Study protocol with statistical analysis plan

Fostering sustainable dietary habits through optimized school meals – OPTIMAT

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Introduction

Public school meals have been highlighted as a suitable setting for children to internalize sustainable dietary habits, which may persist throughout life [1, 2]. Radical changes to food production and consumption are needed to ensure the attainment of Agenda 2030 for Sustainable Development [3], and fulfillment of the Paris Agreement [4]. Planning of school meals must take many aspects into account: health promotion, environmental impact, acceptability by the consumers and affordability to those paying for the meals. Currently many schools use organic products, recycle food packaging and aim to reduce food waste, but environmental impacts like greenhouse gas emissions (GHGE) have so far not received much attention.

In Sweden, fully subsidized lunches are served daily in primary schools to all 1.3 million children aged 6 to 15 [5]. Due to their reach and scale (approximately 230 million meals/year at an annual cost of around 5.6 billion SEK), school meals have enormous potential to increase children's knowledge about health and sustainability, foster sustainable dietary habits and to enable sustainable public procurement.

This study aimed to: a) apply linear programming to develop a GHGE-reduced, nutritionally adequate, and affordable four-week lunch menu plan optimized for minimum deviation from the current food supply; and b) evaluate the climate impact of the menu, effects on food waste, food consumption, and pupils' satisfaction with school lunches. Our hypothesis is that school meals can be optimized to be nutritious and more climate friendly, without negatively affecting acceptance, food waste and cost.

Methods

Design

An interrupted time series (ITS) analysis design will be used to compare the effect of an optimized menu to the baseline menu on daily food waste and consumption at school level. For a baseline period of four weeks children in primary schools will receive a baseline menu. After a two-week break, the optimized four-week menu will be served (intervention period).

Recruitment of schools

During the fall of 2018, public meal managers in three municipalities of Stockholm, Sweden, were invited to information meetings about the intervention. The public meal managers were asked to attend the meeting together with school chefs from primary schools had shown interest in sustainability issues. To be eligible for the intervention, schools were required to have on-site kitchens. They also needed to be able to provide previously used recipes for a standard four-week menu electronically.

Optimization

Recipes for an original (baseline) four-week school lunch menu plan previously served at the recruited schools, will be obtained through the municipality's electronic meal planning system. The foods included and amounts are considered as the baseline food supply. Each food item included has a code that can be coupled to the Swedish national food database and a national climate database for foods containing life cycle data for each food item [6]. This baseline food supply will be optimized using linear programming.

The optimized food list, not including new foods or excluding foods from the baseline list, will be handed to a professional meal planner who develops a new menu plan for the intervention using all foods on the optimized list.

Outcomes

To assess the effect of the new menu plan, data on food waste and consumption will be collected in each intervention school four weeks before (baseline) as well as during the four-week intervention with a 2-week brake in between measurement periods. A tool for measuring food waste in school restaurants developed by the National Food Agency in Sweden will be used. The tool requires weighting (using school kitchen scales) of all kitchen waste (both preparation waste and cooking waste); all food prepared in the kitchen; the share of the prepared food that is not eaten and has to be thrown away (serving waste); the share that can be saved; and plate waste. The number of plates used daily by the pupils in the school restaurant will also be recorded. These measurements will be made daily by the personnel in the school kitchens during the baseline as well as during the intervention period. Based on these measurements, the total food consumption (kg) will be calculated as the total amount of food prepared in the kitchen (kg) minus the total amount of prepared food that is not eaten and has to be thrown away (overall waste in kg), the total amount of plate waste (kg), and the total amount of food that could be saved (kg). Plate waste per pupil (g) will be calculated for each day by dividing the total amount of plate waste by the total number of plates used. Similarly, the consumption per pupil (g) will calculated for each day by dividing the total consumption by the total number of plates used.

Data on school meal satisfaction will be collected at each intervention school through an online questionnaire at baseline and during the last week of the intervention period. Pupils in grades 5 and 8 answer the questionnaire containing ten questions related to the school lunch. Five of the ten multiple-choice questions specifically cover their general (i.e. not for that specific day of week) sense of satisfaction with the school lunch. The questions include how often they consider that the school lunch tastes good, how many days per week that they tend to eat from the school lunch, how often they usually feel full after having eaten lunch, and how often they tend to throw away food in the school restaurant. They are also asked to provide an overall rating of the school lunch.

Qualitative study

Six focus group discussions (FGD) with pupils in grades 5 and 8 and three FGDs with meal staff will be conducted to explore their experiences with the intervention as well as the barriers and facilitators to scaling up.

Statistical analysis plan

In order to compare food waste and consumption between the two periods (baseline and intervention), interrupted time-series (ITS) analysis will be used [7]. ITS analysis will be implemented at school level to assess the difference between the two periods daily in the number of pupils consuming lunch (n), kitchen waste (kg), prepared food (kg), serving waste (kg), total plate waste (kg), plate waste per pupil (g), total consumption (kg), and consumption per pupil (g).

The ITS analysis will based on linear regression models [7]. These models will be determined by three independent variables: (a) A time-variable, applied to adjust for a potential baseline trend; (b) A variable indicating whether the data point represented the baseline or intervention period to assess the level (mean) change resulting from the intervention; and c) an interaction term between (a) and (b) specifying

the slope change resulting from the intervention. Assumptions of normality, homoscedasticity, as well as absence of autocorrelation and partial autocorrelation will be assessed.

The effect of the new menu plan on the five questions related to school meal satisfaction will be explored with Pearson's chi-squared tests ($\chi 2$) within each intervention school.

The software R (version 3.6.1) [8] will be used for statistical analysis.

Qualitative content analysis [9] will be used to analyze the FGDs.

References

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