# Long-Run Effects of an Behavioral Intervention: Experimental Evidence from Meat Consumption

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## 1 Introduction

One third of global greenhouse gas emissions can be attributed to food with the largest share stemming from its production (Crippa et al., 2021). Especially livestock breeding is very resource-intensive and causes significantly more environmental damages than the cultivation of plant-based foods (Willett et al., 2019). Therefore, it is very important to find ways to reduce meat consumption and to make diets more sustainable.

Still, there are many different reasons why people favor meat consumption. While some choose meat out of habit (Zur & Klöckner, 2014) or for pleasure (Valli et al., 2019), others believe that meat is essential for a healthy diet (Valli et al., 2019; Graça et al., 2015). Further reasons are the high costs of meat substitutes (Hosie, 2017) or the

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lack of knowledge and cooking skills that prevent people from eating vegetarian meals (Valli et al., 2019; Randers et al., 2021). However, there is also a lack of awareness about the positive environmental impacts associated with a reduction in meat consumption (Bailey et al., 2014; Lohmann et al., 2022; Macdiarmid et al., 2016).

Previous studies have shown that the most prevalent motives to reduce meat consumption or to become vegetarian are personal health and animal welfare (Ruby, 2012; Sanchez-Sabate & Sabaté, 2019; Fox & Ward, 2008). Although some interventions are successful in enhancing the willingness to reduce meat consumption for environmental reasons, this does not necessarily translate into behavior (Cordts et al., 2014; Perino & Schwirplies, 2022; Loy et al., 2016). Those who do reduce meat consumption for ecological reasons tend to be female, young, partial meat limiters (no vegan/vegetarian), and environmentally conscious and are more likely to reside in Asia and Europe than in the US (Sanchez-Sabate & Sabaté, 2019; Hoffman et al., 2013; Dyett et al., 2013; De Backer & Hudders, 2014).

The results of previous studies targeting meat consumption via environmental treatments are inconclusive. Wolstenholme et al. (2020) find that receiving information on the health and/or environmental impacts of meat is effective in reducing red and processed meat consumption compared to the control group during the intervention period, with some effects remaining one month later. Jalil et al. (2020), Sparkman et al. (2020), Haile et al. (2021), and Lohmann et al. (2022) conducted field experiments in cafeterias and restaurants. While Jalil et al. (2020) find a long-term decline in meat consumption after lectures were given on the effects of meat consumption on climate change and health and Lohmann et al. (2022) observe a decrease in consumption of carbon-intensive meals in university cafeterias after labeling was introduced, Haile et al. (2021) did not find statistically significant long-term aggregate effects of pro-vegan and animal welfare pamphlets. Sparkman et al. (2020) find an increase in vegetarian orders when dynamic norms are included in menus, but this effect was not always statistically significant. In one of their studies, dynamic norms actually led to

a significant decrease in vegetarian orders.

One explanation for these findings might be that the effectiveness of messages depends on how they are framed. Carfora et al. (2019) and Kwasny et al. (2022), for example, find that emotional messages are more effective than completely neutral informational messages. However, these messages should not be fear-based, as there is a risk of backfiring (Sanchez-Sabate & Sabaté, 2019). Furthermore, information messages should match the information needs (Kwasny et al., 2022). In particular, "consumers who consider reducing their meat intake should primarily receive information about reasons to do so. Consumers who already have intentions to reduce their meat intake require information on how to do so" (Kwasny et al., 2022). Moreover, interventions may be more effective by focusing on the benefits of reduced meat consumption rather than stressing the risks of consumption (Carfora et al., 2019). Pre-existing preference for meat is also likely to influence the effectiveness of interventions (Graça et al., 2015). Loy et al. (2016) and Carfora et al. (2017) additionally find that the impact of the information intervention is enhanced when consumers also set personal goals regarding meat consumption.

Although several studies have investigated how meat consumption can be reduced using different types of interventions, there are still multiple research gaps. Most importantly, it is still unclear how interventions affect meat consumption in the long run. Similarly, only a few studies investigate the effect of long-term interventions. Another noteworthy research gap is the use of single interventions and especially the comparison between multiple single interventions as well as the comparison of single interventions with stacked interventions. In addition, there is a lack of studies analyzing the effect on actual behavior rather than on intentions to reduce meat consumption, and of studies using a large representative sample (Sanchez-Sabate & Sabaté, 2019; Kwasny et al., 2022; Meier et al., 2021; Aldoh et al., 2021, Reisch et al., 2021).

In this study, we aim at contributing to the received literature by conducting a large-scale survey experiment among roughly 3,000 individuals. We investigate whether

long-term informational and supportive interventions over a period of four months can reduce the participants' actual meat consumption. Specifically, our treatment groups receive information about the positive effects of reducing meat consumption on climate and the environment as well as vegetarian recipes and tips for a reduction in meat consumption.

Conducting a baseline survey as well as four follow-up surveys approximately one, four, seven, and 12 months after the baseline, we are able to estimate the short-term and the long-term effects of our treatments on meat consumption. Additionally, since we randomize participants into four experimental groups, two of which receive either the informational or the supportive intervention only, one of which receives a combination of both interventions, and one of which serves as the control group, we are able to compare the effects of both single interventions as well as to identify the additional effect of stacking the two interventions.

# 2 Theoretical underpinnings

Referring to Wolstenholme et al. (2021), we base the design of our study on the theory of planned behavior (Ajzen, 1991), the transtheoretical model (Rotter, 1966), and meat-eater identity.

The theory of planned behavior (Ajzen, 1991) seeks to predict and explain an individual's behavior by her intentions and perceived behavioral control. The intention to perform a certain behavior in turn depends on own attitudes towards this behavior, on subjective norms, as well as on perceived behavioral control. In contrast to locus of control (Rotter, 1966), a construct measuring an individual's general perceived control over her life, perceived behavioral control refers to the perceived ability to perform a single specific behavior (Ajzen, 1991).

"Stage of change" is a concept derived from the transtheoretical model, a model of

behavioral change that integrates "processes and principles of change from different theories of intervention" (Prochaska & Velicer, 1997). It comprises six stages of behavioral change: precontemplation, contemplation, preparation, action, maintenance, and termination. In the precontemplation stage, individuals have no intentions to change their behavior, while in the contemplation stage they are considering it. In the preparation and action stage, respectively, individuals prepare for or already start taking actions. In the maintenance stage, they try to avoid falling back into old behavioral patterns. Finally, when having reached the termination stage, behavioral change is fully completed and the risk of relapse is virtually zero. The termination stage is less relevant in practice as it is more an ideal end point than a realistic goal. In the long run, interventions tend to be more successful if they are tailored to an individual's stage of change (Prochaska & Velicer, 1997).

Wolstenholme et al. (2021) extend the theory of planned behavior by including meat-eater identity as a predictor of attitude, subjective norm and perceived behavioral control, as well as of the intention to reduce meat consumption. In their analysis, they combine this model with the transtheoretical model by investigating how the relationships between meat-eater identity, attitudes, subjective norm, perceived behavioral control and intention vary between the different stages of change.

# 3 Experimental Design

With our study we aim at investigating whether we can decrease the participants' meat consumption by informing them about the positive effects of a reduction in meat consumption on the climate and the environment, as well as by providing them with recipes and other supportive information.

To this end, we conduct a survey among 3,000 individuals and elicit the meat consumption of meat-eaters using a food-frequency questionnaire. In particular, we ask survey participants how many portions of meat they ate in the past four weeks. To

reduce recall bias, we subdivide the food-frequency questionnaire into 9 categories. These categories are:

1. Cold cuts, sausage spread, ham (cubes) and the like
2. Bratwurst, boiled sausage and the like
3. Schnitzel, steak and the like
4. Poultry
5. Doner kebab, gyros, burgers and similar dishes with meat or sausage
6. Pizza, pide, quiche and similar dishes with meat or sausage
7. Mixed dishes like salads, soups or rice dishes with meat or sausage
8. Snacks with meat or sausage
9. Fish and seafood.

For each category, we provide examples as well as pictures depicting the size of one portion in the respective category. In addition, we elicit the extensive margin of meat consumption by asking how many of their meals in the previous week contained meat.

Furthermore, we ask several questions on the participants' intentions, attitudes and motives with respect to a reduction in meat consumption. In particular, based on Wolstenholme et al. (2021) we elicit the participants' stage of change, intention, attitude, perceived behavioral control, subjective norm, and meat-eater identity. We also ask participants about their perceived descriptive and injunctive norm regarding meat-eating, the reasons for their reduction in meat consumption as well as about reasons/problems that prevent them from reducing their consumption. To analyze well-being, we ask participants whether they are satisfied with their current diet, and whether they think that their diet is environmentally friendly and healthy.

For our experiment, we introduce three treatments that aim at reducing the participants' meat consumption. We use a question on eating habits to exclude the study participants who do not eat meat from our experiment.

We then randomize the remaining participants into four experimental groups: the three treatment groups 'Information', 'Support', 'Information + Support', and a control group. While participants assigned to the control group do not receive any treatment, participants in the treatment groups receive newsletters which are supposed to motivate them to reduce their meat consumption. Over a period of about 4 months, starting at the end of the baseline survey period, each participant receives eight newsletters via email, one newsletter every two weeks.

Newsletters for the group 'Information' provide information on the positive effects of a reduction in meat consumption on climate and the environment. Newsletters for the group 'Support' provide several recipes for vegetarian dishes as well as tips that may help to reduce meat consumption. The group 'Information + Support' receives a combination of both newsletters.

At the end of the questionnaire, we inform participants that, in the context of our research project, we aim at investigating eating habits over time, and will therefore invite them to three short follow-up studies in the next months. Additionally, we inform them that in our research project we are designing several newsletters on a climate and environmentally friendly diet. To disguise that we use these newsletters to treat the participants, we tell them that we are highly interested in their opinion about the newsletters, which they can state in the follow-up surveys. We then ask them whether they agree to receive the newsletters via email.

In the emails we remind participants of their agreement to receive the eight newsletters, and ask them to have a close look at the attached newsletter because we are highly interested in their opinion. We then show a preview of the newsletter and participants have to click on the picture or the link below to open the newsletter in their

web browser. At the bottom of the e-mail, we provide the opportunity to opt out of receiving further newsletters via email.

To analyze the effect of our interventions both in the short and in the long run, we elicit the meat consumption approximately one month, four months, seven months and one year after the baseline survey. When filling in the survey for the one-month follow-up, the treatment groups have already received the first two newsletters. The four-months follow-up will take place immediately after the treatment is completed. The seven-months follow-up is three months after the end of the treatment and the last follow-up is about eight months after the end of the treatment.

Besides the questions on meat consumption, in the follow-up surveys we will, among others, also repeat the questions on the participants' stage of change, on the reasons for a reduction in their meat consumption, on the problems they had when trying to reduce their meat consumption, as well as on well-being. The repetition of these questions allows us to measure the effect of our treatments on variables related to meat consumption. Thus, even if our treatments may not reduce meat consumption, we are able to identify whether they changed the participants' intentions to do so, whether they removed some barriers of reducing meat consumption, or whether they moved individuals to a higher stage of change. Moreover, we can investigate whether the treatments affected the participants' well-being.

Additionally, to collect more information on whether participants have read the newsletters, we include questions on how many of the newsletters received since the last survey they have read, how they liked the newsletters, and whether they have tested some of the provided recipes.

# 4 Hypotheses and planned analyses

We hypothesize that the treatment groups will reduce their meat consumption more than the control group.

**Hypothesis 1:** From the baseline to the follow-ups, study participants in groups 'Information', 'Support', and 'Information + Support' will display a larger reduction in their meat consumption than group 'Control'.

Further, we anticipate that the combined treatment has an additional effect compared to only the provision of information or recipes and tips.

**Hypothesis 2:** From the baseline to the follow-ups, study participants in group 'Information + Support' will display a larger reduction in their meat consumption than group 'Information' and the group 'Support'.

To test our hypotheses and check the robustness of our results, we will use several methods including a difference-in-differences regression as well as a simple OLS regression controlling for baseline meat consumption.

Since the transtheoretical model predicts that interventions will be more successful if they match an individual's stage of change, we will conduct heterogeneity analyses of the treatment effects by stage of change. Due to sample size restrictions, we can only form three treatment groups, implying that we do not have a specifically tailored intervention for each stage of change. It is ex ante unclear which intervention will have greater impact at which stage of change. Similarly, we will conduct a heterogeneity analysis with respect to perceived injunctive and descriptive norms. We also expect treatment effects to vary over time.

In an additional analysis, we will use the model by Wolstenholme et al. (2021) to investigate the relationships between attitudes, subjective norm, perceived behavioral control, meat-eater identity, intention and behavior.

# 5 Data

Data for our survey experiment is collected by forsa, a survey institute maintaining a panel of more than 100,000 individuals who are representative of the German-speaking population aged 14 and above. The panel is recruited offline, such that each individual has the same selection probability and voluntary participation in the panel is impossible. forsa will recruit a representative sample of 3,000 adult individuals from its panel and will collect data on socioeconomic and demographic characteristics, as well as on attitudes and preferences regarding various aspects of sustainability. The data will be collected using a state-of-the-art tool that allows panelists to fill out the questionnaire online. The questionnaires are retrieved and returned from home or from mobile devices connected to the internet and the survey can be interrupted at any time. Our study involves a baseline survey and four follow-up surveys. The baseline survey will begin in the mid of July, 2022, and will take about three weeks, until the required sample size is reached. Immediately after the end of the baseline survey the first newsletter will be sent to the treatment groups. The subsequent newsletters will follow in intervals of two weeks.

The first follow-up survey is scheduled one month after the end of the baseline survey. The second follow-up will take place shortly after participants received the last newsletter, i.e., approximately four months after the baseline, and the third follow-up will be conducted roughly seven months after the baseline. The fourth and final follow-up will be part of the next wave of the panel survey, about one year after the baseline.

# 6 Power simulation

To ensure that we have enough power to test the effectiveness of two single interventions and the combination of these, we conducted a power simulation using the

program command in Stata 16.1.

Based on the per capita meat consumption in Germany 2021 of 55 kg per year (Bundesanstalt für Landwirtschaft und Ernährung, 2022) and assuming a normal distribution, we simulate various longitudinal data sets with two periods, pre and post treatment, and two experimental groups, a control group and a treatment group. In these data sets we vary the sample size, the effect size, as well as the standard deviation of meat consumption which varies between around 45% and 70% of the mean in the received literature.

We then regress monthly meat consumption on a treatment dummy using two different estimation methods: a simple OLS regression in which we control for baseline meat consumption and a difference-in-differences (DiD) regression. Using the simulate command we repeat these regressions 1,000 times for each combination of sample size, effect size, and standard deviation, and save the t-values of the estimated treatment effects. For each effect size we then identify the sample size required to identify the respective effect in a comparison of two groups with a power of 80% and a significance level of 5%, which corresponds to the sample sizes for which the absolute t-value of the estimated effect is equal to or larger than 2.8.

The following tables show the sample sizes required for pairwise comparisons of three and four experimental groups (i.e., one control group and two or three treatment groups) using an OLS regression with lagged dependent variable and a DiD regression, assuming a standard deviation of meat consumption of roughly 45% and 70% of the mean, respectively. We assume that roughly 2,000 participants will take part in our follow-up surveys. Therefore, the results of our power simulation indicate that we are able to identify an effect of $\delta = 6\%$ to $\delta = 7\%$ in case of three experimental groups, and an effect of $\delta = 7\%$ to $\delta = 8\%$ in case of four experimental groups if we assume a relatively low standard deviation of 45% and use the more efficient method of an OLS regression with lagged dependent variable. In a more pessimistic scenario with a higher standard deviation of 70% and using a DiD regression, the minimum

detectable effect is $\delta = 9\%$ to $\delta = 10\%$ in case of three groups and $\delta = 10\%$ to $\delta = 12\%$ in case of four groups. Due to the small difference in the minimum detectable effect between three and four experimental groups, we decide to use four groups, i.e., three treatment groups and one control group.

| | Required sample size for OLS with LDV | | | |
|---|---|---|---|---|
| | 3 groups | | 4 groups | |
| | $sd = 45\%$ | $sd = 70\%$ | $sd = 45\%$ | $sd = 70\%$ |
| $\delta = 0,01$ | >3000 | >3000 | >4000 | >4000 |
| $\delta = 0,05$ | >3000 | >3000 | >4000 | >4000 |
| $\delta = 0,06$ | 2250 | >3000 | 3000 | >4000 |
| $\delta = 0,07$ | 1650 | 2250 | 2200 | 3000 |
| $\delta = 0,08$ | 1350 | 1800 | 1800 | 2400 |
| $\delta = 0,09$ | 1050 | 1500 | 1400 | 2000 |
| $\delta = 0,10$ | 900 | 1200 | 1200 | 1600 |
| $\delta = 0,11$ | 750 | 1050 | 1000 | 1400 |
| $\delta = 0,12$ | 600 | 900 | 800 | 1200 |
| $\delta = 0,13$ | <600 | 750 | <800 | 1000 |
| $\delta = 0,14$ | <600 | 600 | <800 | 800 |
| $\delta = 0,15$ | <600 | <600 | <800 | <800 |

**Table 1:** Required sample size for OLS with LDV

| | Required sample size for DiD regression | | | |
|---|---|---|---|---|
| | 3 groups | | 4 groups | |
| | $sd = 45\%$ | $sd = 70\%$ | $sd = 45\%$ | $sd = 70\%$ |
| $\delta = 0,01$ | >3000 | >3000 | >4000 | >4000 |
| $\delta = 0,05$ | >3000 | >3000 | >4000 | >4000 |
| $\delta = 0,06$ | 3000 | >3000 | 4000 | >4000 |
| $\delta = 0,07$ | 2250 | >3000 | 3000 | >4000 |
| $\delta = 0,08$ | 1650 | 2850 | 2200 | 3800 |
| $\delta = 0,09$ | 1350 | 2250 | 1800 | 3000 |
| $\delta = 0,10$ | 1200 | 1800 | 1600 | 2400 |
| $\delta = 0,11$ | 900 | 1500 | 1200 | 2000 |
| $\delta = 0,12$ | 750 | 1200 | 1000 | 1600 |
| $\delta = 0,13$ | 750 | 1050 | 1000 | 1400 |
| $\delta = 0,14$ | <600 | 900 | <800 | 1200 |
| $\delta = 0,15$ | <600 | 900 | <800 | 1200 |

**Table 2:** Required sample size for DiD regression

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