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Promoting vegetable consumption, smaller portions and reduced salt-intake in a self-service buffet in a hospital cafeteria in Norway

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TITTEL/TITLE

Nudging towards healthier food choices. Promoting vegetable consumption, smaller portions and reduced salt-intake in a self-service buffet in a hospital cafeteria in Norway

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SAMMENDRAG/SUMMARY:

«Nudges» eller såkalte små dytt kan gjøre det lettere for folk å ta bedre valg, som (for eksempel) å spise sunnere, uten å begrense valgfriheten/tilgjengeligheten. Denne studien undersøkte om små endringer eller dytt i en sykehuskantine kunne hjelpe pasienter til å velge sunnere og mer «hjertevennlig mat». Prosjektets mål var å utvikle og teste ut et sett med enkle og lite kostbare «nudging»-metoder som gjør det lettere å velge mer helseriktig mat, å vise om metodene eller tiltakene gav endringer i spiseatferd og lage en praktisk veileder som beskriver resultatene og erfaringene fra prosjektet slik at disse kan brukes av kjøkkenansvarlige på andre spiseplasser.

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De utprøvde små dyttene innebar at det ble iverksatt noen endringer i omgivelsene maten ble valgt i. Dette dreide seg om endringer;

- i grad av tilgjengelighet (saltposene) og,
- i standardvalget (størrelse på tallerkener og serveringsbestikk) og
- i rekkefølgen på mattilbudet i lunsjbuffeten (grønnsaker først).

De små dyttene hadde til hensikt å;

- Redusere saltinntaket. Saltet ble ikke gjemt, men deltakerne måtte ta de ekstra skrittene for å få tak saltposene. På spisebordet ble saltposene erstattet med annet krydder uten salt.
- Øke mengden grønnsaker spist. I påleggs- og salatbuffeten ble maten arrangert slik at grønnsaker stod plassert der man naturlig forsynte seg først og de mest kaloririke matvarene ble plassert til slutt. Det ble brukt mer fristende betegnelser på grønnsaker og grønnsaksretter. Tallerkenene stod plassert ved salatbuffeten slik at det var naturlig å forsyne seg der først.
- Redusere porsjonsstørrelsene ved å tilby mindre tallerkenstørrelse og serveringsbestikk av mindre størrelse. De opprinnelige tallerkenene på 24 cm ble byttet ut med tallerkener på 21 cm. Det ble også satt fram serveringsbestikk av mindre størrelse for de mest kaloririke matrettene.

Forsøket bestod av fire ulike nudge-tiltak, inkludert en periode hvor alle tre tiltakene ble kombinert og iverksatt samtidig. Hvert forsøk varte i fire uker, etterfulgt av en fire ukers kontrollperiode. Totalt deltok 108 pasienter i studien. En utvalgt gruppe pasienter fikk fotografert og/eller veid sine lunsj-tallerkener. Dette ble gjort for å kunne foreta en visuell analyse og kategorisering av hvilke typer mat og smakstilsetninger som ble valgt. Og for å registrere og kvantifisere mengde mat som pasientenes forsynte seg med på de to ulike tallerkenstørrelsene.

Effektene av endrede matvalg (som salt- og grønnsaksforbruk) ble også målt basert på det totale konsumet av disse varene på kantinenivå.

Kan enkle og små dytt hjelpe folk til å spise sunnere? Undersøkelsen viste at det er mulig. La folk forsyne seg først med grønnsaker ved å plassere disse først i buffeter. Øk også utvalget av grønnsaksretter. Da forsyner gjestene seg mer. I vår studie 53 prosent mer.

Mindre tallerkenstørrelse førte til at gjestene forsynte seg med 23 prosent mindre mat.

Ved å gjøre salt mindre tilgjengelig og tilby saltfrie krydderalternativer på spisebordet, kan man oppnå at folk forsyner seg av langt mindre mengde salt. I denne studien 22 prosent mindre salt.

I den perioden hvor alle tre tiltakene eller dyttene ble kombinert så ble også da saltforbruket redusert i forsøksgruppen (13 prosent nedgang), mens porsjonsstørrelsen kun viste en liten nedgang. Dette kan sannsynligvis forklares med at når gjestene forsynte seg rikelig med grønnsaker, hele 69 prosent mer, så virket dette inn på mengden mat på tallerkenene.

Denne studien viste at «nudges» eller såkalte små dytt kan forandre folks matvalg i virkeligheten og dermed understøtte et mer helseriktig og sunt kosthold med mindre salt, mer grønnsaker og mer passende porsjonsstørrelser.

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Preface

In Norway, as in rest of the world, the increase in non-communicable diseases (NCDs) such as cardiovascular diseases (CVD), type 2 diabetes, and several types of cancer has been linked to unhealthy dietary choices, including too much energy-dense and salty foods, and a low intake of fruits and vegetables (F&V). In Norway, NCDs account for 87% of all disease-related deaths (Stewart & Wild, 2017).

As a high consumption of F&V helps to promote health and prevent lifestyle related diseases, partly through lowering the consumption of energy-dense foods with high salt content, it is vital to increase the intake of F&V in all meals during the day, in both public and private settings.

People often assemble their meal according to their own preferences, and despite good intentions, food choices are often made "mindlessly" and not based on rational, long-term health considerations. Through adjustments in the environment where meals are served, it may be possible to direct people unconsciously to more healthy options. These studies are based on knowledge from behavioural economics, and specifically a concept called "nudging", which is a strategy to influence or alter people's behaviour in a predictable way without forbidding any options or significantly changing economic incentives (Leonard, 2008). Nudges gently steer decisions towards options that seem more salient, straightforward or the "default" (Hansen & Jespersen, 2013)

"Nudges" can make it easier for people to make better behavioural choices (e.g. eat healthier) without limiting availability. This study tested whether nudges could improve food behaviours in a hospital cafeteria.

This project "Små dytt for bedre helse" ("Small nudges for better health") was funded by the Norwegian ExtraFoundation for Health and Rehabilitation (grant number 2016/RB81848), with Norwegian Association for Heart and Lung Disease (LHL) with their clinic at Feiring as the project owner. Nutritionist Laila Dufseth (LHL) has been the project leader. Food scientist and researcher Hilde M. Helgesen from NIBIO has together with Marije Oostindjer (NMBU/Animalia), Erik K. Arnesen (LHL) and Ellen-Margrethe Hovland (Animalia/Gartnerhallen) been responsible for the scientific part of the project.

Ås, 09.08.2019

Hilde M. Helgesen

Content

1 Introduction

The global increase in non-communicable diseases (NCDs) such as cardiovascular diseases (CVD), type 2 diabetes, and several types of cancer has been linked to unhealthy dietary choices, including too much energy-dense and salty foods, and a low intake of fruits and vegetables (F&V) (Gakidou, Afshin, & Abajobir, 2017; Micha et al., 2017). In Norway, NCDs account for 87% of all disease-related deaths (Stewart & Wild, 2017).

As a high consumption of F&V helps to promote health and prevent lifestyle related diseases, partly through lowering the consumption of energy-dense foods with high salt content, it is vital to increase the intake of F&V in all meals during the day, in both public and private settings (Oyebode, Gordon-Dseagu, Walker, & Mindell, 2014; Tetens et al., 2013; Van Duyn & Pivonka, 2000; (McMichael, 2008).

The majority of health promotion efforts provide general education and information to consumers regarding healthy diets, and/or aim to improve attitudes, intentions and self-efficacy towards healthier dietary behaviour (Thomson & Ravia, 2011; Wansink, 2015). Despite public information campaigns, legislation, and education based on scientific evidence, a gap exists between peoples' knowledge and their actual behaviour (Bhattarai et al., 2013; Brambila-Macias et al., 2011; Snyder, 2007) (Snyder et al., 2004; (Sørensen, Groth, Fagt, & Iversen, 2013; Thomson & Ravia, 2011). Even individuals diagnosed with, for example, CVD find it hard to adhere to dietary recommendations, even though one should expect their motivation to follow such advice would be strong (Kotseva et al., 2016). With this low effectiveness of information and education for behaviour change in mind, the public health sector is looking into the role of food environments in promoting healthier food choices (Appleton et al., 2016).

The number of meals and snacks eaten outside of the home, in restaurants, at work cafeterias, or at fast food outlets is increasing. Such out-of-home meals are often more energy-dense, with larger portion sizes and poor nutritional content (Prentice & Jebb, 2003; Bell & Swinburn, 2004; Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Ledikwe, Ello-Martin, & Rolls, 2005; Kearney, Hulshof, & Gibney, 2001; O'dwyer, McCarthy, Burke, & Gibney, 2005; Appleton et al., 2016). In these settings, people often assemble their meal according to their own preferences, and despite good intentions, food choices are often made "mindlessly" and not based on rational, long-term health considerations. Unfortunately, people tend to eat the food which is most salient (Wansink, 2010). Through adjustments in the environment where meals are served, it may be possible to direct people unconsciously to more healthy options. These studies are based on knowledge from behavioural economics, and specifically a concept called "nudging", which is a strategy to influence or alter people's behaviour in a predictable way without forbidding any options or significantly changing economic incentives (Leonard, 2008). Nudges gently steer decisions towards options that seem more salient, straightforward or the "default" (Hansen & Jespersen, 2013). For more than twenty years, numerous studies such as Kahn & Wansink (2004), Wansink & Just (2011), Downs, Loewenstein, & Wisdom (2009), Freedman & Brochado (2010), Wansink & Chandon (2014), Kroese, Marchiori, & de Ridder (2015) and van Kleef, Seijdell, Vingerhoeds, de Wijk, & van Trijp (2018) have contributed with new knowledge on the links between different types of nudges, food choices, and consumption. One of the most well-known biases or type of nudges exploited, is the default effect or the status quo bias (Kahneman, Knetsch, & Thaler, 1991) and more recently Friis et al. (2017) studied how a default choice promoted vegetable consumption in a self-service buffet.

The current study investigates three different nudges in addition to one combination nudge in a complex real-life clinical setting where CVD patients in a rehabilitation program and other diners make decisions on which foods to pick in a self-service buffet-lunch at the hospital cafeteria.

The aim of the study was to investigate:

1. A nudge involving a repositioning of salt shakers, which made them less accessible, while making other flavourings without salt more accessible. This intervention was supplemented by cues, such as visual stimuli in the form of signs above the buffet indicating salty and less salty food items, and a small sign placed on each dining table with a positive message about using herb mixes and other spices. Similar types of nudge interventions by making unhealthy food less available have been studied by Maas, de Ridder, de Vet, & De Wit (2012) and Rozin et al. (2011).
2. A nudge involving modification of the patients' self-served portion sizes by reducing plate size, reducing serving spoon sizes for calorie-dense sauces and mayonnaise based salads, and increasing the serving spoons for low-calorie items. This was supplemented by cues such as visual stimuli in the form of a sign above the buffet motivating people to watch their portion size, and a sign on each dining table in the cafeteria raising awareness of portion size and satiety. Similar types of nudge interventions concluded that people consistently consume more food and drink when offered larger-sized portions, packages or tableware than when offered smaller-sized versions (Wansink & Van Ittersum, 2013).
3. A nudge involving a re-organization of the buffet to make vegetables more salient and attractive, by placing the vegetable dishes first in the buffet-line and giving them descriptive and attractive names, introducing a ready-assembled mixed salad to the buffet, adding more vegetable garnishes, serving a vegetarian hot dish once a week, and placing a sign above the buffet and on each table illustrating the plate model with indication of the recommended share of vegetables on the plate. Other studies with similar interventions concluded that altering the serving sequence increased vegetable consumption in different populations from a 19% plate-share of fruits and vegetables in the control group to a 33% share in the intervention group (Kongsbak et al., 2016) and an 11% increase in sales of vegetables when these were presented first (Wansink & Just, 2011).
4. A combination of the three separate nudges above, implemented all together in the same period.

2 Methods

The study was conducted from April 2016 to May 2017. The entire study was conducted in the cafeteria at the LHL-clinic Feiring, Norway, a hospital owned by the non-profit Norwegian Association for Heart and Lung Disease (LHL), which both performs procedures and offers rehabilitation for patients suffering from cardiac conditions.

2.1 Participants

The participants in the study were all patients attending a four-week rehabilitation program. During this program, patients remain at the hospital for the entire period except for some who stay at home on the weekends. Activities focusing on a healthy lifestyle are central and this also includes physical activities and exercise. Both theoretical and practical educational activities, such as cooking lessons, supporting a change to healthier lifestyles, take place during the whole stay. Participants typically eat all meals together in the cafeteria, although this is not mandatory (except on photo registration days, see below). The maximum number of participants in one group in the rehabilitation program was 18. Rehabilitation participants ate lunch in a semi-separated part of the cafeteria.

Enrolment in this study was voluntary. On arrival, the participants were given an information sheet about a study on food choices in the cafeteria, without mentioning nudging, communicating that their food habits would be registered during the four weeks, and that they were required to fill in several registrations both during and after the period. If the participants wanted to join the study, they signed a consent form. Participants who did not want to join the study followed the rehabilitation program like the others, but did not complete any of the registrations. The study was registered at ClinicalTrials.gov (ID: NCT 02808910).

An overview of the participant characteristics during each study period is presented in Table 1.

Table 1. Characteristics of the participants in the eight different study periods

Nudge	N	Gender (male/female)	Age (mean)	Body weight, kg (mean)
Salt nudge (SN)	11	10/1	54	95
Salt control (SC)	12	10/2	56	96
Portion size nudge (PN)	13(12*)	7/6	64	83
Portion size control (PC)	14	9/5	58	88
Vegetable nudge (VN)	17	10/7	61	90
Vegetable control (VC)	17(16*)	10/7	57	91
Combination nudge (CN)	14	9/5	62	88
Combination control (CC)	12	7/5	58	91

*Note: final number, drop-out during the four weeks

2.2 Interventions

The nudges were applied in the cafeteria at the LHL-clinic at Feiring, Norway (located about 85 km north of Oslo). The cafeteria is open during breakfast, lunch, dinner, and for an evening snack (timings). For lunch, the cafeteria offers a large salad and a cold-cuts buffet, which normally contains pre-cut vegetables, cold fish and meat items, various sauces, and fruits. At the lunch meal, sections for bread, warm dishes (leftovers from meals from the day before), drinks (coffee, tea, water, milk, juice), and for other items, such as condiments and spices, are offered. During the first half of the study, only

patients and visitors (including short-term patients, patients who were recovering from procedures, and the rehabilitation groups) ate lunch in the cafeteria. During the second half of the study, the hospital personnel also ate in the cafeteria. Unlike the employees who pay for the meals based on a prepaid system, the meals are free of charge for the patients. While only the participants of the rehabilitation program were of interest to this study, all clients of the cafeteria were exposed to the nudges.

Three different nudges were applied to the cafeteria, plus a combination of all three nudges, over a period of four weeks. The kitchen staff implemented all nudges. Each nudge period was followed by a control period, starting a minimum of two weeks after the nudge period was completed. This was done to avoid an overlap of patients belonging to nudge or control groups from interaction with each other. Major holiday periods (Christmas, summer holiday in July, and Easter) were avoided. The changes made during the nudges are described below.

2.3 Salt nudge

During the salt nudge, the following changes were made in the cafeteria: items in the buffet were labelled with green hearts (low in salt) or red hearts (high in salt); salt portion packets (and pepper) were removed from the dining tables and placed on the far side of the cafeteria (not easy to reach); herb mixes without salt were placed in an attractive basket on each dining table; a sign was placed on top of the buffet that explained the red and green hearts; and a small sign with a positive message about using herbs and spices to spice up the food, with a reference to the herb mixes on the table, was placed on each dining table.

During the control period, no labels or signs were present referring to salt or the herb mixes. Salt and pepper (standard 1g portion packets) were present on each table in baskets; the herb mixes were placed on the far side of the cafeteria.

2.4 Portion size nudge

During the portion size nudge, the following changes were made in the cafeteria: the regular plates for breakfast and lunch were replaced with smaller plates (from 24 cm diameter to 21 cm diameter; soup/dessert bowls were not changed); serving spoons were changed so that calorie-dense sauces and mayonnaise based salads were served with a small spoon rather than a large one, while low-calorie foods were served with a large spoon; a sign was placed above the buffet motivating people to watch their portion size; and a sign placed on each dining table in the cafeteria raised awareness of portion size and feeling full.

During the control period, no signs were present on the tables or the buffet, and the regular plates for all meals were 24 cm in diameter.

2.5 Vegetable nudge

During the vegetable nudge, the following changes were made in the cafeteria: vegetable side dishes were given descriptive and attractive names such as "Three bean salad", "Mediterranean" or "Asian salad"; one hot vegetarian lunch dish was introduced on Wednesdays; all vegetables were moved to the beginning of the buffet (and sauces to the end); more vegetable garnishes were added to the cold fish and meat platters in the buffet; a ready-mixed salad was introduced to the buffet (noodle salad and a bean salad); a sign was placed above the buffet that showed the plate model (indicating that half of the plate should consist of vegetables); and a smaller version of this sign was placed on each table.

During the control period, the vegetables and sauces in the buffet were in their normal positions; no extra vegetable garnish or salad was provided; no specific vegetarian lunch was served; and no signs were present on the tables or above the buffet.

2.6 Combination nudge

During the combined nudge period, all changes described for the three nudges were implemented. All three signs that were on top of the buffet during the three nudges were present throughout the period, while the signs on the dining tables were rotated between the tables every other day so that the participants saw all three signs several times during the four weeks (without getting overwhelmed).

During the control period, the cafeteria was as normal, as previously described for the control periods per nudge.

2.7 Measurements

Four types of measurements were made during the study: participant surveys, photos of the participants' lunches, registrations by the kitchen staff, and body weight changes (measured on arrival and on departure of the program four weeks later).

2.8 Satisfaction survey

Participants were asked to fill out a cafeteria satisfaction survey once per week to see whether the nudges had an impact on how favourable the cafeteria was perceived. Seven statements were given: I find the cafeteria appealing; I miss more variation in the food offered; I find the food appetizing; I am satisfied with the taste of the food; I think the buffet is not organized and cleaned well; I experience that the staff is service minded; I have learnt to eat new foods after arriving here) to which participants responded on a 7-point scale (Agree strongly to Disagree strongly, with the option I don't know). Participants also indicated how many of their lunches they had eaten in the cafeteria (all, most, some, first time). The procedures were the same for the eight study periods. All surveys were conducted digitally.

2.9 Lunch photos

Participants took photos of their lunch twice per week, with the help of the staff at the LHL-clinic Feiring to ensure good quality photos. The days on which the lunch photos were taken differed somewhat between weeks depending on the program and on special events, but all participants from the same study period took the lunch photos on the same days. Photos were taken of all the plates consumed during the lunches, including desserts and drinks consumed with lunch. All photos included a label with the participant number and date.

During the salt nudge and salt control periods, the participants' plates were photographed with a card on which participants indicated whether or not they had added salt, any of the three herb mixes, ketchup, mustard, olive oil, vinegar, soy sauce or other, in order to assess their individual usage of salt and the herb mixes (see Appendix A). During the portion size nudge and control, the plate was put on a scale, and the plate content and weight were both included in the photo (see Appendix B). During the vegetable nudge and control period, no special additions to the photo were made. During the combination nudge and control periods, participants added the registration card for salt, herb mixes, and other condiments, as well as their plate weight to the photos.

2.10 Registrations by the kitchen staff

During the salt nudge and control periods, the kitchen staff registered the usage of salt, pepper, and the three herb mixes, three times per week (Monday, Friday, Sunday). During the salt nudge, salt packets were only available in one place, and the total usage by the entire cafeteria was therefore registered. Herb mix usage was measured per table during both periods. During the control period,

salt (and pepper) packet usage was registered per table daily (20 packets were available per table each day), and use of the herb mixes was registered for the entire cafeteria.

During the vegetable nudge and control periods, the kitchen staff weighed the consumption of tomatoes, cucumber, bell pepper, pre-cut fruits, and ready-mixed salads daily during weekdays, and the vegetarian lunch dish on the days they were offered.

During the portion size nudge and control periods, the kitchen staff made no additional registrations. During the combination nudge and control periods, the same registrations were conducted as

2.11 Photo analysis

At the start of the analyses of the lunch plate photos, two of the authors discussed and tested the method until they reached a consistent scoring of each plate. Then, one researcher analysed all plates. For the salt nudge and control photos, the card that was added to the photo was analysed per photo, and registrations were made about what the participants added, with special interest in salt, the herb mixes, and soy sauce (as a salty product). In addition, for each plate, the number of foods that, in the buffet, were labelled with a green or red heart were registered (in five categories, from 0 to 4 or more) (see Appendix A). For the portion size nudge and control, the weight of the food (total weight – respective plate weight) was recorded for the entire meal (see Appendix B). For the vegetable nudge and control photos, a digital overlay of a circle, divided into 10 equal (pie) slices, was created. This was aligned with the plate in the photo, and was used to count the number of slices of the circle that were filled with vegetables (including the ready-assembled salads), resulting in a score between 0 to 10 (see Appendix C).

2.12 Data handling and statistical analyses

The effects of the nudges were evaluated by comparing each nudge period with their respective control period. This was done to correct for seasonal differences (including seasonal variation in foods served), and because each nudge was evaluated using different measurements of the photos, and different registrations by the kitchen staff.

For the statistical analyses, Generalized Linear Models (for portion size and weight loss) or Multinomial Logit Models (for all categorical data) were used. The tested models included nudge (Salt, Vegetable, Portion, or Combination Nudge vs Control), a measure of time (lunch number, week, or time after last survey in case of the habit survey), and respondent number. For all statistical analyses, $p<0.05$ was used as the significance level.

3 Results

3.1 Salt nudge

During the salt nudge period, 22% fewer salt packets (817 g) were taken by those eating in the cafeteria compared to in the salt control period (1044 g) (see Fig. 1). The herbs that were offered on the dining tables in the salt nudge period were used, likely to replace some of the salt intake: 626 g was used in the four-week nudge period (no data from control period).

The number of foods chosen that had a green heart label (indicating low salt content in the nudge treatment) was higher for individuals in the salt nudge group (2.5 ± 0.1 per meal) than in the salt control group (2.2 ± 0.1 per meal, MLM, p=0.04), but this effect disappeared when correcting for individual (MLM, individual effect: p<0.0001; nudge effect p=1.0). Only individual effects were found for foods chosen with a red heart label (high salt content, MLM, p<0.01). Lunch number had no effect on choice of foods with green or red hearts.

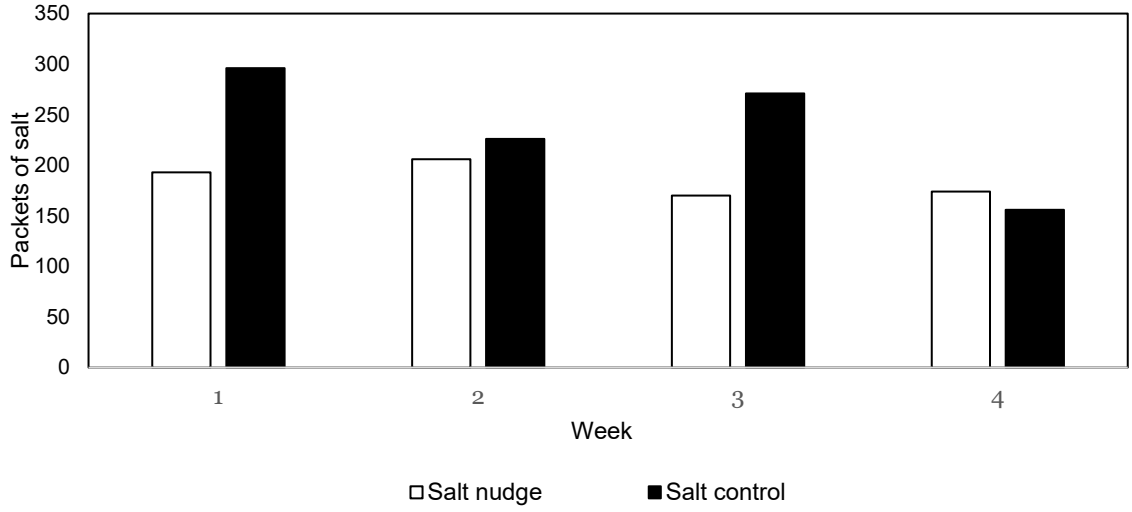

Figure 1. Salt usage (# of packets of salt), during the salt nudge period and the salt control period, for the entire cafeteria.

3.2 Portion size nudge

During the portion size nudge period, participants' meals were 23% smaller by weight than in the portion size control period (352 ± 10 g versus 458 ± 14 g per meal) (see Fig. 2). The effect of the nudge treatment was significant (GLZ, p<0.0001), despite an effect of individual (p<0.01). The effect existed for all weeks.

The smaller plate size did not result in participants in the portion size nudge taking a second plate more often: 24% of the portion size nudge meals consisted of two plates, while 27% of control group meals had two plates.

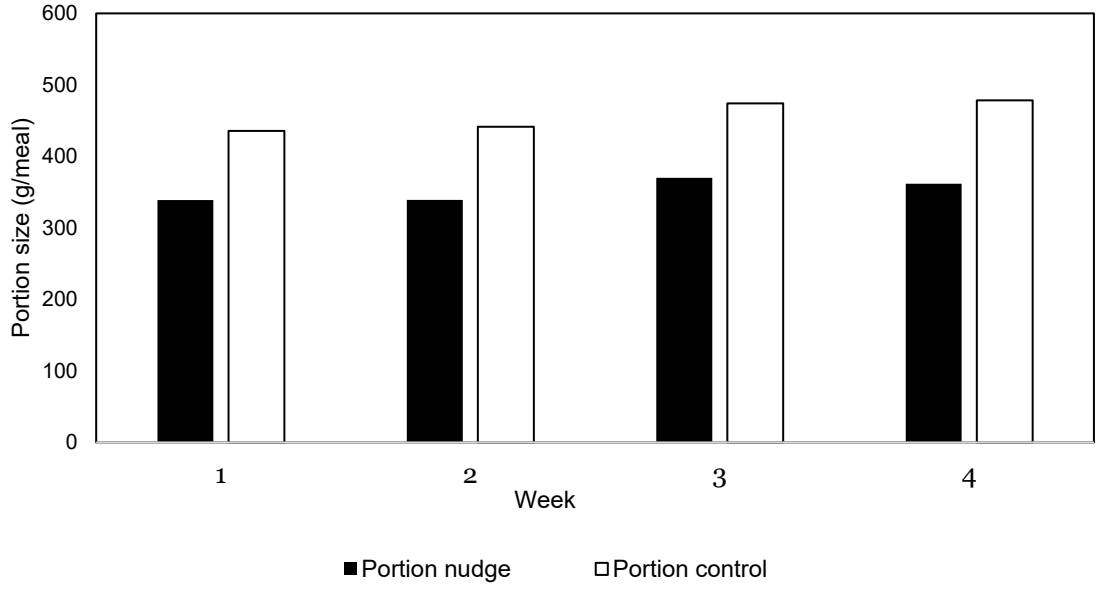

Figure 2. **Lunch portion size as measured in grams per meal, for participants in the portion nudge period and in the portion control group.**

3.3 Vegetable nudge

The addition of more vegetable options to the buffet resulted in a 53% increase in vegetable consumption as measured as kg removed from the buffet averaged per day (vegetable nudge: 9.9 ± 1.0 kilogram; vegetable control: 6.6 ± 0.6 kilogram) (see Fig. 3). The total consumption of fruit plus vegetables per day was similar for the nudge and control periods (vegetable nudge: 12.2 ± 1.1 kg; vegetable control: 11.9 ± 0.7 kg), meaning that participants replaced fruit consumption with vegetable consumption.

The photos indicated that the total consumption of fruit and vegetables by the participants in the study was higher in the control group (4.2 ± 0.2 versus 4.6 ± 0.2 "pies" of the photo per meal were filled with fruits and vegetables, $p<0.05$), caused by several individuals who ate a large portion of fruit after their first plate (individual effect $p<0.0001$).

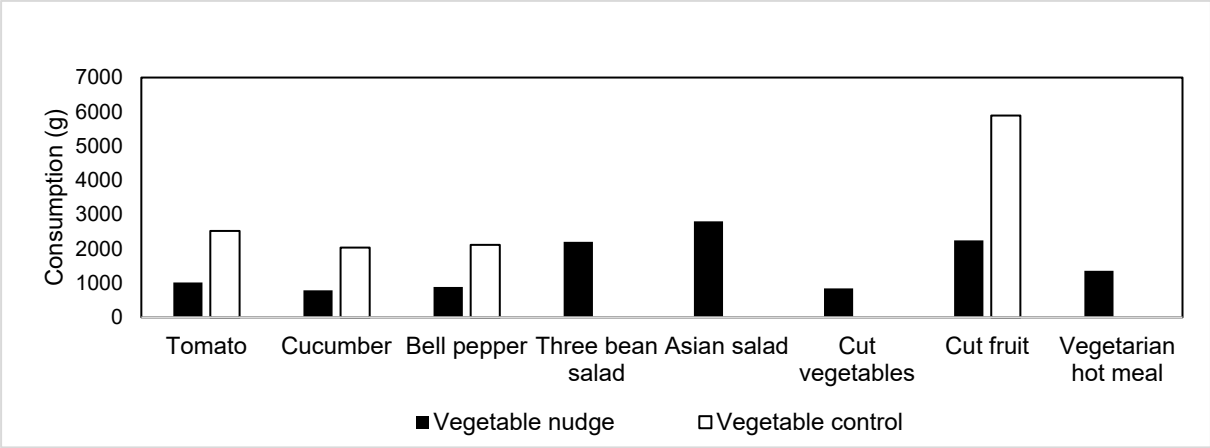

Figure 3. **Vegetable and fruit consumption per day (g/day that was taken from the buffet) for the vegetable nudge period and the vegetable control period. Three bean salad, Asian salad, cut vegetables and a vegetarian hot meal were only offered in the vegetable nudge period.**

3.4 Combination nudge

During the combination nudge period, 13% fewer salt packets (847 g) were taken by those eating in the cafeteria compared to during the salt control period (978 g) (see Fig. 4). Usage of the herbs during the combination nudge period was 591 g.

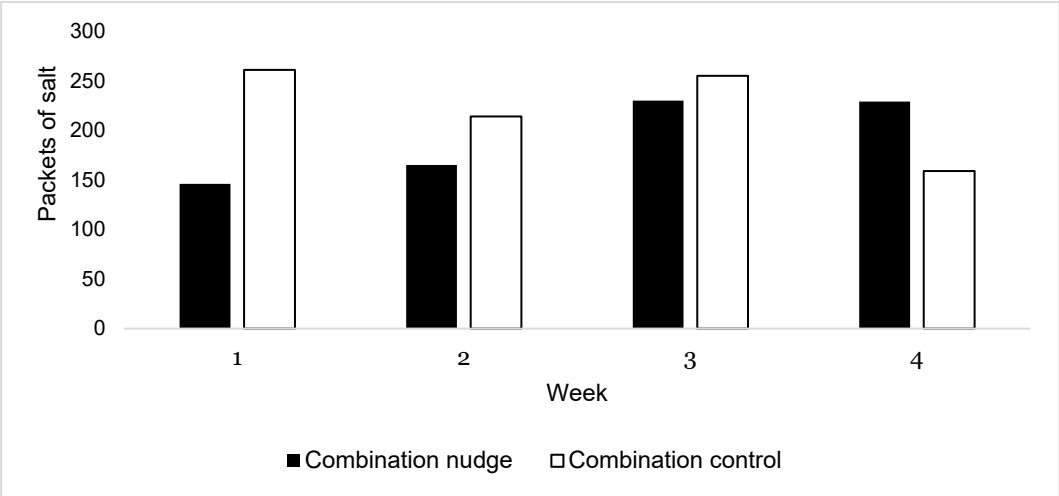

Figure 4. **Salt usage (# of packets of salt), during the combination nudge period and the combination control period, for the entire cafeteria.**

The number of foods chosen that had a green heart label was higher for individuals in the combination nudge group (2.6 ± 0.1 per meal) than in the salt control group (2.2 ± 0.1 per meal, MLM, p=0.02), while the number of foods chosen with a red heart label was higher for individuals in the combination control group (1.5 ± 0.1 per meal) than in the combination nudge (1.1 ± 0.1 per meal, MLM, p=0.03), but both red and green heart food choices were strongly affected by individual differences.

Portion size did not significantly differ between the nudge and the control (nudge period: 404 ± 37 g, control period: 424 ± 45 g). This was likely due to an increased vegetable intake: vegetable

consumption was higher in the nudge group (2.5x more) than in the control group (13.4 ± 1.4 kg versus 5.2 ± 0.7 kg). In this group, however, fruit intake was also high (see Fig. 5).

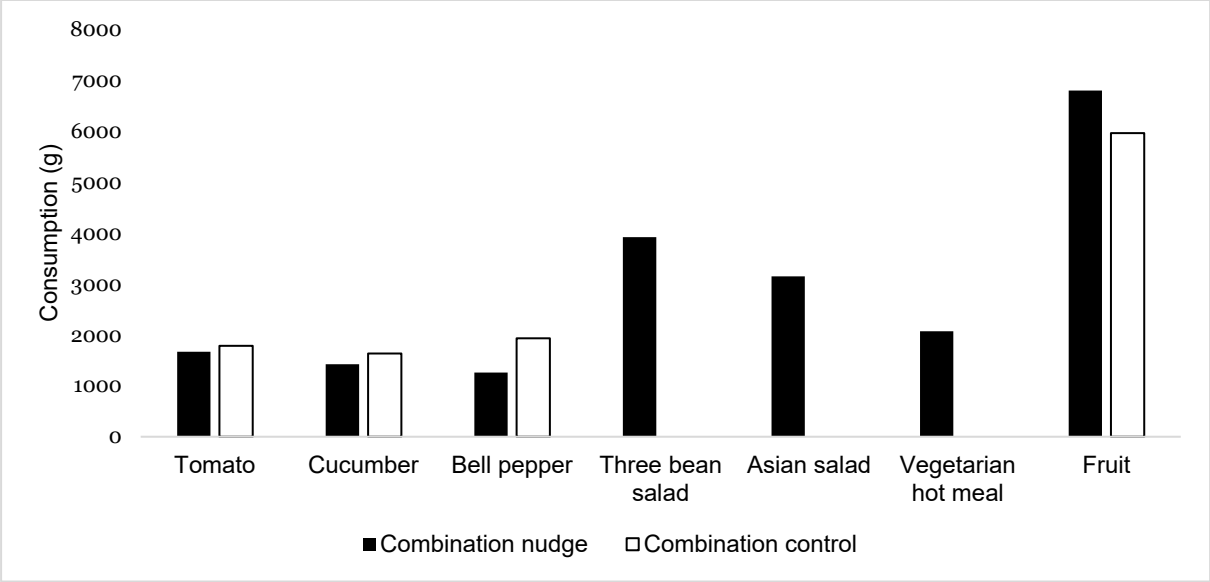

Figure 5. **Vegetable and fruit consumption per day (g/day that was taken from the buffet) for the combination nudge period and the combination control period. Three bean salad, Asian salad, cut vegetables and a vegetarian hot meal were only offered in the vegetable nudge period.**

3.5 Effect of nudges on satisfaction with the cafeteria

In general, the satisfaction with the food and service in the cafeteria was not much affected by the nudges. In the salt nudge, no differences were observed between the nudge and control groups for any of the responses to the satisfaction survey. In the portion size nudge, there was a tendency for differences between the nudge and control groups for two variables, with less favourable ratings from the nudge group ($p<0.1$) (see Table 2). During the vegetable nudge period, the food was deemed more appetizing by the nudge group than by the control group ($p<0.01$) and rated a better taste experience ($p<0.01$). During the combination nudge period, the service was deemed more favourable by the nudge group than by the control group ($p<0.05$), while the variation in the food offered was deemed more favourable by the control group ($p<0.05$).

Respondent number had an effect on “learnt to eat new foods” during the portion nudge period and “the food is appetizing” in the vegetable nudge, and “I miss more variation” in the combination nudge ($p<0.05$), and tended to affect “satisfied with the taste” in the salt nudge and “the cafeteria is appealing” in the portion nudge ($p<0.1$).

Table 2. Average satisfaction scores for each of the groups over the four weeks (1=strongly agree with statement, 7=strongly disagree).

	Salt Nudge	Salt Control	Portion Nudge	Portion Control	Veg Nudge	Veg Control	Combi Nudge	Combi Control
Cafeteria is appealing	1.5	1.3	1.8	1.3	1.2	1.4	1.5	1.9
Miss more variation*	2.9	2.7	4.1	2.6	2.6	2.7	3.9	2.9
Food is appetizing	1.5	1.3	2.0	1.4	1.1	1.6	1.6	1.7
Satisfied with taste	2.0	1.5	2.2	1.3	1.8	1.3	1.8	1.7
Buffet not organized*	1.9	1.6	2.2	1.7	1.7	1.7	1.9	1.9
Staff is service minded	1.2	1.2	2.7	1.4	1.4	1.2	1.5	1.4
Learnt to eat new foods	3.3	3.1	4	3.5	2.7	2.9	2.9	3.0

*Reversed items: scores in these tables were reversed to allow for comparability

3.6 Weight loss during the nudge period

The salt nudge (salt nudge: 0.91 ± 0.46 kg, salt control: 1.5 ± 0.58 kg), the portion size nudge (portion nudge: 0.88 ± 0.41 kg, portion control: 0.13 ± 0. kg), and the combination nudge (combination nudge: -0.64 ± 0.51 kg, combination control: -1.45 ± 0.35 kg) did not affect weight loss during the four-week period. Weight loss tended to be larger in the vegetable nudge group than in the vegetable control group (vegetable nudge: -1.95 ± 0.40 kg, vegetable control: -0.75 kg ± 0.56, $p<0.1$), with all participants except two losing weight during the period. It must be noted though that not all participants had a weight loss goal, nor was the program focused on weight change.

4 Discussion

4.1 Main findings of this study

Our results illustrate that each of the three different types of nudges had a positive effect on the lunch meals' composition by supporting a lower intake of salt, a higher intake of vegetables, and reduced portion sizes. Four important conclusions can be drawn from this study. First, the introduction of a ready-assembled mixed salad in the buffet along with modification of the order of the buffet, placing vegetables first and hence making them easier to reach, had a strong impact on the participants' food choices; in our study, vegetable consumption increased by 53%. Other studies have also found that altering the serving sequence increased vegetable consumption in different populations from a 19% plate-share of fruits and vegetables in the control group to a 33% share in the intervention group (Kongsbak et al., 2016) and an 11% increase in sales of vegetables when these were presented first (Wansink & Just, 2011). In this vegetable nudge, a couple of additional rearrangements of the physical environment in the cafeteria were also introduced. The buffet offered more vegetable options and a wider assortment of vegetables, such as a ready-mixed salad, during the intervention period. Other studies have found that by offering only one additional vegetable, it is possible to enhance healthier food choices in lunch buffets (Bucher, van der Horst, & Siegrist, 2011). Increasing attractiveness by giving vegetable dishes enticing names, and making vegetables more normative by placing signs illustrating the plate model which indicated the recommended share of vegetables, above the buffet and on tables, may also have influenced the result in this study, in line with other studies (Wansink, 2004; Turnwald, Boles, & Crum, 2017). By placing both vegetables and plates at the beginning of the lunch buffet, and more calorie-dense foods at the end, attention was drawn to the healthier options and supported a natural serving sequence promoting vegetables. What is served first in a buffet has a great impact on what is selected, as illustrated in a previous study (Wansink & Hanks, 2013) in which over 75% of diners selected the first food they saw, and the first three foods a person encountered in a buffet comprised 66% of all the foods taken. Priming functioned to make vegetables a more attractive choice, and altering the serving sequence increased vegetable intake. Such easy changes to buffet lines may be implemented at low-cost in public and private foodservice situations, both inside and outside clinical settings to help people eat healthier.

The second important conclusion which can be drawn from this study is that modifying portion sizes by reducing plate sizes in combination with changes in serving utensils and visual clues such as signs, are effective tools for stimulating smaller portions of self-served food at buffets. As we did not measure plate waste, we cannot conclude on the actual amount of the meal which was eaten. Our study focused on food selected. However, people eat less when they are served smaller portions than when served larger ones (Steenhuis, Leeuwis, & Vermeer, 2010; Freedman & Brochado, 2010). It seems that plate size communicates information about the types and amount of food expected to be served on and eaten from a plate. Consumption norms seem to be strongly influenced by environmental cues such as the size of the plate. In a study from 2013, diners who selected the larger plate served themselves 52% more total food and consumed 45% more food than those who selected the smaller plate (Wansink & Van Ittersum, 2013). In our study, a default choice was introduced in the interventions group, as only smaller plates were available at the start of the buffet line. This minor change in plate size, a reduction of 3 cm in diameter, from 24 to 21 cm, resulted in patients serving themselves 23% less food for lunch. Such a default option requires hardly any reflection, and a number of other studies have concluded that pre-set or default options as portion size are a significant determinant of food intake (Hollands et al., 2015). Nordic Choice Hotels conducted an experiment in 2012 on how reduced plate size (from 24 to 21 cm) effects the amount of food waste. The result, a reduction of 19.5%, will potentially save 613 tons of food waste annually if launched at all 170 hotels, and corresponds to a saving of 1166 tons of carbon dioxide and up to 31 billion Norwegian kroner (Kallbekken & Sælen, 2013). A reduction of

plate size seems to be a win-win solution for reducing both food intake and waste as also illustrated by the work of Wansink & Van Ittersum (2013).

Our study took place in a real buffet in a clinical setting with actual plates, and the findings are supported by other research with similar effect on default servings on actual plates (Hinton et al., 2013; Rolls, Morris, & Roe, 2002,; Robinson, Aveyard, & Jebb, 2015; Hollands et al., 2015; Wansink & Van Ittersum, 2013). Regardless of plate size, people have a tendency to eat what is on the plate, and plentiful environments such as a food buffet present a risk factor for over-consumption and promote weight gain (Robinson et al., 2015). A review article found that when people were offered larger-sized portions, packages or tableware, they consume more food and drink, compared to use of smaller-sized versions (Hollands et al., 2015).

The third important conclusion which can be drawn from this study is that it is possible to reduce the intake of salt in a cafeteria by making salt less easily accessible.

A reduction of 22% was achieved during the intervention period just by removing the small salt packages from each dining table to a placement harder to spot. Minor rearrangements in the physical cafeteria environment, such as making salt less accessible, and other flavourings more accessible, led diners to add less salt to their lunch meal. This is in line with previous studies on the positive effects of rearranging the physical environment by, for example, placing unhealthy foods farther away and therefore reducing their accessibility (Kahn & Wansink, 2004; Maas et al., 2012,; Olstad, Goonewardene, McCargar, & Raine, 2014; Rozin et al., 2011). Salt consumption was lower in all weeks except the fourth week, but as the food offering and number of people taking meals differs slightly per week, it is unclear whether this is due to random variation, whether the salt usage effect is only short-term, or whether another factor played a role (e.g. education about salt in week 4). However, our study does not show whether or not the effect would last in a longer run, such as beyond four weeks, which was the intervention length in this study.

The forth conclusion which can be drawn is based on the results from the combination nudge where all of the three interventions were tested out at the same time and during the same period. It is interesting to compare the effects of the combination nudge on usage of salt, vegetables, and portions to the effects of each of the three nudges when they were tested one by one. More salt was used in the combination nudge compared to when salt was the only intervention. The reduction in salt-usage was 22% in the salt intervention versus 13% in the combination-intervention. Diners' attention to a variety of different visual clues with a number of different messages related to salt-intake, recommended portion-size, and vegetable intake, may have represented an overload of information. This might have had an impact on the increase in salt-intake compared to the intervention with only salt. However, the findings from the combination nudge period also highlight that reducing plate sizes may not reduce portion sizes when simultaneously trying to increase vegetable consumption, even though this would likely have a beneficial effect on energy density.

4.2 Limitations and future research

This study took part in a real-life setting and did not allow controlling for all external factors as in a lab-based experiment. As choice of food in a natural setting is influenced by several external factors (Kahn & Wansink, 2004), such factors outside our control may have affected the results when comparing across the intervention and control group.

Besides these general limitations, a number of other more specific limitations related to this study suggest that the findings should be interpreted cautiously. It is important to take into account that our intervention in the cafeteria could promote healthier eating since one must assume that many of the diners, and particularly the patients who got their plates weighed, may have changed their choice of food. The results in our study, smaller servings, more vegetables, and less salt for lunch, may be compensated during other meals the same day.

People have a tendency to clean their plate or to eat all or most of the food on the plate. This phenomenon was found to be commonplace in a self-service restaurant, where in 86% of the meals, 90% of the meal was eaten (Hinton et al., 2013). Even though leftovers on the plates were not measured in our study, we may assume that food items on the plates were eaten, as previous reports indicate that individuals eat 92% of self-served food, regardless of portion size and type of food (Wansink & Johnson, 2015).

We measured the total weight of food consumed, but the actual energy intakes were not calculated. Any long-term behavioural effects in the patients' home environments are unknown.

4.3 Implications

Our study suggests that policies and practices that successfully reduce the size, availability and appeal of larger-sized portions, smaller sizes of plates/tableware and serving utensils can contribute to meaningful reductions in the quantities of food people select and consume in the immediate and short term.

By design, our study does not provide direct evidence of the health effects of the nudging interventions. However, the effects on consumption would be relevant both clinically and for public health if sustained. A 53% increased vegetable consumption is encouraging, as a low vegetable intake is one of the major behavioural risk factors for death and NCDs in Norway and other high-income countries (Gakidou et al., 2017). As little as one extra serving of fruits and vegetables per day is associated with 4-5% lower risk of coronary heart disease, stroke, and CVD mortality (Dauchet, Amouyel, & Dallongeville, 2005; Wang et al., 2014). Regarding salt, we found a 22% reduction in the use of table salt during the salt nudge. Dietary salt is linearly associated with blood pressure, and hypertension is a leading cause of CVD. In the randomized controlled trials of hypertension prevention (TOHP), a 25-35% salt intake reduction was associated with a significant 25-30% lower risk of CVD after 10-15 years of follow-up (Cook et al., 2007). Even though patients with hypertension tend to be especially responsive to salt restriction, small reductions in the average blood pressure through salt reduction on a population level are also important for public health (Mozaffarian et al., 2014). Notably, one of the WHO's global NCD targets is a 30% salt reduction by 2025 (Mendis, 2014). Our findings imply that nudging could be a valuable strategy to approach this target, in addition to product reformulations and use of salt replacers, while consumer education alone may not be sufficient (Trieu et al., 2017).

The results of this intervention also add to the current evidence base for designing effective nudging interventions. In general, the interventions in the study required little to no reflection by the diners. Such automatic decision processes, as opposed to intensive, reflective decision-making which may hinder compliance with dietary recommendations (Nørnberg, Houlby, Jørgensen, He, & Pérez-Cueto, 2014), may add to the explanation of the effects in this study. In a recent review and meta-analysis, Cadario & Chandon (2017) also proposed that the efficacy of nudges increases as they target actions directly, rather than raising attention or interest. Action-focused nudging interventions can influence behaviour without necessarily changing people's preferences or intention, e.g. through making the healthier choice the standard option or more convenient. Changing plate or portion size were found to be the most efficient, while purely descriptive labelling (e.g. salt content) had no effect (Cadario & Chandon, 2017). We also found that labelling seemed to have only a minor impact on the choice of low-salt foods, while moving salt away from the dining tables, i.e. a more action-focused strategy, had a significant effect. The findings from the combination nudge period also highlight that reducing plate sizes may not reduce portion sizes when simultaneously trying to increase vegetable consumption, even though this would likely have a beneficial effect on energy density in the lunch.

Some of the most important findings from the project will be implemented in the Norwegian Heart and Lung Foundation's new hospital at Gardermoen. The size of the plates for all meals except for

dinner will be changed to 21 cm in diameter. Salt-free spices will replace salt at the dining tables, while salt will be available in the cafeteria, but placed out of sight and, as a consequence, less accessible. As far as the budget allows, the kitchen staff will serve plenty of vegetables, mixed salads, and vegetable dishes. In addition, and in line with the findings, the buffet order will be changed by placing vegetables first and hence making them easier to reach. Through these modifications in the eating environment in the hospital cafeteria, the foundation aims for a persistent change in the patients' food choices leading to improvement in their health.

5 Conclusions

This work has demonstrated that it is possible to influence the behaviour of diners when it comes to food choices in a real-life meal-setting without restricting food choices. More specific studies show that nudging is a promising tool for shifting the meal composition to a healthier one. If the aim is to promote and increase vegetable intake, placing vegetables first in a buffet, combined with increased variety of vegetables, seem to be effective ways to achieve this. Additionally, this study has illustrated that using smaller plates as a default is effective in reducing portion size. It is also possible to reduce salt-intake by replacing salt at dining tables with salt-free spices and by making salt less accessible in the cafeteria.

These findings have promising application to the foodservice sector as an actor with impact on public health, as an increasing number of meals are eaten out-of-home. Our study implies that by changing the setup or design of elements in the eating-environment, the foodservice sector could facilitate important changes towards healthier diets. The environmental changes tested in this study, could easily be implemented and have little cost in restaurants and cafeteria settings and may represent a win-win solution by reducing both food intake and waste and at same time supporting public health aims.

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Appendix

APPENDIX A. Photo analysis. Salt intervention. Photo of lunch meal for patient number 11. Registration of number of food items chosen with low or high salt-content indicated with green or red hearts in the buffet. Three green hearts and four red hearts registered, along with one item (eddik which is vinegar) marked as added to the meal by the patient (on the card at the top of the photo).

APPENDIX B. Photo analysis. Portion size intervention. Photo of lunch meal with two plates. Weight registration. Left: 24 cm plate-size with 416 gram food. Right: 21 cm plate-size with 306 gram food.

APPENDIX C. Photo analysis. Vegetable intervention. Photo of lunch meal with a digital overlay of circle divided into ten equal slices. At this plate five slices are registered as covered with vegetables and given a score of five in the analysis.

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