Evaluation of the effect of the "Eat Less Meat" one-month challenge on meat consumption among French university students

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Description:

In a context where meat consumption should be dramatically reduced in western countries to improve both population and planet health, the "Eat Less Meat" one-month challenge is a new behavioural intervention that aims (i) to weaken meat consumption habit and (ii) to enhance intrinsic motivation to eat less meat to trigger long-term reduction in meat consumption. The present registration focusses on the quantitative evaluation of the effect of this challenge on university student's meat consumption.

STUDY INFORMATION

Hypotheses

Main hypothesis:

H1: The "Eat Less Meat" challenge will have decreased meat consumption in participants during the challenge and 3 months after challenge completion compared to before.

Secondary hypotheses:

H2: The "Eat Less Meat" challenge will have increased (resp. decreased) nutritional quality (resp. environmental impact) of the diet in participants during the challenge and 3 months after challenge completion compared to before.

H3: The "Eat Less Meat" challenge will have weakened meat consumption habits in participants during the challenge and 3 months after challenge completion compared to before.

H4: The "Eat Less Meat" challenge will have increased health, ethics and animal welfare motivations for food choices in participants during the challenge and 3 months after challenge completion compared to before.

Study design

Parallel two-arm randomized controlled trial with repeated measures (online questionnaires) pre-, during- and post-intervention. All the participants will be recruited to take part in the "Eat Less Meat" challenge for one month. Participants in the control group will take part in the challenge 3 months after the participants in the intervention group. Participants in both groups will complete the online questionnaires at the exact same time, i.e., pre-, during- and post-intervention measures will take place before the control group starts the challenge. A figure summarizing the study design is available in **Appendix 1**.

Randomization

A 1:1 randomisation sequence will be generated before recruitment using the Random Allocation software[1] to allocate each participant to one of the experimental arm (control or intervention).

SAMPLING PLAN

Data collection procedures

[1] Mahmood Saghaei, 'Random Allocation Software for Parallel Group Randomized Trials', *BMC Medical Research Methodology*, 4 (2004), 1–6 <https://doi.org/10.1186/1471-2288-4-26>.

Inclusion criteria.

- Aged ≥ 18
- BMI ≥ 18.5
- University student in 'Bourgogne Franche-Comté'
- Fluent in French
- Available email address
- Available Instagram profile
- Not vegetarian or vegan or pescatarian
- Not pregnant/breastfeeding
- No iron deficiency

Brief description of the "Eat Less Meat" challenge.

Participants will be recruited through social media, emails, flyers and posters on campus to take part in the "Eat Less Meat" challenge; recruitment materials will mention that the challenge is part of a research study. Eligible participants that will give their informed consent will be able to choose their goal for the challenge for one month: (i) no meat, (ii) meat 3 times a week, (iii) meat 6 times a week (which will need to be lower than current consumption) and will be enrolled in the challenge. The 'meat category' includes all red meat and poultry but not fish or other animal-sourced food products (eggs, dairy, etc.). The first day of the challenge, the participants will receive by email a cookbook of easy-to-prepare and cheap meat-free recipes and a starter kit with advices and motivational tips, then they will receive an email each week with more advices and motivational tips. Participants will be also asked to follow the Instagram account of the challenge where during one month (i) one post will be posted each day, (ii) engaging stories requiring interactions will be posted regularly, (iii) participants can ask their questions to the research team, (iv) participants can interact with each other's. The Instagram posts will cover three main topics: (i) knowledge about meat and its impact on health and environment, (ii) tips for meat-free cooking, (iii) social/contextual pressure to eat meat and how to avoid it. Emails and posts will aim at keeping the participants engaged in the one-month challenge and to enhance their intrinsic motivation to eat less meat.

Data collection for evaluation.

Eligible participants will be informed that their participation will involve completing a first online questionnaire on sociodemographics at the point of inclusion (10 min) and then three other online questionnaires at three time points: pre-, during- and post-intervention (30 min each time, 10€ compensation).

Sample size

As a minimum, we will aim to recruit 200 university students willing to take part in the challenge but we will include in the study all voluntary students that will register. Registrations will close the day before the challenge starts for the intervention group.

Sample size rationale

The sample size was determined based on a power analysis (GPower v3.1) to detect a small effect size of f=0.10 for a within-between interaction in a mixed model with 3 repeated measures. A total sample size of 164 participants was necessary to reach 0.80 power at 0.05 alpha. Considering an attrition rate in between 15 and 20%, we will aim to recruit 200 university students willing to take part in the challenge.

VARIABLES

Manipulated variables

We will manipulate whether participants will be assigned to intervention or control group (challenge 3 months after the intervention group). It will be coded as a binary variable: 'intervention' or 'control' at the participant level.

Measured variables

The sociodemographics questionnaire will record age, gender, scholarship status, educational level, field, parents' educational level, place of living, dieting status and type of diet.

The evaluation questionnaires will record three types of variables at the three time points:

- Food consumption frequency

The food frequency questionnaire (FFQ) will include 109 foods, 12 non-alcoholic drinks and 4 alcoholic drinks with frequency assessed by a 6-item scale from "Never" to "Several times a day"[2]. Participants will estimate their usual portion size for 75 food items using photos on a 5-point scale derived from the SU.VI.MAX portion book[3]. For the 50 remaining food items, we will use the standard portion size. Consumption frequencies of each item will be transformed into daily frequencies and daily intake will be calculated by multiplying the daily frequency by the estimated portion size. Individual nutrients intake will then be calculated for all the participants before and during the lockdown by multiplying the daily intake of each food item by the nutritional values from the SU.VI.MAX nutrient composition database[4]. Participants will be asked about their food consumption for the month before questionnaire completion, i.e., the month before the challenge, the month of the challenge and the third month after the challenge for the intervention group (all the measures will take place before the control group start the challenge).

- Meat consumption habit

The strength of meat consumption habit will be assessed using the Self-Report Habit questionnaire[5] including 12 items accompanied by a 6-point response scale anchored by 'strongly disagree' and 'strongly agree' from 1 to 6. The scores will be coded such that high values indicated strong habits. Participants will be asked about their meat consumption habit at the time of questionnaire completion.

- Food choice motives

The food choice questionnaire (FCQ) will be the adapted French version of the Food Choice Questionnaire[6]. It includes 30 items and 10 subscales: health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity, ethical concern and animal welfare. Answers to each item will range from 1 to 4: 1 = Not at all important; 2 = A little important; 3

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[2] Manik Kadawathagedara and others, 'Diet during Pregnancy: Influence of Social Characteristics and Migration in the ELFE Cohort', *Maternal and Child Nutrition*, 17.3 (2021), 1–13 <https://doi.org/10.1111/mcn.13140>.
[3] S Hercberg, M Deheeger, and P Preziosi, *SU.VI.MAX. Portions Alimentaires : Manuel Photos Pour l'estimation Des Quantités*, Economica (Paris, 2002).
[4] S Hercberg, *Table de Composition Des Aliments SU.VI.MAX*, Economica (Paris, 2006).
[5] Bas Verplanken and Sheina Orbell, 'Reflections on Past Behavior: A Self-Report Index of Habit Strength', *Journal of Applied Social Psychology*, 33.6 (2003), 1313–30 <https://doi.org/10.1111/j.1559-1816.2003.tb01951.x>.
[6] Muriel C.D. Verain and others, 'Sustainable Food Choice Motives: The Development and Cross-Country Validation of the Sustainable Food Choice Questionnaire (SUS-FCQ)', *Food Quality and Preference*, 93 (2021), 104267 <https://doi.org/10.1016/j.foodqual.2021.104267>; L. Marty and others, 'Food Choice Motives and the Nutritional Quality of Diet during the COVID-19 Lockdown in France', *Appetite*, 157 (2021), 105005 <https://doi.org/10.1016/j.appet.2020.105005>.

= Moderately important; 4 = Very important. Participants will be asked about their food choice motives for the month before questionnaire completion.

Indices

Three scores will be calculated based on the FFQ at each time point:

- **Meat consumption.** Meat daily intake (in grams) will be calculated by summing daily intake for all the items of the FFQ that fall into the meat category.
- **Nutritional quality.** Adherence to the French dietary guidelines will be evaluated using the simplified PNNS-GS2[7]. The sPNNS-GS2 builds on the distinction between malus components (less healthy food groups which consumption should be limited, carrying a negative score, i.e., red meat, processed meat, sugary foods, sweet-tasting beverages, alcoholic beverages, salt) and bonus components (healthier food groups carrying a positive score, i.e., fruits and vegetables, nuts, legumes, whole-grain food, milk and dairy products, fish and seafood) reflecting established knowledge on the relationship between food groups consumption and non-communicable disease risk factors. sPNNS-GS2 will computed for each participant with slight modifications to the calculation compared to the initial definition (range: -17 to 11.5) as in previous research[8].
- **Environmental impact.** Greenhouse gas emissions (GHGEs) will be derived from the French food environmental impact data- base Agribalyse 3.0 drawn up by the French Agency for Ecological Transition that includes GHGEs values for 2480 food items (ADEME, 2020), based on Life Cycle Analyses of food products. The items of the food frequency questionnaire will be associated to all the corresponding food items from Agribalyse 3.0. GHGEs of each item of the food frequency questionnaire will be calculated as the average GHGEs of individual foods from Agribalyse 3.0 associated to each item. GHGEs of participants' daily diets will be calculated by multiplying the daily intake of each food item by its associated GHGEs per kg.

One score will be calculated based on the Self-Report Habit questionnaire at each time point:

- The Self-Report Habit Index will be computed by averaging ratings for all the individual items in the questionnaire.

Ten scores will be calculated based on the FCQ at each time point:

- A score for each subscale will be computed by averaging ratings for the three individual items in each of the ten subscales.

ANALYSIS PLAN

Statistical models

We will use linear mixed models to investigate whether changes in measured variables pre- (T0), during- (T1) and post-challenge (T2) differ significantly between participants in the intervention and the control group.

We will run linear mixed models with meat consumption (**H1**), nutritional quality (**H2**), environmental impact (**H2**), Self-Report Habit Index (**H3**), health motives (**H4**), ethics motives

[7] Chaltiel and others, 'Programme National Nutrition Santé - Guidelines Score 2 (Pnns-Gs2): Development and Validation of a Diet Quality Score Reflecting the 2017 French Dietary Guidelines', *British Journal of Nutrition*, 122.3 (2019), 331–42 <https://doi.org/10.1017/S0007114519001181>.

[8] Lucile Marty and others, 'Food Choice Motives and the Nutritional Quality of Diet during the COVID-19 Lockdown in France', *Appetite*, 157.105005 (2021) <https://doi.org/10.1016/j.appet.2020.105005>.

(**H4**) and animal welfare motives (**H4**), as dependant variables, time (T0, T1 / T0, T2), group (intervention, control), time*group interaction as fixed effects and participant as random effect. These models will be adjusted for gender, age and BMI in order to control for potential confounding effects. We will report adjusted mean differences between T1 and T0, and between T2 and T0 for the intervention and the control group.

If we find a significant effect of the intervention on meat consumption, i.e., time*group interaction is significant in the models above, we will run two additional models on the intervention group only to investigate whether the level of the challenge (i.e., (i) no meat, (ii) meat 3 times a week, (iii) meat 6 times a week) differentially influence meat consumption reduction. The first linear mixed model will be run with meat consumption as dependant variable, time (T0, T1 / T0, T2), level (i, ii, iii), time*level interaction as fixed effects and participant as random effect. We will report adjusted mean differences between T1 and T0, and between T2 and T0 for each level. In the second linear mixed model, we will substitute the level of the challenge by the difference between baseline meat consumption frequency (in times per week) and the level of the challenge (continuous variable).

All statistical analyses will be performed using SAS version 9.4 (SAS Institute, Inc., 2012 SAS® 9.4. Cary, NC). The proc mixed will be used for mixed models. The level of significance will be set at $p < 0.05$ for all pre-registered analyses.

Data exclusion

Dietary outcomes (calculated from FFQ) will be coded as missing for participants considered as outliers for energy intake at a given time point, defined as participants in the first and last percentile of energy intake at a given time point. For sensitivity analyses, dietary outcomes will also be coded as missing for participants reporting implausible energy intake at a given time point, defined as being outside of the following ranges: 500–3500 kcal for females and 800–4200 kcal for males as recommended for FFQ data[9]. BMI will be coded as missing for implausible values, i.e., >70 as in previous research[10].

Missing data

As we expect a small extent of missing outcome data, we will not exclude any participant based on missing (or implausible) values[11]. The number of missing (or implausible values) will be reported for each variable and at each time point. Linear mixed models will be based on all

[9] Jinan C. Banna and others, 'Examining Plausibility of Self-Reported Energy Intake Data: Considerations for Method Selection', *Frontiers in Nutrition*, 4.September (2017), 1–6 <https://doi.org/10.3389/fnut.2017.00045>; Lucile Marty and others, 'Food Choice Motives and the Nutritional Quality of Diet during the COVID-19 Lockdown in France', *Appetite*, 157.105005 (2021), 105005 <https://doi.org/10.1016/j.appet.2020.105005>; Tess Langfield, Andrew Jones, and Eric Robinson, 'The Impact of Increasing the Availability of Lower Energy Foods for Home Delivery and Socio-Economic Position: A Randomised Control Trial Examining Effects on Meal Energy Intake and Later Energy Intake', *British Journal of Nutrition*, 17, 2022, 1–9 <https://doi.org/10.1017/s0007114522002197>.

[10] Eric Robinson, Andrew Jones, and Lucile Marty, 'The Role of Health-Based Food Choice Motives in Explaining the Relationship between Lower Socioeconomic Position and Higher BMI in UK and US Adults', *International Journal of Obesity*, 2022, 1–7 <https://doi.org/10.1038/s41366-022-01190-4>; Eric Robinson, Steven Gillespie, and Andrew Jones, 'Weight-Related Lifestyle Behaviours and the COVID-19 Crisis: An Online Survey Study of UK Adults during Social Lockdown', *Obesity Science and Practice*, 6.6 (2020), 735–40 <https://doi.org/10.1002/osp4.442>.

[11] Rolf H.H. Groenwold, Karel G.M. Moons, and Jan P. Vandenbroucke, 'Analysis Randomized Trials with Missing Outcome Data: How to Analyze and What to Report', *Canadian Medical Association Journal*, 186.15 (2014), 1153–57.

available data points only. Sensitivity analyses will be conducted using multiple imputation, first on missing values only and then on missing and implausible values[12].

Exploratory analysis

Any supplementary analysis that is not pre-registered here will be described as an exploratory analysis.

[12] Peng Li and Elizabeth A Stuart, 'Best (but Oft-Forgotten) Practices : Missing Data Methods in Randomized Controlled Nutrition Trials', *American Journal of Clinical Nutrition*, 109 (2019), 504–8.

Appendix 1. Study design