Situations matter for meat consumption

A diary study of the within- and between-person associations

Patricia Wowra, Tina Joanes, Sonja Geiger, Wencke Gwozdz

Abstract

While previous research on understanding meat consumption has predominantly focused on personal factors, such as attitudes or sociodemographic characteristics, less attention has been given to the role of situational factors such as location and social setting. This study aimed to investigate such situational factors associated with meat consumption and whether they relate to meat consumption due to within-person associations (such as eating a meal with others or alone) or between-person associations (such as some individuals typically eat meals with others while other individuals typically eat alone). Finally, the role of sociodemographic characteristics for meat consumption was explored. A five-day diary study was conducted in which 230 participants recorded 2,461 meals and the corresponding situations. The results of multilevel logistic regressions indicate that meat consumption was more likely to occur when meals were eaten hungrily, together with others, and at noon or in the evening. The association of hunger and time with meat consumption was due to within-person associations, while the association of social setting with meat consumption was due to both within-person and between-person associations. No sociodemographic characteristics were associated with meat consumption. These findings have important implications for understanding meat consumption and designing effective interventions tailored to either persons or situations.

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Introduction

Meat consumption has been identified as a high-impact behavior detrimental to planetary and human health [1, 2]. The production of meat is a key driver behind the transgression of several planetary boundaries, including climate change, biochemical flows (nitrogen and phosphorous cycles), and the alteration of biosphere integrity [3, 4]. Meat consumption also has implications for human health, as its overconsumption is associated with an increased risk of developing non-communicable diseases. In particular, excessive consumption of red and processed meat has been associated with health risks such as cardiovascular diseases, cancer, diabetes, and an increased risk of mortality [5, 6]. This is especially relevant for high-income countries, where meat consumption per capita exceeds the recommendations made by national or international dietary guidelines [7]. For instance, in 2022, the average weekly meat consumption per capita in Germany was 1,000 g [8, 9]. In contrast, the German Nutrition Society (DGE) recommends an intake of no more than 300 g of meat per week, while the EAT-Lancet Commission proposed in their Planetary Health Diet an intake of no more than 200 g of meat per week [3, 10]. Hence, reducing meat consumption in high-income countries is pivotal for transitioning towards a healthier and more sustainable food system. Achieving this requires an understanding of factors that influence meat consumption.

Most prior research on meat consumption has investigated psychological factors at the level of the individual [11], including cognitive or affective factors [12, 13]. These factors have been targeted in interventions to change meat consumption (e.g., [14]). Although focusing on psychological factors is effective in changing intentions, it has proven less effective in changing and maintaining reduced meat consumption (e.g., [15]). Our present study proceeds from the premise that this ineffectiveness

can be partially attributed to the neglect of situations that impact meat consumption [16, 17].

'Situations' here are defined as 'momentary encounters with those elements of the total environment which are available to the individual at a particular time' [18]. A situation can exert a powerful influence on behavior, acting either as a predictor of behavior itself or as a facilitator or barrier to translating intentions into behavior [19]. For example, while learning about the environmental impacts of livestock may lead an individual to intend to reduce the consumption of meat products, this intention might not translate into behavior in certain situations, such as when eating at a restaurant where vegetarian options are not offered or when dining with a friend who loves to eat meat.

The role of situations in understanding and changing behavior has generally been under-investigated and under-theorized [20]. This is also true for meat consumption, as most studies are conducted in laboratory or online settings with questionable ecological validity (e.g., [21]). Even when studies are conducted in 'real life', typically only a few factors of eating situations (such as location or the presence of other people) are considered at a time and in isolation from each other (e.g., [22]). As a consequence, we lack more comprehensive assessments of eating situations. This is further exacerbated as few theories include situational factors in their frameworks or specify what these factors are, how they influence behavior, and how they interact with psychological factors (e.g., [23]). Hence, there remains a gap in our empirical understanding of how situations influence behaviors, including meat consumption.

Conceptual framework and state of research

To conceptualize eating situations, we identified six relevant situational factors based on the conceptual framework developed by Bisogni et al. [24]: hunger, mood, location, social setting, activity, and time (◆ Figure 1). Each of these factors consists of various features, e.g., 'time' can be described more precisely as '8 a.m.' or 'after waking up'. In the following, we briefly review previous literature with regard to each factor.

Hunger refers to levels of satiety. Notably, prior research has observed a discrepancy between anticipated and perceived satiety for dishes with and without meat. While the *perceived* level of satiety is similar or even higher after eating a dish with plant-based protein sources than for a dish with meat, the *anticipated* satiating effect of meat is significantly higher than in the case of meat-reduced dishes [25, 26]. This is consistent with other findings showing that meat is typically considered a central component of a 'proper' meal, with high satiating power [27, 28]. These factors may lead to higher meat consumption when people feel hungry.

Mood here refers to the affect at mealtime. In this study, our interest is in both positive and negative affect since affect has been shown to play a vital role in eating in general [29]. However, limited research has examined the links between meat consumption and positive or negative affect. Previous studies focus on the effects of stress on meat consumption, with inconclusive findings [30, 31].

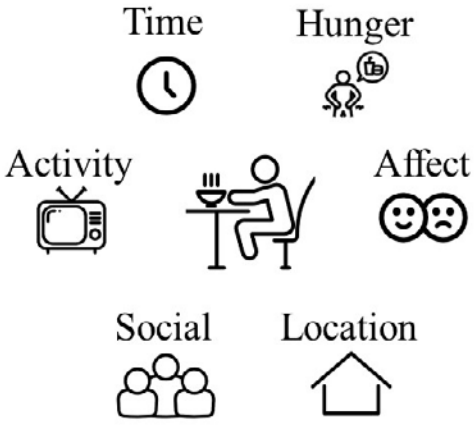

Fig. 1: **Prototypical representation of eating situations** (own presentation)

Location refers to the settings in which eating takes place. Studies found that eating out is associated with a higher likelihood and greater quantity of meat consumption, even among individuals who intend to reduce their meat consumption [32, 33].

Social setting refers to the presence or absence of others during a meal. It has been found predictive of meat consumption in former studies, with the likelihood and quantity of meat consumption increasing when eating with others [32, 33]. Besides this overall finding, meat consumption has been found to increase when eating with family members [32, 33] and to decrease when eating with strangers [34].

Activity concerns whether eating is undertaken as a stand-alone activity or simultaneously with another activity, such as watching TV or browsing the Internet. We are unaware of any prior study investigating the association between meat consumption and eating while performing other activities. While such an association has been found for other dietary behaviors such as snacking (e.g., the consumption of sweet snacks has been associated with watching TV, see [35]), it remains to be seen whether this association pertains in the case of meat consumption.

Time refers to the time of day (e.g., morning) or day of the week (e.g., Sunday). Studies found that meat is most likely consumed at noon and in the evening, however, different peak times of meat consumption are observed across countries [32, 33].

Prior research on the relationship between situation and meat consumption has tended to be unsystematic and overly narrow by only

focusing on selected situational factors. Our study addresses this gap by assessing the associations between a theory-based set of situational factors and meat consumption.

Moreover, an important aspect of this relationship is rarely assessed: whether situations are associated with meat consumption due to within-person association (e.g., eating a meal with others or alone) or between-person association (e.g., some individuals typically eat with others while others typically eat alone). For example, the *within-person association* of meat consumption and social setting reflects whether an individual is more likely to eat meat when eating with others in a given situation than when eating alone. This means that a person is more likely to eat meat during a meal when others are present, regardless of whether they typically eat alone or with their family. The *between-person association* of meat consumption and social setting reflects whether individuals who tend to eat with others are more likely to eat meat than individuals who tend to eat alone. This means that a person who typically eats with their family is more likely to eat meat, regardless of whether other people are present during a specific meal. In the current study, we take account of this by decomposing the association between situational factors and meat consumption into its within-person and between-person association. Applying this distinction enables us to identify more clearly how the eating situation influences meat consumption and whether it is situations or individuals in typical situations that matter most.

Finally, prior research has also linked meat consumption with sociodemographic characteristics such as age, gender, income, and household composition. Higher meat consumption was found to be related to younger age, men, and households without children [7, 36, 37]. The relationship between meat consumption and income varies depending on the cultural context [36, 37]. Accordingly, our study also examined the role of these sociodemographic characteristics.

In summary, we seek to address the following exploratory research questions (RQ):

RQ 1: Which situational factors are associated with meat consumption?

RQ 2: What is the relative importance of within- and between-person associations of each of the situational factors and meat consumption?

RQ 3: What role do sociodemographic characteristics play in meat consumption?

This study contributes significantly to the literature by shifting the focus from individual-level determinants of meat consumption to the situations in which meat consumption occurs. By distinguishing between within-person and between-person associations, it offers a deeper understanding of how situations are linked to meat consumption. The insights gained can be used to develop interventions that are tailored to the eating situations. Hence, this study not only broadens the field of meat consumption research but also increases the potential for practical applications in promoting healthier and more sustainable diets.

Materials and methods

Procedure

The online diary study was conducted on five consecutive days in the period January 11–15, 2021, through an online questionnaire that was available for participants to complete from 7 p.m. until noon the following day. To minimize the impact of self-selection and social desirability bias, the purpose of this study was framed neutrally. Participants were informed that the study aimed to investigate dietary behaviors of consumers, without explicitly mentioning meat consumption. The participants were instructed to fill out the questionnaire after their last meal of the day and to report their eating behaviors for that day, including how many meals they had eaten (excluding snacks), in which situations they had eaten, and whether they had eaten meat. All participants were compensated. The study was funded by Justus-Liebig-University Giessen.

Participants

The study aimed to recruit a sample of adult meat-eaters in Germany and therefore included individuals who were at least 18 years old and not following a vegetarian or vegan diet. The participants were recruited by the German market research company Aproxima via online panels using simple random sampling. Of the 481 people who started the study, 230 respondents completed all five days of the diary study, reporting a total of 2,461 meals (770 breakfasts, 794 lunches and 897 dinners)[1]. The final sample comprised 230 participants, see ◆ eSupplement Table e3 for a description.

Measures

Most variables were assessed with a single item to reduce the response time of the questionnaire.

Meat consumption as the dependent variable was measured by asking participants to identify whether the meals they ate and recorded contained meat, including dishes with processed meat such as cold cuts or Bolognese sauce with minced meat. This question was dichotomous, requiring either 'meat' or 'no meat' in response.

Hunger was assessed with the question 'How hungry were you before the meal?'. Participants could answer on a unipolar visual ana-

logue scale ranging from 0 (not at all hungry) to 100 (extremely hungry) [38]. For the analyses, the scale was divided by 10 to facilitate interpretation in the multilevel logistic models and ranged from 0 (not at all hungry) to 10 (extremely hungry).

Mood during mealtimes was assessed using the abbreviated version of the Positive and Negative Affect Schedule (PANAS) [39, 40]. It consists of two subscales with three items each, with the items 'happy', 'relaxed', and 'energized' comprising the positive affect subscale and the items 'angry', 'afraid', and 'sad' comprising the negative affect subscale. These items were rated on a 7-point scale from 1 (not at all) through 4 (moderately) to 7 (extremely).

Location was determined with the question 'Where did you eat the meal?'. The responses were dichotomized into 'home' or 'elsewhere'.

Social setting[2] was measured with the question 'Were other people present during the meal?'. The response options were dichotomous, either 'with others' or 'alone'.

Activity was assessed with the question 'Did you do anything else besides eating?', with examples of activities including watching TV, working, or surfing the Internet. The participants could answer either 'with activity' or 'without activity'.

Time was measured via a drop-down menu which was divided into one-hour intervals. Since preliminary analysis revealed three peaks of meal consumption during the day, we transformed this variable into a categorical variable with three values: 'morning', 'noon', and 'evening'.

The **sociodemographic characteristics** we assessed comprised age (in years), gender (female vs. male), employment status (in four categories: full-time, part-time, in education, non-working), net monthly household income (in five categories: < 450 €, 450–< 1,500 €, 1,500–< 2,500 €, 2,500–< 4,000 €, and ≥ 4,000 €), whether children or other adults lived in the household. These sociodemographic characteristics were recorded on the first day of the study.

Levels	Variables
2 = person	age, gender, employment status, income, children and adults in the household
1 = meal	hunger, positive affect, negative affect, location, social setting, activity, time
	DV: meat consumption

Tab. 1: **Multilevel structure and variables assessed at each level**
DV = dependent variable

Statistical analyses

All statistical analyses were performed using RStudio (Version 4.0.2). Given the binary nature of the dependent variable and the nested structure of the data, with meals (level 1) nested in persons (level 2), two-level logistic models were fitted[3]. The multilevel structure of this study and the variables examined at each level are displayed in ◆ Table 1.

A two-level logistic model was fitted for each RQ with different predictor variables. All models were fitted with random intercepts and fixed slopes, i.e., each person's intercept could vary, while the slopes of the independent variables were fixed across individuals. Odds Ratios (OR) and associated 95% Confidence Intervals (95% CIs) were estimated.

Null Model: First, a null model (without predictors) was estimated (Akaike information criterion [AIC] = 3150.86, Log-likelihood = –1574.43). This model was used to estimate the intraclass correlation coefficient (ICC), which quantifies the percentage of the observed variance in meat consumption that can be attributed to between-person differences. As indicated in the ICC, 31% of the variability in the odds of eating meat could be explained by between-person differences. The Null Model therefore confirmed the necessity of the multilevel structure.

Model 1: To examine the association between situational factors and meat consumption (RQ 1), a model was fitted with all the situational factors (level-1 variables) uncentered, i.e., each factor containing both their within- and between-variations.

Model 2: To further investigate the decomposed effects of the situational factors (RQ 2), a model was fitted in which each situational factor was decomposed into its between-person and within-person variation. This was accomplished by creating two variables for each situational factor to account for the respective variation.

[1] In attrition analyses, we found differences between participants who completed all five days and those who dropped out regarding sociodemographic characteristics and meat consumption on the first day (◆ eSupplement Table e1 and e2). For a discussion of these implications, see Limitations and future research.

[2] Additionally, we incorporated another cue of social setting that measured whether other people present also ate meat. The participants could answer with either 'the other person(s) ate meat', 'the other person(s) did not eat meat', 'some of the other people ate meat' and 'do not know if the other person(s) ate meat'. While this second social cue was not included in the models to ensure equal weight of each situational dimension in the analysis, it was employed in a supplementary analysis to investigate whether meat consumption was more likely when others also ate meat (◆ eSupplement Table e4).

[3] A prior analysis checked if a 3-level structure with meals (level 1) nested in days (level 2) nested in persons (level 3) was necessary. Since the variance of the day-level was close to zero (= 0.0037), two-level models were fitted.

For the between-person variation, each situational factor was averaged per person (also called a 'cluster mean'; see [41] or [42]), reflecting differences between persons, e.g., that some people typically eat out more often than others. For the within-person variation, each situational factor was centered around the respective person's average (also called 'centered within cluster'; see [41] or [42]), reflecting situational differences within an individual, e.g., being hungrier at one meal than at another. In this way, we constructed a model separating situational factors into their within- and between-person variation.

Model 3: Finally, we examined the role of sociodemographic characteristics (level-2 variables) for meat consumption (RQ 3). For this purpose, Model 2 was extended to include sociodemographic characteristics (age, gender, employment status, income, children, and adults in the household). Age was grand mean-centered, while the other sociodemographic characteristics were included as uncentered variables in the model.

Results

For a descriptive overview of the situational factors, both uncentered and decomposed into their within-person and between-person variation, see ◆ eSupplement Table e5. All of the fitted models can be found in ◆ Table 2.

Which situational factors are associated with meat consumption?

To assess the association between situational factors and meat consumption, we fitted a two-level logistic model without centering the situational factors, see Model 1 in ◆ Table 2. The following situational factors were associated with meat consumption: hunger, social setting, activity, and time. The odds of eating meat increased by 1.12 (OR = 1.12; 95% CI: 1.05–1.19) when hunger increased by one unit. The odds of eating meat were 1.99 times higher (OR = 1.99; 95% CI: 1.55–2.56) when other people were present during a meal than when eating alone. The odds of eating meat while engaged in other activities were 1.31 times higher (OR = 1.31; 95% CI: 1.02–1.68) than when not doing anything besides eating. In terms of time, the odds of eating meat at noon or in the evening were 2.96 or 3.40 times higher (at noon: OR = 2.96; 95% CI: 2.28–3.83; in the evening: OR = 3.40; 95% CI: 2.64–4.38) than in the morning. These results suggest that eating meat was more likely when hungry, eating with others, doing something besides eating, and eating at noon or in the evening.

What is the relative importance of within- and between-person associations of each situational factor and meat consumption?

To investigate the association between situational factors and meat consumption in more depth, we decomposed the situational factors into their within- and between-person variations, see Model 2 in ◆ Table 2. The associations between hunger and meat consumption as well as time and meat consumption were purely within-person. Thus, within a given person, the odds of eating meat increased on average by 1.14 (OR = 1.14; 95% CI: 1.06–1.22) when hunger increased by one unit. Meals eaten at noon and in the evening on average had 3.04 or 3.47 times the odds of containing meat (at noon: OR = 3.04; 95% CI: 2.33–3.96; in the evening: OR = 3.47; 95% CI: 2.68–4.50) than meals in the morning. We found no statistically significant association between the between-person variables of hunger and time with meat consumption. This suggests differences between individuals in general hunger levels and eating times were not associated with the likelihood of consuming meat. In other words, our findings indicate that meat consumption did not differ between individuals who typically experience more hunger than others or between people who typically eat most of their meals during later times of the day.

Social setting was associated with a higher likelihood of meat consumption both within- and between-person. The within-person association indicated, that within a given person, on average, eating a meal with other people resulted in 1.93 times greater odds of eating meat (OR = 1.93; 95% CI: 1.45–2.56) than eating alone. The between-person association indicated that a person who ate all their meals with other people would on average have 2.24 times higher odds of eating meat (OR = 2.24; 95% CI: 1.30–3.88) than a person who eats all their meals alone. This suggests that situational and individual differences in social setting were associated with the likelihood of eating meat. In other words, our findings indicate that meat consumption was more likely in situations when other people were present, and for individuals who typically ate with others. Although engaging in another activity while eating was positively associated with meat consumption in the uncentered model (Model 1), we found no association when differentiating between within- and between-person. The remaining situational factors (positive and negative affect as well as location) were not associated with meat consumption either within-person or between-person.

These findings show that eating meat is more likely in a situation when one is hungry, rather than for individuals who typically feel hungrier than others. Eating meat is also more likely in a situation where meals are eaten at lunchtime and in the evening, rather than for

	Model 1 (N_{Meals} = 2,461, N_{ID} = 230)		Model 2 (N_{Meals} = 2,461, N_{ID} = 230)		Model 3 (N_{Meals} = 2,461, N_{ID} = 230)	
Situational factors	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Hunger						
uncentered	1.12***	1.05–1.19				
within-person			1.14***	1.06–1.22	1.14***	1.06–1.22
between-person			1.04	0.90–1.19	1.05	0.91–1.22
Positive affect						
uncentered	0.96	0.85–1.07				
within-person			0.96	0.84–1.09	0.96	0.84–1.09
between-person			0.99	0.79–1.24	0.93	0.74–1.17
Negative affect						
uncentered	0.99	0.88–1.11				
within-person			0.98	0.85–1.13	0.98	0.85–1.13
between-person			1.02	0.83–1.26	0.96	0.77–1.19
Location	reference = home					
uncentered	1.09	0.79–1.52				
within-person			1.03	0.73–1.46	1.04	0.73–1.47
between-person			1.70	0.65–4.44	2.11	0.74–5.99
Social	reference = alone					
uncentered	1.99***	1.55–2.56				
within-person			1.93***	1.45–2.56	1.93***	1.45–2.56
between-person			2.24**	1.30–3.88	1.89*	1.01–3.55
Activity	reference = without activity					
uncentered	1.31*	1.02–1.68				
within-person			1.28	0.97–1.70	1.28	0.96–1.70
between-person			1.39	0.82–2.36	1.37	0.81–2.32
Time: noon	reference = morning					
uncentered	2.96***	2.28–3.83				
within-person			3.04***	2.33–3.96	3.04***	2.33–3.97
between-person			1.82	0.58–5.74	2.09	0.66–6.59
Time: evening	reference = morning					
uncentered	3.40***	2.64–4.38				
within-person			3.47***	2.68–4.50	3.48***	2.68–4.51
between-person			2.11	0.62–7.24	3.20	0.92–11.16
Sociodemographics						
Age					1.00	0.99–1.02
Gender					reference = female	
male					1.35	0.89–2.05
Employment status					reference = full-time	
part-time					1.01	0.55–1.87
in education					1.34	0.64–2.83
non-working					1.68	0.92–3.06
missing					8.11	0.41–158.78
Monthly household net-income					reference = 1,500–< 2,500€	
< 450 €					1.61	0.43–6.10
450–< 1,500 €					0.69	0.37–1.27
2,500–< 4,000 €					0.84	0.51–1.41

≥ 4,000 €					0.62	0.34–1.14
missing					1.04	0.21–5.18
Adults in the household					reference = no adults	
other adults					1.31	0.72–2.39
missing					1.43	0.50–4.09
Children in the household					reference = no children	
children					1.44	0.81–2.53
missing					0.71	0.38–1.35
Random effects						
ICC	0.34		0.33		0.32	
person-level-variance	1.71		1.66		1.52	
Model fit statistics						
AIC	2,966.32		2,978.42		2,990.21	
Log-likelihood	–1,473.16		–1,471.21		–1,464.11	
difference Log-likelihood	101.27***		102.2***		109.32***	
Df	8		16		29	

Tab. 2: **Overview of all the fitted two-level logistic models**
AIC: Akaike Information Criterion (measure for model evaluation); 95% CI: 95% Confidence Interval; Df: degrees of freedom; ICC: Intraclass Correlation Coefficient (measure of the proportion of total variance explained by differences between individuals); Log-Likelihood: measure for evaluating the model quality; N_{ID}: number of participants; N_{Meals}: number of meals; OR: Odds Ratio
The Null Model served as a baseline model without predictors, Model 1 was fitted with all the situational factors (level-1 variables) uncentered, Model 2 was fitted with each situational factor decomposed into its between-person and within-person variation, Model 3 extended Model 2 by including sociodemographic characteristics; Model comparison: Model 1, 2 and 3 were compared against the Null Model (ICC = 0.31; person-level variance = 1.44; AIC = 3150.86; Log-likelihood = –1,574.43). *** p < 0.001, ** p < 0.01, * p < 0.05

individuals who typically eat at these times. Additionally, eating meat is more likely in a situation when one eats with others, as well as for individuals who typically eat with others. ◆ Figure 2 illustrates which situational factors were associated with meat consumption (Model 1) and how each association can be decomposed into its respective within- and between-person association (Model 2).

What role do sociodemographic characteristics play in meat consumption?

Finally, to account for sociodemographic characteristics, we extended the model by age, gender, employment status, income, and children and adults in the household, see Model 3 in ◆ Table 2. The associations between the situational factors and meat consumption remained similar to those in Model 2. However, none of the sociodemographic characteristics were associated with meat consumption, which suggests that the likelihood of meat consumption did not differ by sociodemographic characteristics[4].

Discussion

This exploratory study has examined the relationship between eating situations and meat consumption, focusing on 1) situational factors associated with meat consumption, 2) the relative importance of within- and between-person association of the situational factors and 3) the role of sociodemographic characteristics. Our results show that 1) hunger, advanced time (noon or evening), the presence of other people, and engaging in a second activity while eating were associated with an increased likelihood of eating meat. These results for time and social setting are consistent with findings in previous literature, whereas the results for hunger and activity have not previously been shown. We further investigated 2) whether the associations between the situational factors and meat consumption can be attributed to situational (within-person) or individual (between-person) differences. For hunger and time, the results were due to within-person and not between-person association, i.e., they were an effect of the situation (e.g., momentary hunger) and not the person (e.g., some people being hungrier than others). Social setting was the only situational factor associated with meat consumption both within- and between-person, since both the social setting in a given eating situation and the

[4] We also fitted a model using only the sociodemographic characteristics and no situational dimensions. Again, we found that no sociodemographic characteristics were associated with meat consumption.

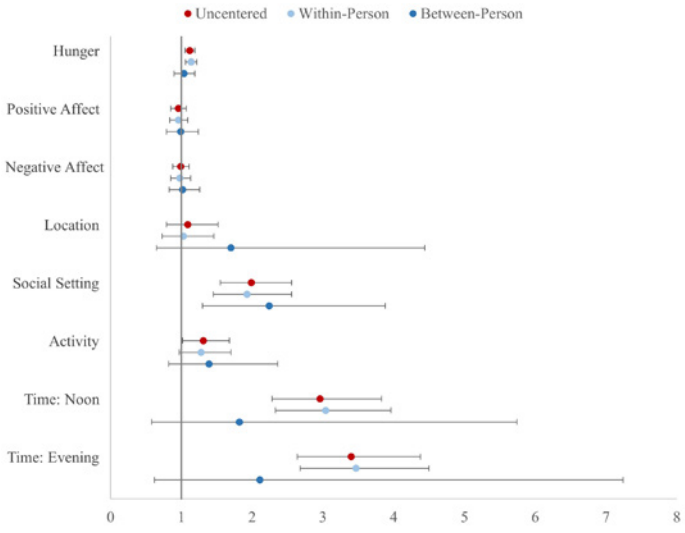

Fig. 2: **Odds Ratios** (OR) **for association of meat consumption and situational factors based on logistic multilevel models**
OR with respective 95% Confidence Interval for meat consumption. Situational factors are either presented uncentered (Model 1) or decomposed into their respective within- and between-person variation (Model 2).

social setting a person typically eats in played a role in meat consumption. Contrary to previous research, 3) no sociodemographic characteristics were related to the likelihood of meat consumption. In summary, our findings highlight the importance of eating situations for meat consumption, especially situational differences, compared to individual differences and sociodemographic characteristics.

Below we present possible explanations for our findings and suggest leverage points for interventions to address each situational factor (hunger, time, social setting, and activity) with its respective association (within- vs. between-person). It should be emphasized that our findings are primarily descriptive and hence cannot confirm causality, meaning we cannot state, for example, that hunger causes greater meat consumption.

Explanation of findings and leverage points for interventions

Hunger: Our study identified hunger as an important situational factor for meat consumption. The association between meat consumption and hunger was due to within-person association, i.e., the hungrier a person was in a situation, the higher the likelihood of eating meat during a meal. These results must be interpreted in the context of the sample, which includes only individuals who eat meat, so we cannot determine whether they hold true for vegetarians or vegans. Nonetheless, our findings align with previous research that has found people anticipate meatless dishes to be less satiating compared to dishes with meat [26, 25], meaning our results could be moderated by beliefs that vegetarian meals are less satiating than meals with meat [28]. Accordingly, interventions to reduce meat consumption could aim to change beliefs about the satiety of vegetarian meals. For instance, advertising filling and hearty vegetarian dishes as such could impact food choices when people are hungry in a given eating situation [43]. In addition, interventions could focus on ensuring the availability of satiating vegetarian meals in restaurants and canteens. While previous interventions have shown that increasing the availability of vegetarian meals and increasing the distance between vegetarian and non-vegetarian meals are effective ways to reduce meat consumption [22, 44], our results suggest that such interventions could be further augmented by focusing specifically on satiating vegetarian meals rather than just any vegetarian meals, e.g., spaghetti with soy Bolognese sauce rather than vegetarian salads.

Time: Consistent with previous research findings, our study found time to be associated with meat consumption, with meat being more likely to be consumed at noon and in the evening compared to in the morning. Again, this was due to the within-person association of time with meat consumption, i.e., the actual times at which people ate their meals rather than people tending to eat all their meals later in the day. One potential explanation for this association is that cultural norms may dictate the composition of dishes for different meal types (breakfast, lunch, and dinner). In Western societies, many people perceive meat as an integral part of a proper lunch and dinner, which is reflected in popular and traditional recipes [45]. To facilitate the transition to a meat-reduced diet while preserving such recipes, meat could be replaced or blended with plant-based meat alternatives in traditional lunch or dinner dishes. Additionally, efforts could be undertaken to shift norms towards a new definition of what constitutes a 'proper' lunch and dinner. These efforts could include governments issuing national dietary guidelines recommending less meat, restaurants and canteens offering more vegetarian lunches and dinners or reducing portions of meat while increasing portions of vegetables; and celebrities or athletes acting as role models by promoting vegetarian meals as proper lunch and dinner meals [46, 47].

Social Setting: Social setting was the only situational factor significantly associated with meat consumption within-person and between-person, i.e., meat consumption was more likely both when other people were present in an eating situation than when eating alone and among individuals who, on average, ate more meals with others than alone. Interventions targeting social settings could

thus focus on eating situations where meals are eaten with others (within-person) and on individuals who typically eat with others (between-person).

The within-person association between social setting and meat consumption could be due to preparing and sharing the same meal when eating together. These results align with previous research that identified the convenience of preparing the same meal when eating with others as a driver of meat consumption [48]. Similarly, it could be mediated by a widespread perception that meat is an integral part of an appropriate meal when eating with guests [32, 27]. Another explanation for the within-person association could be social modeling effects in the eating situation whereby people use the behavior of others as a guide for their behavior [49]. Since the majority of people worldwide consume meat, eating with others could tilt a person's food choice toward meat consumption. This notion is supported by the supplementary analysis, which examined the association between meat consumption and whether other people ate meat in the situation (◆ eSupplement Table e4). The supplementary analysis indicates that meat consumption was more likely when others ate meat than when they did not. Interventions could also take advantage of these social modeling processes. For example, communication strategies could draw attention to others' behavior by pointing out the vegetarian choices of other customers, or by emphasizing that only a limited number of vegetarian options remain [49, 50].

Regarding the between-person association between social setting and meat consumption, this association may result from people within a social network following similar diets. For example, studies have found that committed meat-eaters tend to have fewer vegetarians in their social networks (household, family, and friends) compared to non-committed meat-eaters and vegetarians [51]. It is likely that individuals who typically eat with others from their social network feel they have to adjust their own food choices to meet the needs of others, e.g., in deciding what to cook for a family or which restaurants to go to when eating out with friends, thereby potentially locking in dietary behaviors, including how often or how much meat they consume. However, since individuals can have a far-reaching impact on their social network, interventions to address this between-person association between meat consumption and social setting could target meat-eaters within a social network of other meat-eaters. This could be done by offering cooking classes for couples and families or by targeting people who host meals, encouraging them to act as role models by serving vegetarian meals to their guests [52].

Despite a large body of research on the social factor of meat consumption, prior studies have not distinguished or ascertained whether findings regarding this factor are due to situational (within-person) or individual (between-person) differences. Our results suggest this is an important distinction that should be applied in future studies, not least because it entails different implications for intervention research. Specifically, future research could focus on whether a specific meal or meals in general are eaten with others, the types of relationship the individual has with others present at meals and the dietary habits and identities of those present.

We recognize that the proposed strategies to address the within- and between-person association of social setting may not exclusively influence each association but can also have positive spillover effects. For example, if new social norms are established as to what is appropriate to eat with guests as a strategy for within-person association, these norms may further extend into a social network and change the dietary behaviors of individuals who typically eat with others (between-person effect) [53]. Similarly, targeting individuals who typically eat with others as a strategy for addressing the between-person association will most likely affect the dietary choices of these co-eaters present in a given eating situation (within-person effect) [54]. We thus consider social setting to be a promising leverage point for interventions to reduce meat consumption since individuals can act as multipliers and role models in situations and within their networks, which could lead to cultural and lifestyle changes on a larger scale [49].

Activity: Finally, we conclude that there is inconclusive evidence for a link between meat consumption and engaging in a secondary activity while eating. Although there was a significant, albeit small, association between activity and meat consumption, no effect was found when activity was decomposed into its within- and between-person variation. Further work is required to deepen our understanding of what specific activities individuals are engaged in while eating meat.

Limitations and future research

Notwithstanding the valuable insights yielded by our research into situational influences on meat consumption, this study has several limitations. First, data were collected in January 2021 at the height of restrictions related to the COVID-19 pandemic, which resulted in major disruptions of normal eating routines [55, 56]. In Germany, there was a notable increase in self-prepared meals [55, 57] and a shift towards primarily eating at home due to the closure of restaurants and physical workplaces [56]. Additionally, there has been an increase in the frequency of communal meals. Caution is therefore advised when interpreting and generalizing these results.

Another limitation relates to potential biases in the final sample, which may be attributed

to the non-representative sample (underrepresentation of women [58]) and that is further skewed due to potentially biased attrition (higher dropout rates among frequent meat eaters). To reduce this bias, future research could use representative samples and reduce the self-selection bias by incorporating other food categories to conceal the study's specific purpose.

A third possible limitation relates to the role of sociodemographic factors in meat consumption. Unlike previous research, our study detected no significant differences in meat consumption among our participants in terms of their sociodemographic characteristics. These null findings may be due to methodological limitations such as using a non-representative sample or excluding individuals following a vegetarian or vegan diet, but they could be attributed to the difference in our measurement of meat consumption (quantity vs. frequency). Future research could endeavor to capture both the frequency and quantity of meat consumption to provide a more comprehensive picture of both aspects.

Furthermore, each situational factor was conceptualized by one feature (e.g., social setting was dichotomized into 'alone' vs. 'others present'). Future research could include more features to conceptualize situational factors in more detail (e.g., social setting could be further described by the gender of the people present and their relationship to the person eating [33]).

As a promising avenue for future research, the combined role of situational factors such as hunger and time, sociodemographic factors such as gender and age, and psychological influences such as intention and values on meat consumption is yet to be determined. Investigating the degree to which these are interrelated and how they interact would provide us with a more comprehensive understanding of the underlying mechanisms that drive behavior [59]. Future research could investigate interactions such as sociodemographic characteristics that determine in which situations individuals eat meat, situational variables that hinder people from implementing their intentions, or individuals selecting eating situations according to their goals [60]. In short, our study indicates that future research would benefit from a better understanding of situation-person interactions.

Conclusion

Our diary study underscores the importance of situational influences on eating behavior, particularly meat consumption, and contributes to the ongoing efforts to design more effective interventions to reduce meat consumption. Our results suggest that future research should focus not only on *who* eats meat but also *when*, *with whom*, *how hungry* they are when eating, and *what* people do while eating. While acknowledging the importance of tailoring interventions to specific sociodemographic groups, we contend it may be equally important to identify meat-specific eating situations and tailor interventions accordingly.

Disclosures on Conflicts of Interest and the use of AI
The authors declare that there is no conflict of interest. AI was used for language optimization.

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