]	NA	NA	NA
Ketchup			
SSR1[5]	21	25	NA
SSR2	0.57 (0.82)	1.34 (1.97)	*6.08** (<0.001)

Note(s): [1]SSR1 = self-service restaurant, vocational school, SSR2 = self-service restaurant, spa hotel. Data presented as grams/customer, based on three days of data, unless otherwise mentioned. T-statistic indicates a decrease/increase of mean consumption in grams/customer, *p*-value with an asterisk at the 0.05 level

[2]2 days of data, N = 512, on soup days (Weds.) salad buffet available (for an extra charge, mainly for teachers and other employees). Salad buffet consumption/customer: control 308 g (N = 21), nutrition label 273 g (N = 22), −11%

[3]Data include Karelian pie (á ~ 80 g) which is served on soup day (Weds.) in addition to bread; most customers use the spreads with pie

[4]Data not reliable as customers independently looked for extra salt at spice counters near the lunch restaurant, and researchers could not weigh all salt used during the intervention week

[5]1 day of data, at school, ketchup is served only with French fries with sausage (Thurs.), N = 602

Table 2. Mean food consumption (SD) in lunch buffet during control and intervention (nutrition label) weeks in the study restaurants[1]

seasoning counters near the research lunch restaurant, and researchers could not measure all salt consumed. Similarly, ketchup consumption increased during the intervention in SSR2 among the elderly ($t = 6.08$, $p < 0.001$) and in SSR1 among late adolescents. In SSR1, ketchup was served only on one day when French fries with sausage were on the menu (Thursday), and a 19% increase was observed in ketchup consumption during the nutrition label period compared with the control period. In addition, on soup days (Wednesday), salads were not served free of charge for the students in SSR1, but pickled cucumbers were available. After the nutrition label posting, the consumption of pickled cucumber increased from 2.7 g/customer to 4.8 g/customer, indicating an almost 80% increase in the consumption of pickled cucumber during the intervention in the SSR1.

The effect of point-of-choice nutrition labelling on the consumption of dishes with and without labels

In SSR1 with a younger customer profile, seven main courses were served during the research: the same foods in both the control and intervention periods. Two of the seven foods were labelled with nutritional labels during the intervention. A reduction in consumption was seen only in the main courses without nutrition labels (five items, $t = -2.95$, $p = 0.003$, Figure 5). In contrast, the consumption of the main courses with nutrition labels did not change during the intervention period (two items, $t = 0.27$, $p = 0.786$, Figure 6).

In SSR2, which had an older customer profile, 16 main courses were offered during the study period. Eight of them were labelled with nutritional labels during the intervention. Nutrition labels did not affect the consumption of the main course (eight items, $t = -0.97$, $p = 0.333$). However, the consumption of foods without nutrition labels was reduced by 6% during the intervention period compared with the control period (eight items, $t = -4.77$, $p < 0.001$, Figure 6).

The effect of point-of-choice nutrition labelling on the relative consumption of salads with and without labels

In SSR2 with an older customer profile, the relative consumption of nutrition-labelled salads increased by 3.7% during the intervention period compared to the control period. However, these changes were not statistically significant at the p-level of 0.05 ($z = 1.60$, $p = 0.109$, Figure 7). Because the salad buffet in SSR1 consisted mainly of salads with a healthier nutrient profile, the effect of the nutrition label on the intake of salads without nutrition labels was not measured in SSR1.

The amount of plate waste in research restaurants during control and intervention periods

In the SSR1 with a younger customer profile, the amount of plate waste increased by 8% (from 19.6 to 21.1 g/customer, $t = 2.25$, $p = 0.025$) after nutrition label postings (Figure 8). In SSR2, the amount of plate waste decreased during the intervention compared to the control period (from 14.2 to 13.4 g/customer, $t = -4.81$, $p < 0.001$).

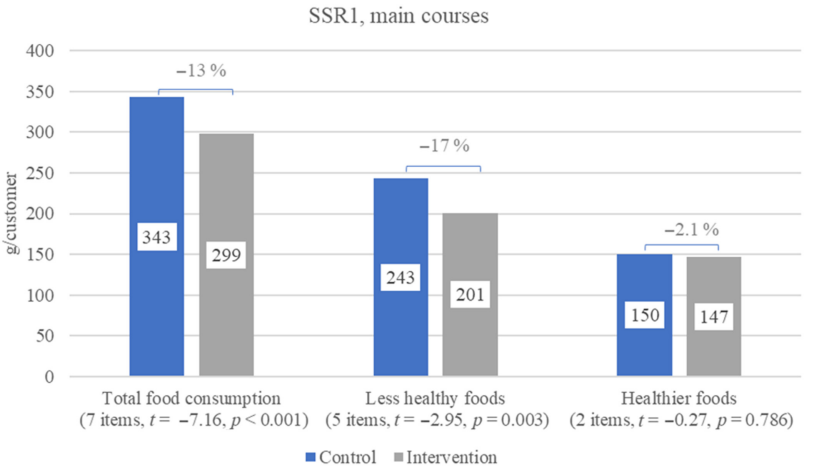
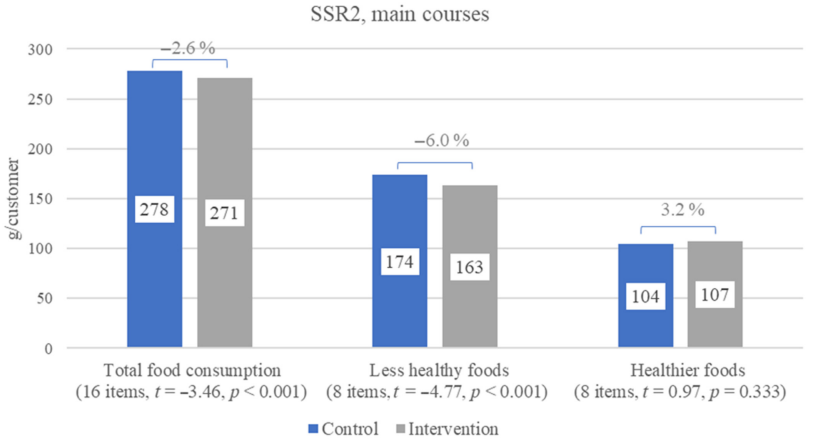


Figure 5.
The mean consumption of main courses, consumption of less healthy and healthier foods in the vocational school self-service restaurant (SSR1) during control and intervention weeks[1]

Note(s): [1] g/customer/day, mean, three days of data during control and intervention weeks

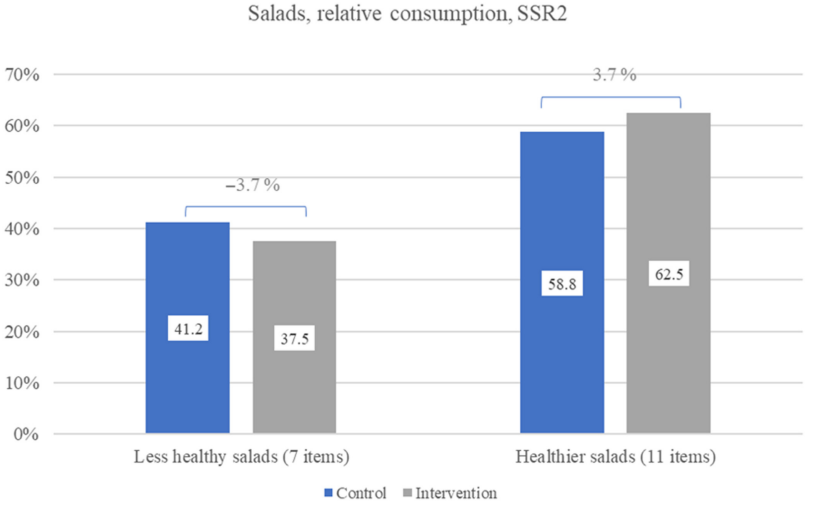
Source(s): Authors' work



Note(s): [1] g/customer/day, mean, three days of data during control and intervention weeks

Source(s): Authors' work

Figure 6. The mean consumption of main courses, consumption of less healthy and healthier foods in the spa hotel self-service restaurant (SSR2) during control and intervention weeks[1]



Note(s): [1] g/customer/day, mean, three days of data during control and intervention weeks, $p = 0.109$

Source(s): Authors' work

Figure 7. The relative consumption of healthier and less healthy labelled salads during control and intervention periods in the spa hotel self-service restaurant (SSR2)[1]

Discussion and conclusions

A consumer study evaluating the effect of the well-known nutrition label on lunch buffet consumption of SSRs in real-life conditions has not been conducted among different types of customer groups. In our empirical research, for the first time, the products of self-serving lunch lines were measured by product categories, including the consumption of main courses,

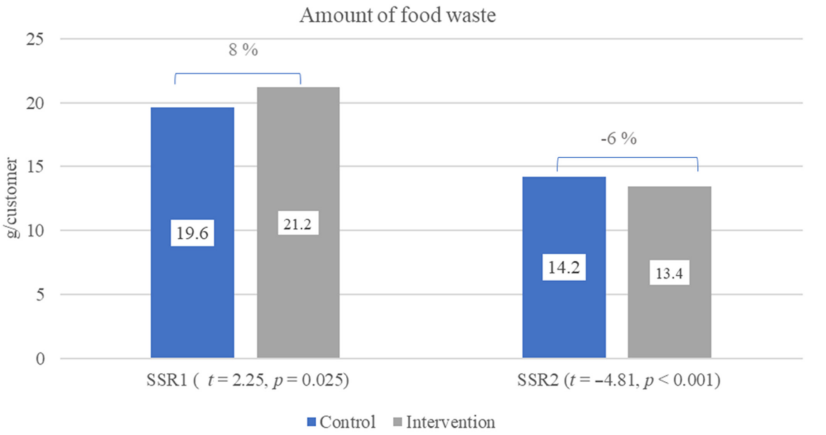


Figure 8.
The mean amount (g) of plate waste per customer in the study restaurants[1]

Note(s): [1] three days of data during control and intervention weeks, SSR1 (vocational school), SSR2 (spa hotel)
Source(s): Authors' work

salads, bread, spreads, and milk/buttermilk. In addition, no previous studies have measured the effect of nutrition labels on the use of flavour enhancers, such as salt and ketchup, or on the amount of plate waste, in the lunch buffet of SSRs.

Key findings

In both restaurants, a decrease in the consumption of main courses and salads was observed during the nutritional labelling intervention. A closer data analysis revealed that a decrease in consumption was observed only for less healthy foods without a nutrition label. However, the consumption of healthier nutrition-labelled products did not change during the intervention in either study group. Rantala *et al.* (2022) reported a reduction of 15–24 g/customer in the absolute consumption of salad bar items, warm meals, and condiments in the self-serving lunch buffet among Finnish adults after Heart Symbol posting. Although the results of Rantala *et al.* are in line with those of our study, they are not entirely comparable because the data collection methods and product category classifications used in their study differed from ours. Healthier nutrition-labelled salads are, on average, lighter in both grams and density than less healthy non-nutrition-labelled salads, which are often pasta-based, cheese-based, or mayonnaise-based salads. Our study revealed that the relative consumption of nutrition-labelled salads increased by almost 4% during the intervention in SSR2 with elderly customers. Although the results for the consumption of salads with and without nutrition labels were not statistically significant between the study periods, the results partly explain why the absolute consumption of salads (in grams) was lower during the intervention period. In addition, customers may have selected smaller portions of the main course during the nutrition label period. Our results indicate that nutrition labels, such as Heart Symbol, guide customers to eat fewer main foods and salads and select healthier choices. Cadario and Chandon (2020) concluded in a field experiment meta-analysis that nudging interventions are more effective at reducing unhealthy eating than at increasing healthy eating. Several earlier studies have shown the beneficial effects of nutritional labelling on total food consumption and healthier food choices (Sinclair *et al.*, 2014; Brown *et al.*, 2018; Robinson *et al.*, 2023), which aligns with our results.

The elderly ate more bread during the intervention; that is, they apparently replaced the decreased consumption of the main courses with bread. Similarly, milk and buttermilk consumption increased among the elderly in the nutrition label condition, possibly because of the increased bread consumption. According to the Finnish Consumer Research Centre, the elderly population (people over 65 years old) consumes approximately twice as much bread as people under 25 years old (Aalto, 2018). Although total bread consumption increased during the intervention in SSR2, the spread per 10 g of bread decreased in the elderly. During the intervention, adolescents increased their consumption of rye and crispbread, which likely explained the increased margarine consumption in SSR1 during the nutrition label period. In Finland, rye bread is recommended by the National Nutritional Council (The National Nutrition Council of Finland, 2014). Interestingly, younger customers in SSR1 also increased their consumption of salad dressings after nutrition labelling. Although the changes observed in the consumption of the main courses and salads were comparable in both study groups, the results indicated that the influence of nutrition labels on food choices exhibited some variation between the two groups. This was particularly noticeable in the elderly group, where there was an increase in the consumption of bread and milk, and among late adolescents, who showed an elevated consumption of rye bread and salad dressing. Exploring the distinctions and similarities in the behaviours of diverse consumer groups is an important aspect to consider in future studies.

In this study, for the first time, we measured changes in the use of flavour enhancers after posting a nutrition label. The results show that real-life empirical studies are needed to consider all aspects of consumer behaviour studies. In a laboratory experiment, Liem *et al.* (2012) found that FOPs with reduced-salt labels could negatively affect taste perception, which might increase the use of table salt. In Finland, the Heart Symbol, the nutrition label used in this study, was strongly associated with reduced salt and fat contents in the product. In our study, the increase in table salt use more than doubled in SSR1 with younger customers during the intervention period. In SSR2 with the elderly, we could not reliably measure salt consumption due to the customer's increased need for table salt, as they independently looked for extra salt from other restaurants and spice counters near the lunch restaurant. Therefore, it can be assumed that salt consumption also increases in the elderly. However, the mean salt consumption per customer was low (23 mg/person) among younger customers, suggesting that only some added extra salt after the nutrition label posting. In addition to increased table salt consumption, nutrition labels had adverse effects on ketchup consumption, as increases of 19 and 135% were observed in the mean ketchup consumption per customer in SSR1 and SSR2, respectively. SSR1 customers, primarily vocational school students, also increased their consumption of pickled cucumbers during the nutrition labelling period.

The effect of nutrition labels on the amount of plate waste has not been studied in previous studies of buffet lines in SSRs with customers of different ages. Interestingly, in our study, the amount of plate waste increased in the SSR1 with late adolescents after posting a nutrition label. For SSR2 with the elderly, the results were the opposite. In addition, it should be noted that in the control week, young people had 40% more plate waste than elderly people did. A previous Portuguese study reported a lower amount of plate waste in the elderly population (Partearroyo *et al.*, 2020). Raghunathan and Chandrasekaran (2021) reported that older people have stronger food waste aversion than younger people, which supports our findings. Earlier studies by Adams *et al.* (2016) and Ilic *et al.* (2022) concluded that a greater selection of vegetables and fruits from the lunch line was associated with higher plate waste among middle and primary school students. In our study, the relative consumption of healthier, mostly vegetable-based foods increased, which may, to some extent, explain increased plate waste in the SSR1 with younger customers during the intervention.

Study implications

Our findings provide valuable insights into the impact of nutrition labelling on consumer behaviour, benefiting both public policymakers and marketers. In recent years, there has been growing demand for actions that promote healthier food options and dining environments. Authorities are constantly exploring innovative approaches to steer consumers towards healthier choices (WHO, 2018). Researchers have continuously produced scientific information related to health and nutrition communication to meet the needs of authorities (Medina-Molina and Pérez-González, 2021; Peonides *et al.*, 2022; Hercberg *et al.*, 2023). Our study offers new perspectives on the effects of nutrition labelling on consumer behaviour in real-life settings. However, before drawing definitive conclusions, further research is needed to examine the various aspects of nutrition labelling and its influence on consumer behaviour.

The nutrition label was shown to influence customer food choices and food behaviour in real-life conditions among different customer groups. In line with several earlier empirical studies conducted among different age groups (Hanks *et al.*, 2012; Hunsberger *et al.*, 2015; Bucher *et al.*, 2016; Sacco *et al.*, 2017; Naicker *et al.*, 2021), the effect was mostly beneficial as the nutrition label guided customers to decrease the consumption of unhealthy food choices. Our study contributes valuable insights to the pre-existing nudging studies, because it was conducted in real-life settings, and the impact of nutrition labelling on food consumption was assessed at the product group level among diverse customer groups. We demonstrated that both late adolescents and the elderly show an interest in healthy eating, indicating that appropriate nudging methods can influence the food choices and preferences for healthier options in both age groups. However, the use of taste enhancers (salt and ketchup) increased, which was a confounding finding, as the effect of nutrition labelling was the opposite of the original goal, of reducing salt consumption. The reason for this is unclear, but it could be due to the complex forces of lay beliefs, goals, and habits behind customers' choices of healthier products, as recently reviewed by Goukens and Klesse (2022). Predominantly, lay beliefs have been shown to prevent rather than facilitate healthy eating habits (Chandon and Wasink, 2007; Bucher *et al.*, 2015; Suher *et al.*, 2016). Earlier consumer behaviour studies have shown that certain people have a stronger "unhealthy is tasty" (UT) belief than others; those with a strong UT belief avoid healthy food because they assume a healthy diet is unpalatable, and that UT believers and UT non-believers experience foods with healthy and unhealthy images differently (Briers *et al.*, 2020; Paakki *et al.*, 2022). Our study, conducted in real-life lunch environments, also suggests that some consumers may perceive nutrition-labelled foods as less tasty because nutrition labelling increases the use of flavour enhancers, such as salt and ketchup, among customers. In addition, earlier FOP studies have indicated that health-conscious consumers respond best to nutrition labelling, and interpretive FOP labels such as nutrient and health logos reduce the taste evaluation of food products (Campos *et al.*, 2011; Ikonen *et al.*, 2020). Also, taste-focused labelling has been shown to be more effective than health-focused labelling in increasing healthy food selection among adults (Turnwald *et al.*, 2019; Boles *et al.*, 2022). Our research confirms these findings regarding the significance of sensory quality and taste expectations in the acceptability of foods. A recent survey conducted among late Finnish adolescents (ages 15–19) indicated that taste is the primary factor influencing their food purchases, followed by price, with health being ranked third (Ministry of Agriculture and Forestry of Finland, 2023). In a similar vein, among the Finnish elderly population (ages 65–75), taste is the most important selection criterion, along with quality, preference for novel taste experiences and local production, with health being less emphasised (Lepistö, 2021). Recently, Bédard *et al.* (2020) concluded in their review article that eating pleasure may actually be a key factor in promoting healthy eating. Regarding our study, a deeper understanding of the underlying reasons, particularly opinions and attitudes, enabling or hindering the changes in consumer behaviour could have been achieved through

qualitative focus group interviews, as demonstrated by Hunsberger *et al.* (2015) in their study of school children. In our study, the foods offered at the buffet were consistent between the control and intervention periods, but nutrition labelling led customers to use more flavour enhancers. The reason for this phenomenon remains unclear, and further research is needed before making public policy recommendations. To achieve success in this venture, it is essential to allocate adequate resources to the development of health-focused products within all sectors of the food industry. Furthermore, it is crucial to assess sensory quality and product acceptability among consumers before introducing any modified products to the market. Product communication strategies, including the impact of health and sustainability labels on consumer behaviour, should be carefully tested in real-life environments. These actions can provide answers to the following questions: Is there a need to inform consumers about the healthiness of products? Should all communication prioritise taste and eating pleasure as the primary focus? If successful, these initiatives have the potential to reshape consumer attitudes and the overall food culture that cherishes the "healthy is tasty" belief.

The reasons for the increased amount of plate waste during nutrition labelling among adolescents remain unclear and must be further investigated. A recent nudging study conducted in the university environment revealed that food waste increased with the increased consumption of vegetables and that information on the social costs of food waste reduced the amount of food waste. However, the mitigating effect of social cost information on food waste disappeared if participants received information on the health-improving effects of increased vegetable consumption (Qi *et al.*, 2022). Earlier, Jürkenbeck *et al.* (2021) revealed that, among the younger German generation, climate change awareness varied significantly, and participants who were aware of climate change had a higher probability of following a climate-friendly diet. Thus, environmental labels or information on the societal costs of food waste may affect younger generations' consumer behaviour more effectively than nutrition or health labels, which should be studied in the future. The interrelationships between eco-friendly actions, healthy eating choices and food waste are complex. Thørgensen *et al.* (2010) previously stated that, in addition to ability and knowledge, motivation is needed to implement the desired actions, and that especially among young consumers, personal norms, preferences and interest are stronger than the social norms exerting pressure to avoid food waste. To achieve the set health and environmental goals, improving the quality of diet and reducing its environmental impact are efforts that should be simultaneously pursued: consumers should increase their consumption of fruit and vegetables and throw them away less (Conrad *et al.*, 2018). Recent studies indicate that young consumers need more information and education about the ability to combine food waste reduction practices with healthy nutrition, which supports our findings (Savelli *et al.*, 2020; Clement *et al.*, 2023).

Conclusions and future research

In this study, we have shown for the first time that in the lunch buffet of SSRs, the use of nutrition labels seems to be associated with the decreased average consumption of main courses and salads and with the increased relative consumption of products with better nutritional quality among late adolescents and the elderly, which was mainly explained by the decreased consumption of foods without a nutrition label. Although the point-of-choice nutrition label seemed to guide customers to healthier choices on average, the increased average consumption of salt and salty flavour enhancers was a worrying new finding that should be investigated further, utilising mixed method studies. In addition, future studies should aim to evaluate the effects of nutrition labels on the overall dietary quality of customers in different age groups, such as the actual nutrient content. Finally, we found that nutrition labels were associated with reduced plate waste among the elderly, whereas the

opposite was true for adolescents. The reasons for increased plate waste in adolescents should be further investigated.

Limitations

This study was conducted at the beginning of 2022, when the COVID-19 pandemic caused restrictions on the operating activities of research restaurants. However, the results were generally similar for both restaurants in younger and elderly participants. Thus, it can be concluded that COVID-19 did not significantly affect the study, and the minor change in the service line order during the intervention due to the loosening of COVID-19 restrictions had no significant impact on the results in SSR2.

The number of customers was based on the plates used and not on the actual number of customers in the dining restaurants, which could have affected the results of the mean consumption per customer measurement. Also, plate waste included all thrown-away items in total, not product category-specific leftovers. However, the environment and data collection were similar in the control and intervention periods; if there had been inaccuracies in the measurement, all measurements should have been similar. Therefore, the average results are comparable.

The research findings rely on data collected over a span of three days during both the control and intervention periods. To enhance the persuasiveness of the results, a more extensive range of time points and time-series analyses would have been beneficial. Also, conducting a follow-up survey or informant interviews concerning healthy eating habits and sustainability issues would have provided valuable additional information for the interpretation of our results. Nevertheless, as the outcomes were consistent in both restaurants, we can draw preliminary conclusions. Furthermore, our results align with those of a previous master's thesis that implemented four nutrition label nudging interventions in cafeterias located in industrial workplaces in Finland (Karhu, 2019).

This study was conducted in a rural area; therefore, the representativeness of the study groups was limited. Before generalising the results to urban communities, the study should be repeated in urban areas. According to a Finnish Institute for Health and Welfare study, people in rural areas do not follow nutritional recommendations as strictly as urban residents (Valsta *et al.*, 2022).

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Supplementary material

Menus and nutrition labelled foods in the study restaurants

Serving line	Weekday	Category	Food item	Nutrition label
1, 2, 3	Tuesday	Main course	Mashed potatoes	No
	Tuesday	Main course	Fish fingers	No
	Tuesday	Main course	Vegetable balls	No
	Tuesday	Salad	Fresh cucumber cubes, crated cabbage, and carrot	Yes
	Tuesday	Salad	Canned fruits and beetroot cubes	No
	Tuesday	Salad	Salad dressing	No
Table 1	Tuesday	Drinks	Fat-free milk and buttermilk	Yes
	Tuesday	Spread	Margarine	Yes
	Tuesday	Breads	Whole grain, crisp and rye breads	No
1, 2, 3	Wednesday	Main course	Pea soup (with meat)	No
	Wednesday	Main course	Vegetable lentil soup	Yes
	Wednesday	Salad	Pickled cucumber	No
Table 1	Wednesday	Drinks	Fat-free milk and buttermilk	Yes
	Wednesday	Spread	Margarine	Yes
	Wednesday	Breads	Whole grain, crisp and rye breads, Karelian pie	No
1, 2, 3	Thursday	Main course	French fries with sausage	Yes[#]
	Thursday	Main course	Mifu® (meat-free, milk protein-based stripes) potato casserole	No
	Thursday	Salad	Fresh tomato cubes, crated cabbage, and carrot	Yes
	Thursday	Salad	Canned fruits	No
	Thursday	Salad	Salad dressing	No
Table 1	Thursday	Drinks	Fat-free milk and buttermilk	Yes
		Spread	Margarine	Yes
		Breads	Whole grain, crisp and rye breads	No

Note(s): [#]Recipe developed for this study; nutritional content calculations checked by the experts of Finnish Heart Association
Source(s): Authors' work

Table A1.
Self-service restaurant 1 (vocational school)

Serving line	Weekday	Category	Food item
1, 2	Tuesday	Main course	Soup of the day, vegetable (spinach) soup
	Tuesday	Salad	Fresh cucumber and tomato cubes, green salad leaves, crated cabbage salad
	Tuesday	Salad	Feta salad, olives
	Tuesday	Salad	Salad dressing
	Tuesday	Main course	Cooked potatoes
	Tuesday	Main course	Steamed vegetables
	Tuesday	Main course	Fish casserole
	Tuesday	Main course	Pulled pork
Table 1	Tuesday	Drinks	Fat-free milk and buttermilk
	Tuesday	Drinks	Milk, buttermilk (non-fat-free)
	Tuesday	Spreads	Butter, 2–3 different fat blends
	Tuesday	Breads	Wheat, whole grain, crisp and rye breads
1, 2	Wednesday	Main course	Soup of the day, vegetable (lentil) soup
	Wednesday	Salad	Fresh cucumber and tomato cubes, green salad leaves
	Wednesday	Salad	Canned beetroot salad
	Wednesday	Salad	Caesar salad
	Wednesday	Salad	Berries, redberries
	Wednesday	Main course	Cooked potatoes
	Wednesday	Main course	Mashed potatoes
	Wednesday	Main course	Steamed vegetables
	Wednesday	Main course	Salmon, baked in oven
	Wednesday	Main course	Blood sausage (Finnish speciality)
Table 1	Wednesday	Drinks	Fat-free milk and buttermilk
	Wednesday	Drinks	Milk, buttermilk (non-fat-free)
	Wednesday	Spreads	Butter, 2–3 different fat blends
	Wednesday	Breads	Wheat, whole grain, crisp and rye breads
1, 2	Thursday	Main course	Soup of the day, pea soup (with meat)
	Thursday	Salad	Fresh cucumber and tomato cubes, and grated carrot salad
	Thursday	Salad	Pasta-chicken salad
	Thursday	Salad	Salad dressing
	Thursday	Main course	Cooked potatoes
	Thursday	Main course	Fish casserole
	Thursday	Main course	French fries with sausage
	Thursday	Main course	Bean-root-stew
Table 1	Thursday	Drinks	Fat-free milk and buttermilk
	Thursday	Drinks	Milk, buttermilk (non-fat-free)
	Thursday	Spreads	Butter, 2–3 different fat blends
	Thursday	Breads	Wheat, whole grain, crisp and rye breads

Source(s): Authors' work

Table A2.
Self-service restaurant 2 (Spa hotel) – control period

Serving line	Weekday	Category	Food item	Nutrition label
1, 2	Tuesday	Main course	Soup of the day, vegetable (sweet potato) soup	No
	Tuesday	Salad	Fresh cucumber and tomato cubes, green salad leaves, crated cabbage salad	Yes
	Tuesday	Salad	Feta salad, olives	No
	Tuesday	Salad	Salad dressing	No
3	Tuesday	Main course	Cooked potatoes	Yes
	Tuesday	Main course	Steamed vegetables	Yes
	Tuesday	Main course	Fish casserole	No
	Tuesday	Main course	Pulled pork	No
Table 1	Tuesday	Drinks	Fat-free milk and buttermilk	Yes
	Tuesday	Drinks	Milk, buttermilk (non-fat-free)	No
	Tuesday	Spreads	Butter, 2–3 different fat blends	No
	Tuesday	Breads	Wheat, whole grain, crisp and rye breads	No
1, 2	Wednesday	Main course	Soup of the day, vegetable (lentil) soup	Yes
	Wednesday	Salad	Fresh cucumber and tomato cubes, green salad leaves	Yes
	Wednesday	Salad	Canned beetroot salad	No
	Wednesday	Salad	Caesar salad	No
	Wednesday	Salad	Berries, redberries	Yes
3	Wednesday	Main course	Cooked potatoes	Yes
	Wednesday	Main course	Mashed potatoes	No
	Wednesday	Main course	Steamed vegetables	Yes
	Wednesday	Main course	Salmon, baked in oven	Yes
	Wednesday	Main course	Blood sausage (Finnish speciality)	No
Table 1	Wednesday	Drinks	Fat-free milk and buttermilk	Yes
	Wednesday	Drinks	Milk, buttermilk (non-fat-free)	No
	Wednesday	Spreads	Butter, 2–3 different fat blends	No
	Wednesday	Breads	Wheat, whole grain, crisp and rye breads	No
1, 2	Thursday	Main course	Soup of the day, pea soup (with meat)	No
	Thursday	Salad	Fresh cucumber and tomato cubes, and grated carrot salad	Yes
	Thursday	Salad	Pasta-chicken salad	No
	Thursday	Salad	Salad dressing	No
3	Thursday	Main course	Cooked potatoes	Yes
	Thursday	Main course	Fish casserole	No
	Thursday	Main course	French fries with sausage[#]	Yes
	Thursday	Main course	Bean-root-stew	Yes
Table 1	Thursday	Drinks	Fat-free milk and buttermilk	Yes
	Thursday	Drinks	Milk, buttermilk (non-fat-free)	No
	Thursday	Spreads	Butter, 2–3 different fat blends	Yes
	Thursday	Breads	Wheat, whole grain, crisp and rye breads	No

Note(s): [#]Recipe developed for this study; nutritional content calculations checked by the experts of Finnish Heart Association
Source(s): Authors' work

Table A3.
Self-service restaurant 2 (Spa hotel) – intervention period

Corresponding author
Terhi Junkkari can be contacted at: terhi.junkkari@seamk.fi