University of Mannheim

School of Social Sciences

Department of Psychology

The Family Meal Potential:

Routines and Family Members Fostering Nutritional Health

Vanessa Knobl

Inaugural dissertation

submitted in partial fulfillment of the requirements

for the degree Doctor of Social Sciences

at the University of Mannheim

Supervisors:	Prof. Dr. Jutta Mata
	Prof. Dr. Sabine Sonnentag
Evaluators:	Prof. Dr. Sabine Sonnentag
	Prof. Dr. Theda Radtke
Dean:	Dr. Julian Dierkes
Date of Defense:	March 12, 2025

sharing a meal means

nourishing my body while

learning from your thoughts.

Table of Contents

Contributions Based on This Dissertation

This dissertation contains a research program that has been published or prepared for publication as follows:

Dallacker, M., **Knobl, V**., Hertwig, R., & Mata, J. (2023). Effect of longer family meals on children's fruit and vegetable intake: A randomized clinical trial. *JAMA network open*, *6*(4), e236331-e236331. https://doi.org/10.1001/jamanetworkopen.2023.6331

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2022). Happy and healthy: How family mealtime routines relate to child nutritional health. *Appetite*, *171*, Article 105939. https://doi.org/10.1016/j.appet.2022.105939

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2024). *Do parents' estimates of sugar, salt, and fat relate to family health?* [Manuscript submitted for publication].

Knobl, V., & Mata, J. (2024). Intersecting perspectives: Advocating for sustainable family meals across generations. *Appetite*, *201*, Article 107618. https://doi.org/10.1016/j.appet.2024.107618

Mata, J., **Knobl, V.**, & Takezawa, M. (2025). Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption. *Appetite*, Article 107916. https://doi.org/10.1016/j.appet.2025.107916

Summary

Frequent family meals are positively associated with children's nutritional health. Thus, they represent a critical dietary environment for the prevention of non-communicable diseases such as obesity. Beyond meal frequency, the way *how* families eat together and plan such meals also appear to be highly important for nutritional health outcomes. This dissertation examines the role of family mealtime routines, parental influence as nutritional gatekeepers and role models, and children's food preferences in shaping the nutritional health of families. To address these research questions, I examined associations between key steps of the family meal process (planning, purchasing, preparing and eating meals) and the nutritional health of both children and parents, utilizing diverse methodological approaches and outcomes, particularly emphasizing family meals as social environments and children as active agents.

In Manuscripts 1 and 2, we examined how mealtime routines influence children's fruit and vegetable intake. In Manuscript 1, 50 parent-child dyads attended two laboratory dinners to test the causal effects of meal duration on children's dietary intake. One session matched their typical family mealtime duration; the other extended it by 50%. Results showed that longer meals led to significantly higher fruit and vegetable intake in children but not increased consumption of bread or cold cuts.

In Manuscript 2, we assessed the role of mealtime routines in daily family life, their interrelations, and their predictive effects on children's nutritional health. Over seven days, 310 parents reported on their daily family meal. Results confirmed consistent reporting of key routines, such as a positive atmosphere and avoidance of TV or smartphone use, across most meals. Weak intercorrelations among the seven routines suggested they represent distinct constructs. Parental modeling and a positive atmosphere remained significant predictors of children's fruit and vegetable intake. These findings highlight the importance

of not only *how often* families eat together but also *how* they do so, emphasizing mealtime duration, atmosphere, and parental modeling as most crucial for children's nutritional health.

In Manuscript 3, we investigated how parents' knowledge of nutrient content (sugar, salt, and fat) in food products relates to their family's long-term nutritional health. A total of 508 parents, who report to be primarily responsible for meal planning, completed an at-home interview, including a questionnaire and a nutrient estimation task for nine food products. Additionally, the parent and one child were weighed and measured. Results showed that parents consistently misestimated nutrient content. General numeracy predicted more accurate salt estimations, while nutrient awareness was more relevant for sugar and fat estimations. No significant associations were found between nutrient underestimations and BMI or health conditions. These findings suggest that while parents struggle to accurately estimate nutrient levels, this (missing) knowledge alone does not exert a stable influence on health outcomes. This implies that food choices are also shaped by other factors, such as for example children's preferences, and not primarily by parental nutritional knowledge. Manuscripts 4 and 5 further explore this dynamic, focusing on the role of children's preferences in shaping healthy and sustainable family meals, with preference for meat examined as a key outcome.

In Manuscript 4, we explored generational differences in dietary preferences and their impact on family meals. Surveys of 500 adolescents and 500 adults from their parental generation assessed food-choice motives, dietary styles, and advocacy for sustainable food practices. Adolescents were three times more likely than parents to abstain from meat. Although they were not more likely than adults to advocate for reduced meat consumption at family meals, they were more likely to promote reducing other animal products and introducing plant-based options. Adolescents with strong sustainability motives, reflected in their dietary habits, were also more likely to advocate for sustainable family meals.

In Manuscript 5, we examined 57 parent-child negotiations on the amount of meat in a shared family meal in a videocall, focusing on generational influence and determinants of the amount of meat decided on. Both generations were found to have equal influence on the final meat content of the meal. However, when children were non-meat eaters or when dyads reported prior conflicts about meat consumption, they agreed on significantly less meat for the meal. These findings highlight a) the active role of children in meal planning and their potential to influence healthier, more sustainable family meals, but also b) the importance of psychological variables such as motivation, values, and behaviors over demographic affiliation.

In sum, this dissertation highlights the potential of family meals as a social eating environment for promoting children's nutritional health. Both the critical role of mealtime routines and the unique role of children as active advocates —often overlooked in previous theories—were underscored, emphasizing the need for future research and consideration in interventions. By utilizing diverse methodological approaches and examining family meals as a process from planning to eating at the table, I gained practical insights and endorse family meals as an invaluable context for fostering nutritional health in families.

.

General Introduction

In Germany, dietary recommendations for healthy eating are not met by the vast majority of children. For instance, only 14% of children aged 3 to 17 years meet the recommended intake of fruits and vegetables of 5 portions a day (Robert Koch-Institut, 2018). Additionally, their consumption of added sugars, salt, and fat exceeds the recommended maximum levels, averaging 1.5 to 3 times the advised limit (Libuda et al., 2014; Perrar et al., 2024; Remer et al., 2022). Although a growing number of adolescents in Germany are opting for a meat-free diet (Bundesministerium für Ernährung und Landwirtschaft, 2023), their average meat consumption still exceeds recommendations by 50% (Brettschneider et al., 2021).

This is especially problematic as children represent a particularly vulnerable group when it comes to nutrition-related diseases. During this critical phase of life, healthy eating habits are established that often persist into adulthood (Mahmood et al., 2021). Conversely, unhealthy eating habits in childhood increase the risk of nutrition-related diseases: Overconsumption of sugary, salty, and fatty foods as well as red meat, is linked to e.g. cardiovascular diseases, tooth decay, type 2 diabetes, and obesity (Filippini et al., 2022; Gu et al., 2023; Hooper et al., 2020; Moores et al., 2022; Santos et al., 2022). Also, these negative consequences persist into later life: Having obesity already in childhood is highly related to adult obesity and obesity-related diseases (Umer et al., 2017; Woo et al., 2020), emphasizing the importance of prevention at an early age. Those relationships between nutrition and corresponding health outcomes are referred to as the broad concept of *nutritional health* in research literature (e.g., Dallacker et al., 2018), measured through different short and long-term proxies as, for example, self-reported dietary patterns relying on dietary guidelines (e.g., *Healthy Eating Index*; Hu et al., 2020), intake of specific food, including fruit and vegetable intake (Caspi et al., 2012) or outcomes of healthy eating, such as Body Mass Index (BMI; Khanna et al., 2022).

The family environment plays a pivotal role in shaping nutritional health: Shared meals are among the most common health-related practices, with families in Germany eating together multiple times per week (Frank et al., 2019). Previous empirical evidence shows that the more frequently families eat together, the healthier the eating behaviors exhibited by children (Snuggs & Harvey, 2023). Thus, family meals present a low-threshold opportunity to foster healthy eating and prevent nutrition-related diseases. But why are they so influential?

In this dissertation, I focus on family meals as a lever for promoting healthy eating, extending our understanding of how family meals should be structured to improve children's nutritional health and the roles that family members play in fostering healthy outcomes. In the following sections, I will first review the empirical evidence for family meals and their relationship with family health. Following this, I will elaborate on the roles that parents and children play in shaping a healthy family meal. Using the Revised Family Ecological Model by Davison et al. (2013), I will explain how the assumptions in this dissertation can be theoretically justified and identify the research gaps that remain unanswered in the respective framework. Finally, I will outline my research program and provide an overview of my manuscripts, including their methodological approaches.

Family Meals and Nutritional Health

Shared meals serve a purpose beyond the mere consumption of food: They are essential for fostering relationships, strengthening emotional bonds, and creating a sense of connection among individuals (Dunbar, 2017; Woolley & Fishbach, 2017). Within the context of shared meals, family meals hold particular importance. They offer a dedicated time for family members to gather, typically once a day, to discuss their daily experiences, share their thoughts, and strengthen familial bonds (Persson Osowski & Mattsson Sydner, 2019; Robson et al., 2020).

So far, there is no consistent definition of what exactly constitutes a family meal in the literature. Definitions vary widely, particularly regarding the number of participants required and the type of meal involved. Martin-Biggers et al. (2014) provide an overview of definitions used in previous research and conclude that, in general, a family meal can be understood as an occasion where at least two family members sit together and share a meal. For the purposes of this dissertation, these family members are further specified to the combination of at least one child and at least one parent to align with the focus on children's nutritional health and the dynamics between generations.

Existing research highlights the significant health benefits associated with frequent family meals. Studies have shown that children who regularly share meals with their families tend to have a more positive body image and exhibit fewer symptoms of eating disorders (Hammons & Fiese, 2011; Ramseyer Winter et al., 2019). Additionally, family meals have been linked to greater well-being during the COVID-19 pandemic (Berge et al., 2021). Furthermore, regular family meals are associated with healthier eating decisions, such as higher fruit and vegetable intake and less consumption of sugar-sweetened beverages, as well as lower body mass index (BMI) in children (Dallacker et al., 2018b; Robson et al., 2020). Together, these findings emphasize the multifaceted benefits of shared meals for mental and physical well-being. But under which conditions are they especially beneficial?

A previous meta-analysis identified six specific mealtime routines that positively influence children's fruit and vegetable consumption, ranked by the size of their effect: A longer mealtime duration, a positive mealtime atmosphere, higher food quality, parental role modeling, turning off the television during meals, and involving children in meal preparation (Dallacker et al., 2019). Despite the growing body of research on how family meals influence nutritional health, many questions remain unanswered: While there are some initial experimental approaches for certain routines, such as manipulating the mealtime atmosphere (Fiese et al., 2015), evidence for the effect of longer meal durations—identified by Dallacker et al. (2019) as having the largest effect size—is currently limited to correlational data. Further, similar to the already established research on television use, smartphone use may represent another critical routine that could impact family meals and their outcomes (Dwyer et al., 2018; Latif et al., 2020). Also, previous studies have only examined a maximum of two routines simultaneously, raising questions about whether these routines are truly distinct constructs or whether they overlap in practice. Moreover, it remains unclear to what extent families engage in these routines in their daily lives.

To address these gaps, Manuscript 1 investigates the causal effects of mealtime duration on children's nutritional health, while Manuscript 2 explores whether families report the identified routines in their everyday lives and examines how these routines are interrelated.

Parents as Nutritional Gatekeepers

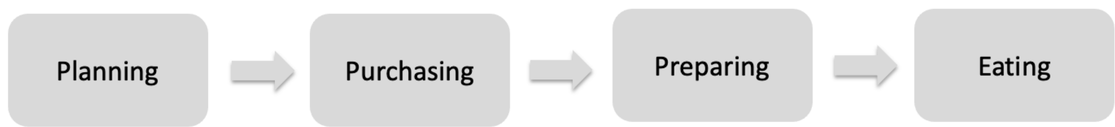
Parents play a dual role in influencing children's eating behaviors—not only as role models but also as *nutritional gatekeepers* (De Bourdeaudhuij & Van Oost, 1998): They are primarily responsible for deciding what food is available and offered to the family (e.g., Quick et al., 2018) and for ensuring that meals are healthy and balanced (Søndergaard & Edelenbos, 2007).

To fulfill their role as nutritional gatekeepers beneficially and provide a healthy, balanced diet, food knowledge is essential for parents. Research demonstrates that knowledge about food ingredients can lead to healthier purchasing decisions, such as reducing the consumption of sugar-sweetened beverages (Bleich et al., 2012). Moreover, a more accurate estimation of the sugar content in foods has been linked to lower BMI levels in adults and children (Dallacker et al., 2018a; König et al., 2019). Manuscript 3 builds on this research and aims to provide further evidence of how parental food knowledge serves as a basis for family health.

The existing research underscores that family meals involve more than just sitting down and eating together: Planning and preparing the meals and doing the groceries are also an important part of the mealtime process (Middleton et al., 2022; Perrea et al., 2012). In this dissertation, the entire process of family meals will be considered (see Figure 1). I will start with focusing on the specific behavior of eating together at the table (Manuscript 1 and 2), but also refer to preceding process steps as preparing the meal together (Manuscript 2), essential variables for purchasing healthy food products (Manuscript 3) and role of family members in planning the meal in a healthy way (Manuscript 4 and 5).

Figure 1

The Family Meal Process Steps based on Middleton et al. (2022) and Perrea et al., 2012.



Children as Active Agents

Traditional theories of cultural transmission generally assume an unidirectional flow of information and influence from parents (or older generations) to children (Cavalli-Sforza et al., 1982), largely neglecting the possibility of a bottom-up process where children influence parents. However, empirical studies suggest that such bottom-up processes are indeed possible across various domains. For instance, children can transfer technical knowledge (Watne et al., 2011) or environmental literacy (Liu et al., 2022) to parents in a process of *reverse socialization* (Gentina & Muratore, 2012). This dynamic can be extended to eating decisions as well. While parents act as nutritional gatekeepers, children often serve as influencers within the family system (Søndergaard & Edelenbos, 2007). Particularly adolescents actively contribute to the planning of family meals and can influence parental decisions by bringing home ideas from peers, school, or social media (Ayadi & Bree, 2010; Kucharczuk et al., 2022; Williams et al., 2019), participating in decisions about which restaurants to visit (Chen et al., 2016), or even challenging existing norms and rules within the family mealtime context (Persson Osowski & Mattsson Sydner, 2019).

Previous research shows that children and parents often have differing preferences regarding meal choices. When children have greater control over meal decisions, this frequently results in less healthy options, as they tend to prefer sweeter foods and carbohydrate-heavy dishes (Kümpel Nørgaard et al., 2007; McKeown & Nelson, 2018). At the same time, there is evidence that adolescents in Germany are reducing their meat consumption compared to the parental generation, reflecting a shift in dietary preferences and values (Bundesministerium für Ernährung und Landwirtschaft, 2019, 2021, 2023). A reduction in meat consumption would offer significant health benefits for individuals as well as the planet (Willet et al., 2019). Adolescents frequently state planetary health and sustainability as key motivators for their meat-reduced diets (Zühlsdorf et al., 2021), qualifying them as potential drivers of more sustainable family eating practices that simultaneously promote individual health, which raises the question: Do adolescents bring sustainability values and motivations also to the family meal table?

Manuscripts 4 and 5 address this question by exploring (1) how generations differ in their advocating for and influence on more sustainable and healthy family meals and (2) which demographical, psychological, and behavioral variables shape these influences.

Research Framework and Research Program Overview

Numerous models exist that aim to explain the relationship between family dynamics and health outcomes (Michaelson et al., 2021). This dissertation is grounded in the Revised Family Ecological Model (Davison et al., 2013), which serves as its overarching theoretical framework. This model theorizes how family processes impact childhood obesity and illustrates how various family factors (ecological, social, and emotional) affect parenting practices, which, in turn, influence children's cognitions and behaviors toward family health. For the purpose of this dissertation, particular attention is given to specific variables from the Revised Family Ecological Model (see Figure 2), which correspond to different steps of the family meal process (planning, purchasing, preparing, and eating; see Figure 1):

Family Knowledge. Knowledge about healthy food products is crucial for planning and purchasing according to a healthy and balanced diet.

Parental Behaviors and Practices. The organization of family meals provides the crucial social environment for all research collected in this dissertation. Additionally, parents providing food based on their knowledge, parents' own dietary habits as model behaviors, their use of screens at family meals as well as take-away frequency as a proxy for food quality were referred to.

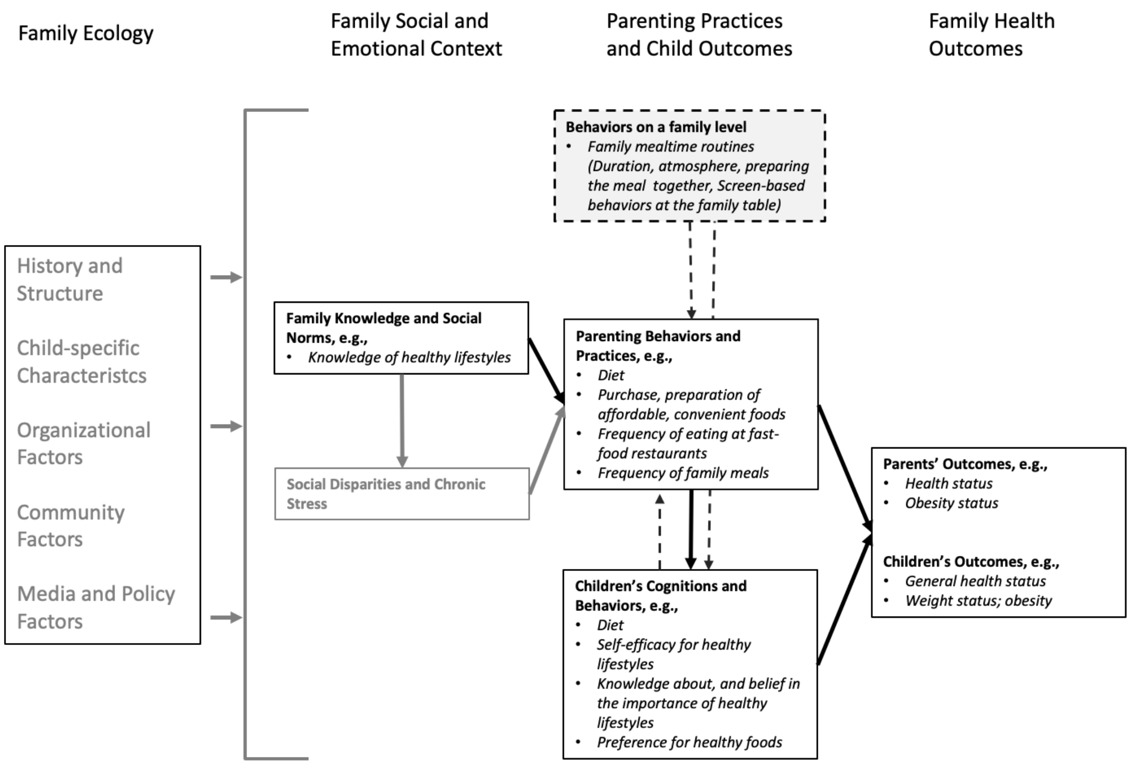
Children's Cognition and Behaviors. The primary focus is on children's diet as a short-term outcome variable, serving as a proxy for family health. Additionally, children's usage of screens at family meals are considered, as well as their preferences, self-efficacy, and knowledge as key determinants for advocating for their needs and influencing family meals in the planning process.

Family Health. Health conditions and weight status of parents and children as long-term outcome variables.

However, despite the model's claim to shift the focus from individuals to the family level, it presents some limitations. While the model includes family norms, beliefs, and knowledge, it does not explicitly address family-level behaviors and the social aspects of eating. The child is depicted as a passive recipient of influence, with no direct link of ecological, social, and emotional context factors to the child's behavior other than through the parent. Also, the model does not include a bi-directional influence, as there is no arrow indicating an influence from the child back to the parent –parallel to cultural transmission theory– which suggests a more general theoretical gap in this area. I aim to address the outlined research gaps and expand the theoretical model by investigating family meal behaviors and the active involvement of children in the family meal process (illustrated in Figure 2 by the dashed box and dashed arrows).

Figure 2

Based on the Revised Family Ecological Model by Davison et al., 2013 Including Research Gaps

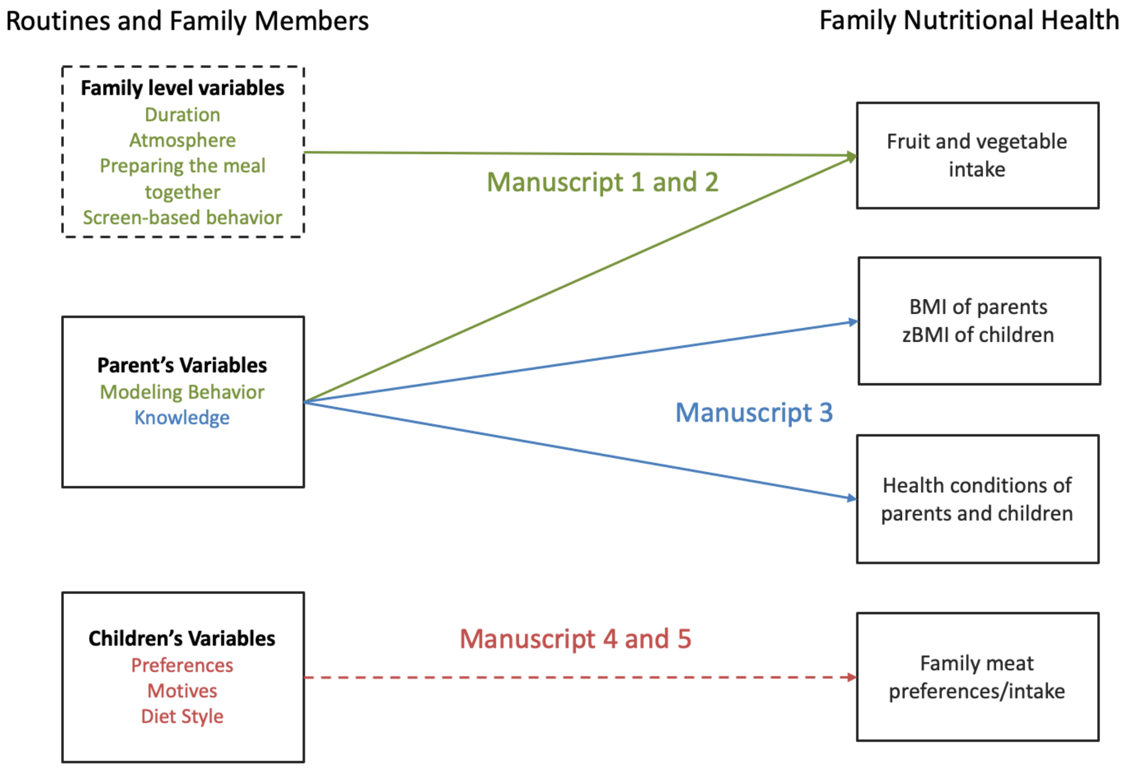


Note. This is a simplified version only including the relevant variables for this dissertation. Aspects, which are not specifically addressed in manuscripts, but are important to understand the framework, are grayed out. The dashed box and arrows are not included in the original model and are contributed as a part of this dissertation.

The research program of this dissertation aims to strengthen and expand the evidence for the existing pathways while also expanding the model to address the research gaps identified. In Manuscripts 1 and 2, we focus on the core aspect of family meals: preparing and eating the meal together. This includes variables highlighted in Figure 2, such as parents' own diet and the quality of the meal. Additionally, by emphasizing family meal routines, we incorporate behaviors that are not attributable to either parents or children alone but occur on a broader social family level (e.g., atmosphere and duration of the meal). In Manuscripts 3 ,4, and 5, we focus on the proceeding process steps in the planning of meals. In Manuscript 3, we explore the role of parents as nutritional gatekeepers, investigating how their knowledge about nutrients in food products as a basis for planning and purchasing healthy meals, impacting family nutritional health. In Manuscripts 4 and 5, we examine how adolescents can influence the eating decisions of the family. Figure 3 shows an overview of how empirical and theoretical research gaps were operationalized in the following manuscripts.

Figure 3

Research Program of this Dissertation with Predictors and Main Outcome Variables



Note. Variables highlighted in green are addressed in Manuscripts 1 and 2, variables highlighted in blue are addressed in Manuscript 3, and variables highlighted in red are addressed in Manuscripts 4 and 5. Dashed boxes and arrows label new theoretical contributions, as shown in Figure 2.

Multimethodological Approach

To comprehensively address the research questions, this dissertation employs a multimethodological approach, utilizing various study designs (survey, experiment, diary study, observational study) and quantitative as well as qualitative methods. This diversity is advantageous because all methods have inherent strengths and limitations - combining them enhances the robustness of findings. However, the choice of methods is also guided by the current state of research and the specific questions being addressed.

For Manuscript 1, building on an existing meta-analysis (Dallacker et al., 2019) that provides a solid foundation, the clear research gap regarding causality of mealtime duration on children's nutritional health is best addressed using a randomized control trial approach. To investigate the daily use of mealtime routines in families, a diary study fitted best for Manuscript 2. Manuscript 3 aims to deepen the evidence for parental knowledge as a crucial basis for family health. To achieve this, an established cross-sectional survey paradigm was adapted and refined.

In contrast, the role of children in the decision-making process is less understood and has been largely overlooked in theoretical frameworks (Michaelson et al., 2021). For this reason, a more qualitative and exploratory approach was adopted. A brief, intergenerational questionnaire administered to an access panel provided an initial overview of generational differences in dietary decisions and advocacy behaviors in Manuscript 4, while Manuscript 5 takes a more detailed dive into a single negotiation process between parents and their children. This observational data, combined with questionnaire responses, offers the granularity needed to gain an initial understanding of the intergenerational decision-making dynamics.

Additionally, the studies vary in the type of family members involved. Some studies focus exclusively on parents, particularly when the research questions pertain to their roles or when children are too young to provide reliable data (Manuscripts 2 and 3). However, to adequately capture social interactions at the family level, this dissertation includes studies with parents and adolescents representing their generation (Manuscript 4), as well as dyadic studies involving both parents and their children (Manuscripts 1 and 5). Adolescents are defined as a subgroup of children aged 10 to 24 (Sawyer et al., 2018). Therefore, I will refer to children in general as a generational group, using the term adolescents when specifically addressing participants or samples of this subgroup.

Proxy measures for nutritional health also vary between studies, fitting best to the research question I aimed to address and the design of the study: We used intake of fruits and vegetables as a short-term outcome variable when looking at specific meals in Manuscript 1 and 2, long-term measures as BMI and health conditions for the cross-sectional approach in Manuscript 3 and meat preferences/intake as a possible niche for adolescents to influence family nutritional health in manuscript 4 and 5.

Manuscript 1 - Effect of longer family meals on children's fruit and vegetable intake: A randomized clinical trial

Published Article:

Dallacker, M., **Knobl, V**., Hertwig, R., & Mata, J. (2023). Effect of longer family meals on children's fruit and vegetable intake: A randomized clinical trial. *JAMA network open*, 6(4), e236331-e236331. https://doi.org/10.1001/jamanetworkopen.2023.6331

JAMA Network Open

Original Investigation | Public Health

Effect of Longer Family Meals on Children's Fruit and Vegetable Intake
A Randomized Clinical Trial

Mattea Dallacker, PhD; Vanessa Knobl, MSc; Ralph Hertwig, PhD; Jutta Mata, PhD

Abstract

IMPORTANCE Family meals are a formative learning environment that shapes children's food choices and preferences. As such, they are an ideal setting for efforts to improve children's nutritional health.

OBJECTIVE To examine the effect of extending the duration of family meals on the fruit and vegetable intake in children.

DESIGN, SETTING, AND PARTICIPANTS This randomized clinical trial used a within-dyad manipulation design and was conducted from November 8, 2016, to May 5, 2017, in a family meal laboratory in Berlin, Germany. Included in the trial were children aged 6 to 11 years who did not follow a special diet or have food allergies and adult parents who served as the nutritional gatekeeper in the household (ie, the family member responsible for at least half of the food planning and preparation). All participants underwent 2 conditions: control, defined as regular family mealtime duration, and intervention, defined as 50% longer mealtime duration (10 minutes longer on average). Participants were randomized to the condition they would complete first. Statistical analyses of the full sample were conducted between June 2 and October 30, 2022.

INTERVENTIONS Participants had 2 free evening meals under different conditions. In the control or regular condition, each dyad ate in the same amount of time as their reported regular mealtime duration. In the intervention or longer condition, each dyad had 50% more time to eat than their reported regular mealtime duration.

MAIN OUTCOMES AND MEASURES The primary outcome was the number of pieces of fruits and vegetables eaten by the child during a meal.

RESULTS A total of 50 parent-child dyads participated in the trial. Parents had a mean (range) age of 43 (28-55 years) years and were predominantly mothers (36 [72%]). Children had a mean (range) age of 8 (6-11) years and included an equal number of girls and boys (25 [50%]). Children ate significantly more pieces of fruits (t_{49} = 2.36, P = .01; mean difference [MD], 3.32 [95% CI, 0.96 to ∞]; Cohen d = 0.33) and vegetables (t_{49} = 3.66, P < .001; MD, 4.05 [95% CI, 2.19 to ∞]; Cohen d = 0.52) in the longer condition than in the regular mealtime duration condition. Consumption of bread and cold cuts did not significantly differ between conditions. The children's eating rate (bites per minute over the regular mealtime duration) was significantly lower in the longer than in the regular condition (t_{49} = −7.60, P < .001; MD, −0.72 [95% CI, −0.56 to ∞]; Cohen d = 1.08). Children reported significantly higher satiety after the longer condition (V = 36.5, P < .001).

CONCLUSIONS AND RELEVANCE Results of this randomized clinical trial suggest that the simple, low-threshold intervention of increasing family mealtime duration by approximately 10 minutes can

(continued)

Key Points

Question How does increased family mealtime duration affect children's fruit and vegetable intake?

Findings In this randomized clinical trial of 50 parent-child dyads, children aged 6 to 11 years ate significantly more fruits and vegetables when family meals lasted approximately 10 minutes longer. Intake of other foods offered did not increase.

Meaning Findings of this trial indicate that increasing family mealtime duration is a simple, inexpensive, and low-threshold intervention that can significantly improve children's diets.

+ Visual Abstract

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Open Access. This is an open access article distributed under the terms of the CC-BY License.

Downloaded From: https://jamanetwork.com/ on 04/03/2023

Abstract (continued)

improve the quality of children's diet and eating behavior. The findings underscore the potential for such an intervention to improve public health.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT03127579

JAMA Network Open. 2023;6(4):e236331. doi:10.1001/jamanetworkopen.2023.6331

Introduction

Low fruit and vegetable intake increases the risk for chronic noncommunicable diseases.[1,2] Yet children worldwide eat considerably less fruits and vegetables than the recommended amount.[3] Family meals are central to children's nutrition, with about two-thirds of their calorie intake coming from food prepared at home[4] and most meals being eaten in the family setting.[5] Family meals thus serve as a formative learning environment that shapes the food choices and preferences of children.[6]

A meta-analysis of observational studies identified several components of family mealtimes that were associated with better nutritional health in children.[7] A longer mealtime duration was the most beneficial. This finding may seem counterintuitive considering that longer mealtimes were reported to be associated with greater food intake.[8] However, many of these studies focused on social occasions with an overabundance of festive foods[9] or longer exposure to food[10] and on adults rather than children. Everyday family meals, in contrast, are embedded in daily routines[5] and typically involve more fruits and vegetables compared with meals eaten outside the home.[11-13] As such, increasing the duration of everyday family meals may increase children's exposure to, and potentially consumption of, healthy foods. Furthermore, eating as a family may have additional (indirect) effects on children's eating behavior, including a positive mealtime atmosphere, which in turn is associated with better nutrition quality.[7] It could also prompt children to eat at a slower pace, which can enhance satiety (ie, feeling full) and reduce food intake.[14,15]

In this randomized clinical trial, we aimed to examine the effect of extending the duration of family meals on the fruit and vegetable intake in children. In terms of this primary outcome, we hypothesized that children eat more fruits and more vegetables when the regular family mealtime duration is extended. We also explored when additional fruits and vegetables were eaten and whether longer meals led to increased consumption of other foods and beverages. In terms of secondary outcomes, we hypothesized that longer family meals facilitate a more positive mealtime atmosphere, decrease eating rates, and increase satiety that, in turn, will lead to lower intake of dessert.

Methods

From November 8, 2016, to May 5, 2017, we conducted a within-dyad randomized clinical trial involving parent-child dyads, which consisted of 1 parent and 1 child aged 6 to 11 years. The Max Planck Institute for Human Development Ethics Committee approved the trial protocol (Supplement 1). Parents provided written informed consent, and children provided oral consent. We followed the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline.

Participants

Eighty parent-child dyads were recruited to participate. Of these dyads, 26 did not meet the inclusion criteria and 4 declined to participate (**Figure 1**). Included in the trial were children aged 6 to 11 years who did not follow a special diet or have food allergies and adult parents who served as the nutritional gatekeeper in the household (ie, the family member responsible for at least half of the food planning and preparation). Potential participants were contacted from a volunteer participant

Downloaded From: https://jamanetwork.com/ on 04/03/2023

database maintained at the Max Planck Institute for Human Development. Note that the preregistration stated that children between 6 and 10 years would be recruited. Due to a misunderstanding, we also recruited 1 child aged 11 years. We cannot think of any reason that this incident should affect the results and conclusions.

All participants underwent 2 mealtime conditions (control or regular and intervention or longer), but they were randomized to the condition they would complete first. The order of the 2 conditions was randomized using a block randomization procedure (AB/BA design), and the interval between conditions was 1 to 3 weeks.

Intervention

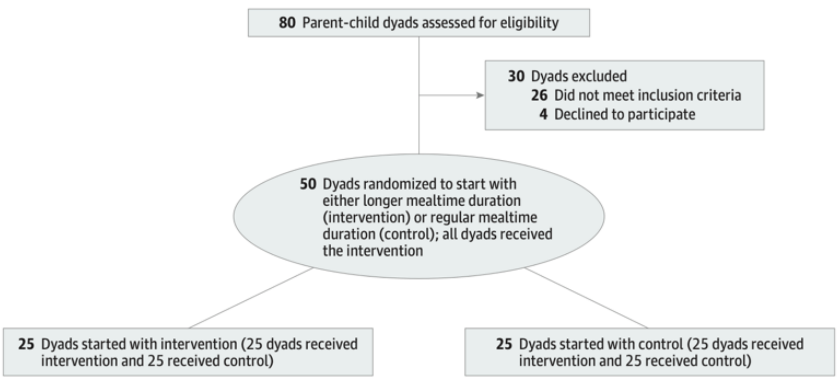
First, parents completed an online preassessment together with their children at home. Second, they were invited to the laboratory for 2 free evening meals, which took place under different conditions. In the regular condition, each dyad was given the same amount of time to finish the meal as their reported regular mealtime duration (mean [SD] reported duration, 20.83 [7.46] minutes). In the longer condition, each dyad had 50% more time than their reported regular mealtime duration (on average, 10 minutes longer).

Participants were served a typical German evening meal of sliced bread, cold cuts of cheese and meat, and bite-sized pieces of fruits and vegetables. At the end of the meal, the table was cleared and participants were offered a dessert of chocolate pudding or fruit yogurt and cookies. Water and 1 sugar-sweetened beverage were provided throughout the meal. All foods and beverages served reflected the child's preferences as reported in the online preassessment. Participants were instructed to not eat anything in the 2 hours before coming to the laboratory for the free meals. Before beginning their meal, participants were informed of the exact time the investigator would return to clear the table. For example, in the regular condition, if the family's regular mealtime duration was 20 minutes and the meal started at 6 PM, participants were informed that the investigator would return at 6:20 PM. We deliberately avoided stating that the participants had 30 (vs 20) minutes available because we did not want to draw attention to the trial objective. Poststudy inquiry showed that no participants suspected that the trial was related to mealtime duration. Third, participants completed a postmeal questionnaire on satiety and perceived mealtime atmosphere.

Trial Outcomes

Video cameras simultaneously recorded the meals from 2 angles: frontal view of the child and frontal view of the parent. The recordings were merged into 1 double-view movie and coded using Datavyu software, version 1.2.2 (Datavyu Team).[16]

Figure 1. Flow Diagram



Downloaded From: https://jamanetwork.com/ on 04/03/2023

Food consumption of the parent-child dyads was coded from the video recordings by independent coders using a standardized coding system. Key variables were the number of pieces of fruits and vegetables, the number of bread and cold cuts (ie, slices of bread, cheese, and cold cut meat; teaspoons of butter and sweet spreads), the amount of dessert (teaspoons of chocolate pudding or fruit yogurt; number of cookies), and the amount of water and sugar-sweetened beverages in milliliters (estimated to the nearest 100 mL). All participants were offered the same food and beverage categories (ie, fruits and vegetables, bread and cold cuts, dessert, and water and sugar-sweetened beverages) and serving sizes. Foods served were held constant within families across regular and longer conditions. The exact food type (eg, type of bread and type of fruit) reflected the child's preferences (eg, favorite bread and top-3 preferred fruits) that were reported in the online preassessment and thus varied between families. Due to the natural variation in the size of fruits and vegetables, it was not possible to ensure that all pieces were uniform. The weight range was 10 to 14 g for cherry tomatoes and 6 to 10 g for grapes and tangerine segments. Other fruits and vegetables (eg, apples and cucumbers) were cut into pieces weighing 9 to 11 g. Variability in size likely balanced out across conditions.

In an independent pilot study (N = 10), negative communication was not observed within dyads (Mattea Dallacker, PhD, unpublished data, 2016). We therefore measured variability between the 2 conditions in self-rated mealtime atmosphere and observed the amount of interpersonal communication. Interpersonal communication was defined as positive or neutral verbal information exchange (eg, about interests or family life), including joking and commenting on feelings or emotions, and was coded from the video recordings using a standardized system (ABC Mealtime Coding System[17]). The proportion of interpersonal communication in milliseconds compared with total mealtime was calculated as an indicator of mealtime atmosphere.[17]

The number of bites taken per minute was coded from the video recordings (see Llewellyn et al[18] for a similar procedure). Mean bites per minute were calculated by dividing the number of bites, counted in the same amount of time in both conditions (ie, regular mealtime duration), by the regular mealtime duration (in minutes). This calculation permitted us to compare the eating rate in the regular condition with the eating rate in the longer condition during the same time window.

Coding was conducted by 2 trained research assistants who were blinded to the trial objective. An independent rater coded a randomly selected 20% of the videos. Interrater reliability was high for food consumption (intraclass correlation coefficient, 0.964-0.997) and interpersonal communication (intraclass correlation coefficient, 0.934).

Demographic characteristics, family mealtime duration, and food preferences of the child were collected in the online preassessment. All participants were from Berlin, Germany; ethnicity was not assessed. Parents were asked to measure the duration of their next main family meal and to use this duration as a basis for estimating their regular mealtime duration. Children's food preferences were measured using a 5-point Likert-type scale, which was adapted from Fildes and colleagues,[19] that rated 40 food and drink items typically served at an evening meal in Germany, with 1 indicating *dislikes a lot* to 5 indicating *likes a lot*. The top-ranked items (with a score of at least 3 for *likes a bit*) were served at the laboratory meal.

After both evening meals at the laboratory, parents rated their satiety on a visual analog scale with the poles of *not hungry at all* and *extremely hungry*,[20] and they rated the atmosphere of the meal on a 5-point Likert scale of 1 indicating *very negative* to 5 indicating *very positive*.[21] Children rated their satiety using a picture rating scale.[22]

Data Preparation

To compare families whose mealtime durations differed, we converted the mealtime from minutes to percentages, with 0% to 100% of mealtime referring to the regular mealtime duration (in both regular and longer conditions) and 100% to 150% of mealtime referring to the extra time (longer condition only). Start and end times of interpersonal communication, start time of each bite, and each food consumed were exported from the Datavyu platform.

Downloaded From: https://jamanetwork.com/ on 04/03/2023

Statistical Analysis

One- or 2-sided, paired *t* tests were performed to compare food consumption in the 2 conditions. A longitudinal multilevel analysis (random slopes and fixed intercept) was conducted to explore consumption dynamics. First, we tested for both conditions and separately for fruits and vegetables whether a linear or a logarithmic curve better described cumulative consumption over time. A linear pattern would suggest that the more time children are given for eating, the more fruits and vegetables they consume at a meal, whereas a logarithmic pattern would suggest that children usually stop eating after a certain amount of time. Percentage of mealtime served as a level 1 variable, with the cumulative number of pieces of fruits and vegetables consumed as the dependent variable.

Second, we included condition as a level 2 variable in the better-fitting model. Using the cross-level interaction of the 2 independent variables, we could explore whether the increase in fruits and vegetables (primary outcomes) consumed by the end of the regular meal duration differed between conditions. We further tested for differences between conditions in the secondary outcomes: amount of interpersonal communication and eating rates (using paired *t* test) and self-rated atmosphere and satiety (using Wilcoxon signed rank test). In both groups, bites per minute in the regular mealtime duration (ie, 0%-100%) served as the dependent variable.

The statistical tests used are generally robust against violations of normal distributions in a sample with more than 30 participants. Nevertheless, we checked for violation of normal distribution using the Shapiro-Wilk test. In case of violation, we reran the analyses using nonparametric tests. In all cases, the results of the parametric and nonparametric test results were equivalent. All participants provided complete data. $P < .05$ indicated significance for all statistical tests. For 2-sided tests, we reported the upper and lower bounds of 95% CIs; for 1-sided tests, only 1 bound was reported, with the other bound being infinity. Statistical analyses of the full sample were conducted between June 2 and October 30, 2022, using R, version 3.2.3 (R Foundation for Statistical Computing).

Results

Fifty parent-child dyads participated in the trial. Parents had a mean (range) age of 43 (28-55) years and included 36 mothers (72%) and 14 fathers (28%); no participants identified as nonbinary. Children had a mean (range) age of 8 (6-11) years and included 25 girls (50%) and 25 boys (50%). Of the parents, 41 (82%) completed academic-track secondary education level. Sample size was calculated based on a meta-analysis on mealtime duration and children's nutritional health[7] using G*Power.[23] With an assumed effect size of Cohen $d = 0.4$ (power = 0.85; $\alpha = .05$), a total sample of 47 dyads was required.

Primary Outcomes

Fruit and Vegetable Consumption

As we hypothesized, children ate significantly more pieces of fruits ($t_{49} = 2.36$, $P = .01$; mean difference [MD], 3.32 [95% CI, 0.96 to ∞]; Cohen $d = 0.33$) and vegetables ($t_{49} = 3.66$, $P < .001$; MD, 4.05 [95% CI, 2.19 to ∞]; Cohen $d = 0.52$) in the longer than in the regular mealtime duration condition. The consumption of bread and cold cuts in kilocalories did not differ significantly between conditions ($t_{49} = 1.25$, $P = .22$; MD, 30.4 [95% CI, −18.28 to 79.08]; Cohen $d = 0.18$), but children drank significantly more milliliters of water ($t_{49} = 3.70$, $P < .001$; MD, 54.2 [95% CI, 24.73-83.67]; Cohen $d = 0.52$) and sugar-sweetened beverages ($t_{49} = 2.37$, $P = .02$; MD, 36.5 [95% CI, 5.53-67.47]; Cohen $d = 0.34$) in the longer condition (**Figure 2**; eTable 2 in Supplement 2). We found similar results in parents (eTable 1 in Supplement 2).

To address potential order effects of the longer condition, we descriptively examined whether the patterns of results replicated across both orders. Results were replicated for all primary outcomes. Given the high educational level among parents in the sample, we reran the analyses and

Downloaded From: https://jamanetwork.com/ on 04/03/2023

included only those children whose parents had not completed academic-track secondary education. We found equivalent results with respect to direction and effect size.

Consumption Dynamics

To explore consumption dynamics over time, we specified a linear and a logarithmic mixed model for the regular and longer conditions. For both conditions, the linear model showed a better fit for fruits (longer condition: Akaike information criterion [AIC], 37 420 vs 41 888; regular condition: AIC, 21 279 vs 25 554) and vegetables (longer condition: AIC, 29 577 vs 41 888; regular condition: AIC, 16 706 vs 19 856). eFigures 1 and 2 in Supplement 2 showed the cumulative distribution of fruits and vegetables consumed over time for each condition and for each child observed. To investigate this finding further, we included condition as a level 2 variable in the better-fitting (linear) model. For vegetables, the cross-level interaction between percentage of mealtime and condition was significantly different from 0 and there was an interaction for the longer condition (b = 0.01; P = .001). This finding means that children had already eaten more pieces of vegetables by the time their regular mealtime was over in the longer condition (ie, 100% of 150% mealtime duration) compared with the regular condition (100% of 100% mealtime duration). For fruits, a significant cross-level interaction emerged ((b = −0.01; P < .001), indicating that children had eaten fewer pieces of fruit by the end of their regular mealtime in the longer vs regular condition. Because more fruit was eaten in the longer condition, this result suggests that the additional fruit was consumed during the extra time.

Secondary Outcomes

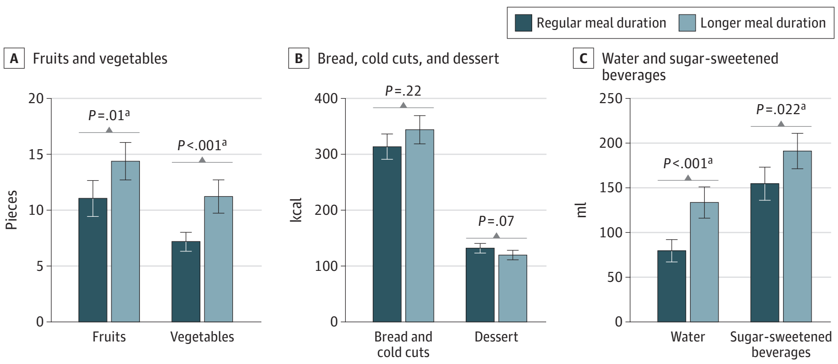
The proportion of time spent engaged in positive interpersonal communication did not differ significantly between the regular and the longer conditions (t_{49} = 1.36, P = .09; MD, 3.2 [95% CI, −0.75 to ∞). Likewise, there was no significant difference in self-rated atmosphere between the 2 conditions (V [Wilcoxon signed rank test] = 126.5, P < .71; 95% CI, −1.00 to 0.00).

Children's eating rate (bites per minute) was significantly lower in the longer than in the regular condition (t_{49} = −7.60, P < .001; MD, −0.72 [95% CI, −0.56 to ∞]; Cohen d = 1.08). Children reported significantly greater satiety in the longer than in the regular condition (V = 36.5, P < .001; 95% CI, 2.00 to ∞). However, consumption of dessert in kilocalories was not significantly lower in the longer condition (t_{49} = −1.47, P = .07; MD, −12.3 [95% CI, 1.69 to ∞]; Cohen d = 0.21).

Discussion

This randomized clinical trial found that children consumed significantly more fruits and vegetables when family meals lasted 10 minutes longer, on average. The 7 additional pieces of fruits and

Figure 2. Children's Food Consumption by Condition and Food or Beverage Category



Fruits were approximately 10 g per piece (6-10 g for grapes and tangerine segments; 10-14 g for cherry tomatoes; and 9-11 g per cut piece of apple, banana, carrot, or cucumber). Cold cuts include cheese, cold cut meats, butter, and sweet spreads. Error bars represent the SEs of the means.

[a] The significant difference between regular and longer mealtime duration conditions.

Downloaded From: https://jamanetwork.com/ on 04/03/2023

vegetables (on average) corresponded to approximately 1 portion or 100 g (eg, 1 medium apple).[24] This outcome has practical importance for public health because 1 additional daily portion reduces the risk of cardiometabolic disease by 6% to 7%.[25] Moreover, this outcome was specific to fruits and vegetables; children did not eat significantly more of the other foods on offer. This finding is in line with results of cross-sectional studies showing that longer family meals are associated with better diet quality in children[7] as well as with observational studies[26] and 1 randomized clinical trial[27] in the school context. That trial[27] found that extending school lunch time increased fruit and vegetable intake.

Higher intake of fruits and vegetables during longer meals cannot be explained by longer exposure to food alone; otherwise, an increased intake of bread and cold cuts would have occurred. One possible explanation is that the fruits and vegetables were cut into bite-sized pieces, making them convenient to eat. Previous studies found that longer exposure to accessible foods increased the intake of these foods.[28,29] Inconvenience or friction[30] may explain why children did not consume more of the main components, such as bread or cheese, during longer meals; grabbing a bite-sized piece of fruit seemed more convenient than topping a slice of bread with cheese. Explorative analyses showed that the longer the meal lasted, the more fruits and vegetables the children ate and that more vegetables were eaten from the start, whereas the additional fruit was consumed during the extra time.

Additionally, longer family meals were associated with a slower eating rate, increased satiety, and a lower risk of obesity in children[31] potentially because increased satiety played a role in reduced snacking between meals.[32] We did not find a more positive mealtime atmosphere during the longer condition possibly because the laboratory setting led to more socially desirable communication, resulting in a ceiling effect.[33]

Strengths and Limitations

The within-dyad manipulation design using video observation permitted causal inferences to be drawn. Despite this major strength, findings from the laboratory setting cannot simply be generalized to natural eating environments. Other limitations are that video observations can increase socially desirable behaviors,[34] the sample had limited ethnic and socioeconomic diversity, and it remains unclear whether the effect of the intervention can be maintained over time. Some limitations were mitigated by the use of a within-dyad design. Comparing dyads with themselves makes it possible to control for situational factors (eg, video observation in both regular and longer conditions) and sample characteristics. Nevertheless, further studies should examine the effects of longer mealtime duration in more diverse samples and across longer time frames.

Conclusions

Results of this randomized clinical trial suggest that increasing family mealtime duration by approximately 10 minutes can improve children's diets and eating behavior. How can families establish new routines with longer mealtimes? Possibilities include focusing on the mealtime that is most likely to succeed (ie, not breakfast when everyone is in a rush), accommodating children's preferences (eg, playing music they have chosen in the background), and setting transparent rules (eg, everyone stays at the table for a certain time). These strategies may not always work; habit change takes effort but the necessary competences can be fostered.[35] The effect of family meal duration on children's intake of fruits and vegetables requires the availability of fruits and vegetables on the table. If the effects of this simple, inexpensive, and low-threshold intervention prove stable over time, it could contribute to addressing a major public health problem.

Downloaded From: https://jamanetwork.com/ on 04/03/2023

ARTICLE INFORMATION

Accepted for Publication: February 20, 2023.

Published: April 3, 2023. doi:10.1001/jamanetworkopen.2023.6331

Open Access: This is an open access article distributed under the terms of the CC-BY License. © 2023 Dallacker M et al. *JAMA Network Open*.

Corresponding Author: Jutta Mata, PhD, Division of Health Psychology, University of Mannheim, L13, 17, 68161 Mannheim, Germany (jutta.mata@uni-mannheim.de).

Author Affiliations: Center for Adaptive Rationality, Max Planck Institute for Human Development, Berlin, Germany (Dallacker, Hertwig, Mata); Division of Health Psychology, University of Mannheim, Mannheim, Germany (Knobl, Mata).

Author Contributions: Dr Dallacker and Ms Knobl had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: All authors.

Acquisition, analysis, or interpretation of data: Dallacker, Knobl.

Drafting of the manuscript: Dallacker, Mata.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Dallacker, Knobl.

Obtained funding: Hertwig.

Administrative, technical, or material support: Dallacker, Mata.

Supervision: Hertwig, Mata.

Conflict of Interest Disclosures: None reported.

Data Sharing Statement: See Supplement 3.

Additional Contributions: Max Planck Institute for Human Development Library Open Access Fund provided financial support to enable the open access publication of this article. Constanze Dolata, MSc, Marie Traub, MSc, and Lisann Appelius, MSc, student research assistants at the Max Planck Institute for Human Development, helped with data collection and video coding. Pia Vogel, BSc, University of Mannheim, coded the video recordings as part of her thesis analyses. Susannah Goss, MA, scientific editor at the Max Planck Institute for Human Development, edited the manuscript. These individuals received no compensation beyond their usual salaries or course credit for their contributions.

REFERENCES

1. Bazzano LA, He J, Ogden LG, et al. Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr*. 2002;76 (1):93-99. doi:10.1093/ajcn/76.1.93

2. Boffetta P, Couto E, Wichmann J, et al. Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). *J Natl Cancer Inst*. 2010;102(8):529-537. doi:10.1093/jnci/djq072

3. Grimm KA, Kim SA, Yaroch AL, Scanlon KS. Fruit and vegetable intake during infancy and early childhood. *Pediatrics*. 2014;134(suppl 1):S63-S69. doi:10.1542/peds.2014-0646K

4. Poti JM, Popkin BM. Trends in energy intake among US children by eating location and food source, 1977-2006. *J Am Diet Assoc*. 2011;111(8):1156-1164. doi:10.1016/j.jada.2011.05.007

5. Frank M, Brettschneider A-K, Lage Barbosa C, et al. Prevalence and temporal trends of shared family meals in Germany: results from EsKiMo II. *Ernahrungs Umschau*. 2019;66(4):60-67. doi:10.4455/eu.2019.013

6. Wyse R, Wolfenden L, Bisquera A. Characteristics of the home food environment that mediate immediate and sustained increases in child fruit and vegetable consumption: mediation analysis from the Healthy Habits cluster randomised controlled trial. *Int J Behav Nutr Phys Act*. 2015;12:118. doi:10.1186/s12966-015-0281-6

7. Dallacker M, Hertwig R, Mata J. Quality matters: a meta-analysis on components of healthy family meals. *Health Psychol*. 2019;38(12):1137-1149. doi:10.1037/hea0000801

8. De Castro JM. Social facilitation of duration and size but not rate of the spontaneous meal intake of humans. *Physiol Behav*. 1990;47(6):1129-1135. doi:10.1016/0031-9384(90)90363-9

9. Ruddock HK, Brunstrom JM, Vartanian LR, Higgs S. A systematic review and meta-analysis of the social facilitation of eating. *Am J Clin Nutr*. 2019;110(4):842-861. doi:10.1093/ajcn/nqz155

Downloaded From: https://jamanetwork.com/ on 04/03/2023

10. Pliner P, Bell R, Hirsch ES, Kinchla M. Meal duration mediates the effect of "social facilitation" on eating in humans. *Appetite*. 2006;46(2):189-198. doi:10.1016/j.appet.2005.12.003

11. Guidetti M, Cavazza N, Graziani AR. Healthy at home, unhealthy outside: food groups associated with family and friends and the potential impact on attitude and consumption. *J Soc Clin Psychol*. 2014;33(4):343-364. doi:10.1521/jscp.2014.33.4.343

12. McCrory MA, Fuss PJ, Hays NP, Vinken AG, Greenberg AS, Roberts SB. Overeating in America: association between restaurant food consumption and body fatness in healthy adult men and women ages 19 to 80. *Obes Res*. 1999;7(6):564-571. doi:10.1002/j.1550-8528.1999.tb00715.x

13. Guthrie JF, Lin B-H, Frazao E. Role of food prepared away from home in the American diet, 1977-78 versus 1994-96: changes and consequences. *J Nutr Educ Behav*. 2002;34(3):140-150. doi:10.1016/S1499-4046(06)60083-3

14. Robinson E, Almiron-Roig E, Rutters F, et al. A systematic review and meta-analysis examining the effect of eating rate on energy intake and hunger. *Am J Clin Nutr*. 2014;100(1):123-151. doi:10.3945/ajcn.113.081745

15. de Graaf C, Kok FJ. Slow food, fast food and the control of food intake. *Nat Rev Endocrinol*. 2010;6(5):290-293. doi:10.1038/nrendo.2010.41

16. Datavyu Team. Datavyu: a video coding tool. Databrary Project. Accessed June 29, 2022. http://datavyu.org

17. Fiese BH, Winter MA, Botti JC. The ABCs of family mealtimes: observational lessons for promoting healthy outcomes for children with persistent asthma. *Child Dev*. 2011;82(1):133-145. doi:10.1111/j.1467-8624.2010.01545.x

18. Llewellyn CH, van Jaarsveld CHM, Boniface D, Carnell S, Wardle J. Eating rate is a heritable phenotype related to weight in children. *Am J Clin Nutr*. 2008;88(6):1560-1566. doi:10.3945/ajcn.2008.26175

19. Fildes A, van Jaarsveld CHM, Llewellyn CH, Fisher A, Cooke L, Wardle J. Nature and nurture in children's food preferences. *Am J Clin Nutr*. 2014;99(4):911-917. doi:10.3945/ajcn.113.077867

20. Flint A, Raben A, Blundell JE, Astrup A. Reproducibility, power and validity of visual analogue scales in assessment of appetite sensations in single test meal studies. *Int J Obes Relat Metab Disord*. 2000;24(1):38-48. doi:10.1038/sj.ijo.0801083

21. Knobl V, Dallacker M, Hertwig R, Mata J. Happy and healthy: how family mealtime routines relate to child nutritional health. *Appetite*. 2022;171:105939. doi:10.1016/j.appet.2022.105939

22. Bennett C, Blissett J. Measuring hunger and satiety in primary school children: validation of a new picture rating scale. *Appetite*. 2014;78:40-48. doi:10.1016/j.appet.2014.03.011

23. Faul F, Erdfelder E, Buchner A, Lang A-G. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behav Res Methods*. 2009;41(4):1149-1160. doi:10.3758/BRM.41.4.1149

24. National Health Service. 5 A day portion sizes. Accessed July 5, 2022. https://www.nhs.uk/live-well/eat-well/5-a-day/portion-sizes/

25. Micha R, Peñalvo JL, Cudhea F, Imamura F, Rehm CD, Mozaffarian D. Association between dietary factors and mortality from heart disease, stroke, and type 2 diabetes in the United States. *JAMA*. 2017;317(9):912-924. doi:10.1001/jama.2017.0947

26. Graziose MM, Ang IYH. Factors related to fruit and vegetable consumption at lunch among elementary students: a scoping review. *Prev Chronic Dis*. 2018;15:E55. doi:10.5888/pcd15.170373

27. Burg X, Metcalfe JJ, Ellison B, Prescott MP. Effects of longer seated lunch time on food consumption and waste in elementary and middle school-age children: a randomized clinical trial. *JAMA Netw Open*. 2021;4(6):e2114148. doi:10.1001/jamanetworkopen.2021.14148

28. Hearn MD, Baranowski T, Baranowski J, et al. Environmental influences on dietary behavior among children: availability and accessibility of fruits and vegetables enable consumption. *J Health Educ*. 1998;29(1):26-32. doi:10.1080/10556699.1998.10603294

29. Stroebele N, De Castro JM. Effect of ambience on food intake and food choice. *Nutrition*. 2004;20(9):821-838. doi:10.1016/j.nut.2004.05.012

30. Wood W, Neal DT. Healthy through habit: interventions for initiating & maintaining health behavior change. *Behav Sci Policy*. 2016;2(1):71-83. doi:10.1353/bsp.2016.0008

31. Fogel A, Goh AT, Fries LR, et al. Faster eating rates are associated with higher energy intakes during an ad libitum meal, higher BMI and greater adiposity among 4·5-year-old children: results from the Growing Up in Singapore Towards Healthy Outcomes (GUSTO) cohort. *Br J Nutr*. 2017;117(7):1042-1051. doi:10.1017/S0007114517000848

32. Sjöberg A, Hallberg L, Höglund D, Hulthén L. Meal pattern, food choice, nutrient intake and lifestyle factors in the Göteborg Adolescence Study. *Eur J Clin Nutr*. 2003;57(12):1569-1578. doi:10.1038/sj.ejcn.1601726

Downloaded From: https://jamanetwork.com/ on 04/03/2023

33. Pesch MH, Lumeng JC. Methodological considerations for observational coding of eating and feeding behaviors in children and their families. *Int J Behav Nutr Phys Act*. 2017;14(1):170. doi:10.1186/s12966-017-0619-3

34. McCarney R, Warner J, Iliffe S, van Haselen R, Griffin M, Fisher P. The Hawthorne effect: a randomised, controlled trial. *BMC Med Res Methodol*. 2007;7:30. doi:10.1186/1471-2288-7-30

35. Hertwig R, Grüne-Yanoff T. Nudging and boosting: steering or empowering good decisions. *Perspect Psychol Sci*. 2017;12(6):973-986. doi:10.1177/1745691617702496

SUPPLEMENT 1.
Trial Protocol

SUPPLEMENT 2.
eTable 1. Food and Beverages Consumed by Adults (N = 50)
eTable 2. Food and Beverages Consumed by Children (N = 50)
eFigure 1. Cumulated Pieces of Fruits Consumed by Each Child in the Two Conditions
eFigure 2. Cumulated Pieces of Vegetables Consumed by Each Child in the Two Conditions

SUPPLEMENT 3.
Data Sharing Statement

Downloaded From: https://jamanetwork.com/ on 04/03/2023

Supplements

Supplement 1: Study Protocol as an eSupplement: https://osf.io/kbsdp?view_only=cf732061e0084486be698adea8b1540a

Supplement 2:

eTable 1. Food and Beverages Consumed by Adults (N = 50)

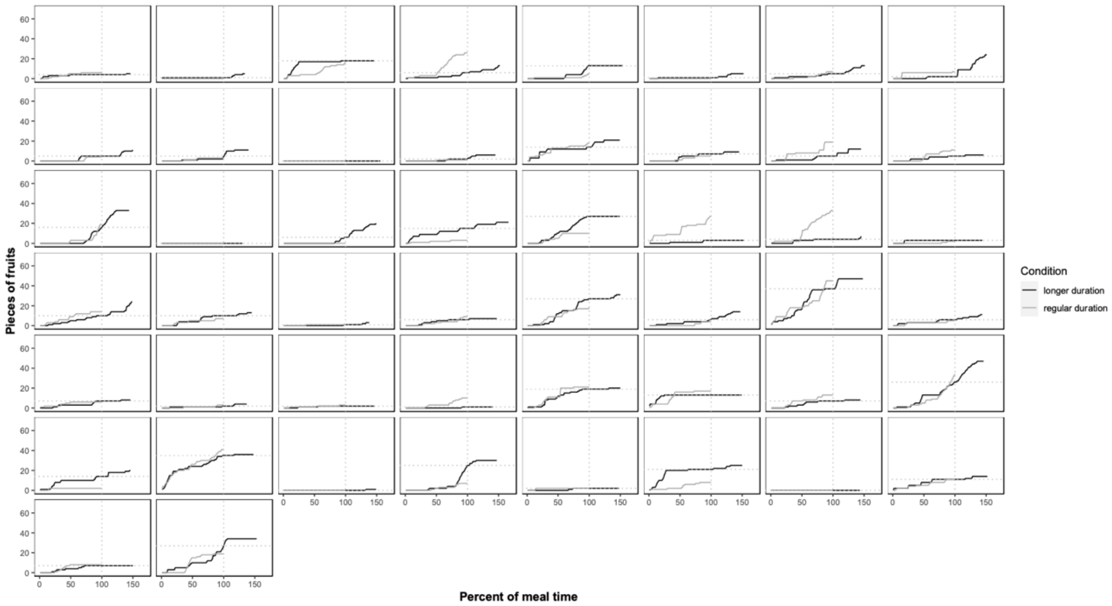
Food item	Regular meal duration M (SD)	Longer meal duration M (SD)	Mean difference (95% CI)	*P*	Cohen's *d*
Fruits (pieces)	15.04 (12.01)	19.34 (12.38)	4.3 (2.02)	0.001	0.45
Vegetables (pieces)	17.88 (11.22)	20.7 (10.3)	2.82 (0.53)	0.022	0.29
Bread and cold cuts* (kcal)	347.1 (140.28)	396.73 (157.99)	49.63 (5.75 – 93.5)	0.028	0.32
Sugar-sweetened beverages (ml)	81.2 (103.97)	103.5 (135.71)	22.3(-1.32 – 45.92)	0.064	0.27
Water (ml)	230.2 (155.86)	283 (164.02)	52.8 (11.08 – 94.52)	0.014	0.36
Dessert (kcal)	87.1 (72.33)	83.7 (71.71)	-3.4 (6.65)	0.287	0.08

*Cold cuts include cheese, cold meat, butter, and sweet spreads.

eTable 2. Food and Beverages Consumed by Children (N = 50)

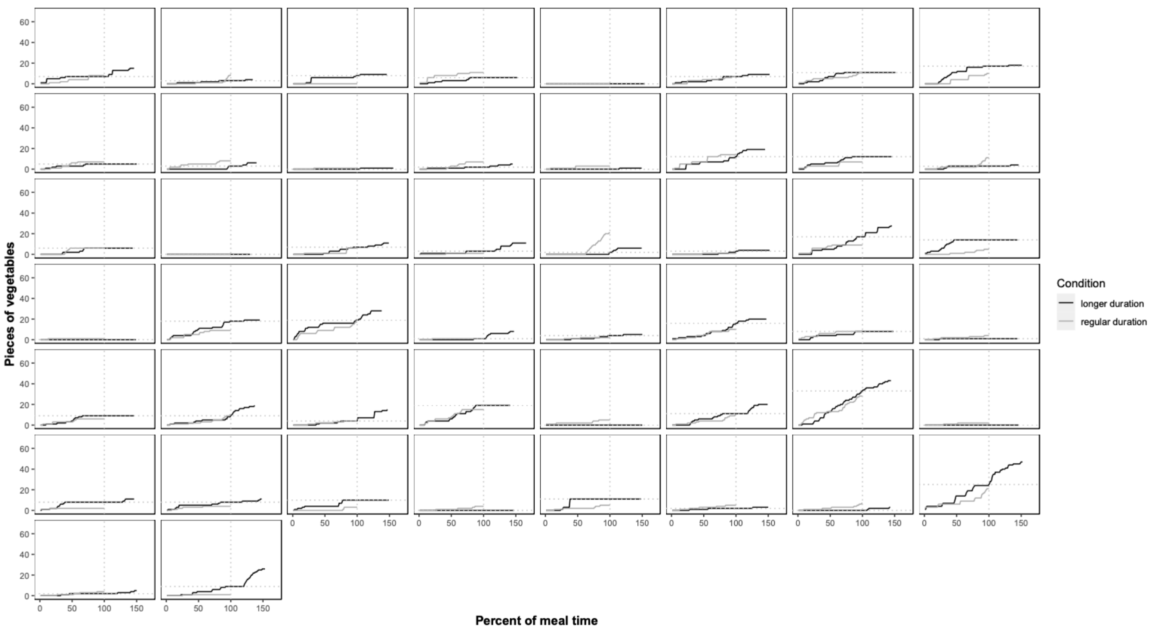
Food item	Regular meal duration M (SD)	Longer meal duration M (SD)	Mean difference (95% CI)	*P*	Cohen's *d*
Fruits (pieces)	11.06 (11.33)	14.38 (11.86)	3.32 (0.96)	0.011	0.33
Vegetables (pieces)	7.18 (6.03)	11.23 (10.51)	4.05 (2.19)	<0.001	0.52
Bread and cold cuts* (kcal)	313.53 (159.62)	343.93 (178.82)	30.4 (-18.28 – 79.08)	0.216	0.18
Sugar-sweetened beverages (ml)	155.2 (129.19)	191.7 (140.57)	36.5 (5.53 – 67.47)	0.022	0.34
Water (ml)	80 (87.69)	134.2 (124.08)	54.2 (24.73 – 83.67)	<0.001	0.52
Dessert (kcal)	131.9 (60.11)	119.6 (60.71)	-12.3 (1.69)	0.073	0.21

*Cold cuts include cheese, cold meat, butter, and sweet spreads.



eFigure 1. Cumulated Pieces of Fruits Consumed by Each Child in the Two Conditions

Meal time on the X axis in percent with the usual mealtime duration as a baseline with up to 100% and the longer mealtime duration up to 150%; N = 50.



eFigure 2. Cumulated Pieces of Vegetables Consumed by Each Child in the Two Conditions

Meal time on the X axis in percent with the usual mealtime duration as a baseline with up to 100% and the longer mealtime duration up to 150%; N = 50.

Manuscript 2 – Happy and healthy: How family mealtime routines relate to child nutritional health

Published Article:

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2022). Happy and healthy: How family mealtime routines relate to child nutritional health. *Appetite*, 171, 105939.

https://doi.org/10.1016/j.appet.2022.105939

Appetite 171 (2022) 105939

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Happy and healthy: How family mealtime routines relate to child nutritional health

Vanessa Knobl [a,*], Mattea Dallacker [b], Ralph Hertwig [b], Jutta Mata [a,b,c]

[a] School of Social Sciences, Department of Psychology, University of Mannheim, Germany
[b] Center for Adaptive Rationality, Max Planck Institute for Human Development, Germany
[c] Mannheim Center for Data Science, University of Mannheim, Germany

ARTICLE INFO

Keywords:
Child
Parent
Family meal
Mealtime routines
Nutrition
Eating

ABSTRACT

Children eat most of their meals in a family context, making family meals a key environment in which to learn about healthy food. What makes a family meal "healthy"? This diary study examined the practice of seven family mealtime routines (e.g., positive mealtime atmosphere, parental modeling, and longer meal duration) and their predictive value for children's healthier nutrition focusing on everyday family meal settings.

Over 7 consecutive days, parents from $N = 310$ families ($M_{age} = 42$ years) described their most important family meal of the day and food intake for an index child ($M_{age} = 9$ years) and indicated what mealtime routines were practiced during the family meal. On average, each parent responded to 5.6 ($SD = 1.4$) of seven daily surveys. Mean correlations between mealtime routines were small (*rs* between −0.14 and 0.25), suggesting independent and distinct routines. Creating a positive atmosphere and turning TV and smartphones off were reported most often (on average, 91.2% and 90.5%, respectively). Parent's fruit and vegetable intake and creating a positive mealtime atmosphere were the strongest predictors for children's higher nutritional quality (i.e., higher vegetable and fruit intake; $ps < .001$). Findings indicate that mealtime routines obtained from independent meta-analyses represent distinct routines. Families practiced these independent and distinct routines to different degrees. Parental modeling and a positive mealtime atmosphere were most predictive of healthier child nutrition in daily family meal settings. More experimental research is needed to better understand causality and provide a better basis for effective interventions.

1. Introduction

Eating is an essential social experience. Most shared meals are consumed in a family context (Frank et al., 2019) and theoretical frameworks emphasize the importance of family systems for health promotion (see Michaelson et al., 2021, for an overview). According to these frameworks, the creation of a healthy environment—including the structuring of family meals, parents acting as nutritional gatekeepers, and parental modeling behavior—is essential for behavior change (e.g., Golan & Weizman, 2001). Extending ecological models, Davison et al. (2013) included the child and their behavior and cognition as an actor contributing to the interdependent system *family*.

There has been disagreement in the scientific literature about what exactly constitutes a family meal (see, e.g., Martin-Biggers et al., 2014, for an overview). Some studies proposed that the entire family has to sit at the table to maximize the positive aspects of eating together (e.g., Øverby et al., 2020), whereas others used a less strict definition (e.g., Robson et al., 2020). Importantly, the meta-analysis by Dallacker et al. (2018) did not find an effect of the number of family members at the table on the relation between family meal frequency and children's nutritional health. As a practical consequence, meals with as few as two people eating together can count as family meals.

Over the past 20 years, numerous studies have consistently shown that more frequent family meals are associated with several positive outcomes regarding children's nutritional health, including higher fruit and vegetable intake and overall healthy eating, lower soft drink consumption, lower body mass index (BMI), and fewer eating disorders (e.g., Dallacker et al., 2018; Glanz et al., 2021; Robson et al., 2020). Yet, the underlying mechanisms are still not well understood (Rosemond et al., 2019), despite promising findings from cross-sectional studies: A meta-analysis by Dallacker et al. (2018) identified six mealtime routines that are linked to healthier nutrition and body weight in children. These

* Corresponding author. University of Mannheim Chair of Health Psychology, L13, 17, 68131, Mannheim, Germany.
E-mail address: knobl@uni-mannheim.de (V. Knobl).

https://doi.org/10.1016/j.appet.2022.105939
Received 2 September 2021; Received in revised form 21 December 2021; Accepted 14 January 2022
Available online 19 January 2022
0195-6663/© 2022 Elsevier Ltd. All rights reserved.

routines include parental modeling, TV off during meals, meals prepared at home, children's involvement in preparation, longer meal duration, and positive mealtime atmosphere. A particular focus of our study was on the practice of these family mealtime routines in a large, heterogeneous sample of families living in Germany. We additionally investigated smartphone use because digital devices are increasingly replacing TV use (Breunig et al., 2020) and their use have been shown to potentially decrease family mealtime enjoyment (Dwyer et al., 2018).

1.1. Research gaps

1.1.1. Validation of the mealtime routines

Dallacker and colleagues' (2019) identification of six mealtime routines was the first systematic approach to summarizing frequently investigated mealtime routines. The routines were drawn from the literature without considering their prevalence. Therefore, Dallacker et al. could not determine the degree to which the routines were actually practiced and integrated into families' everyday life: Do families use one, several or all of these mealtime routines during a typical meal?

1.1.2. Relationship between family mealtime routines

Many studies examined the impact of individual family mealtime routines on various child health outcomes (e.g., fruit and vegetable intake, diet quality, BMI; for a meta-analysis see Dallacker et al., 2019). Only a handful of studies considered *two* different mealtime routines (e.g., Dwyer et al., 2018; Feunekes et al., 1995; Fulkerson et al., 2014; Trofholz et al., 2017). Since a complex social situation such as a family meal is likely not sufficiently described by one or two behavioral routines it means that our knowledge about this paradigmatic social institution family meal is severely limited. Also, investigating intercorrelations between routines addresses the extent to which they represent distinct or overlapping behaviors.

Studies that went beyond a single routine all turned to the relationship of media use and mealtime atmosphere. In summary, media consumption in general and mealtime atmosphere have been found to be negatively correlated. More specifically, TV consumption at family meals was negatively associated with mealtime atmosphere (Trofholz et al., 2017); restaurant meals with family and friends were less enjoyable and associated with a lower sense of well-being when smartphones lay on the table (Dwyer et al., 2018), and general media use was related to lower quality of family communication (Fulkerson et al., 2014). In contrast, link between mealtime atmosphere and the meal's duration has received scant attention: One diary study showed that the duration of a face-to-face social interaction predicted participants' happiness (Vlahovic et al., 2012), and there are indications that this finding generalizes to the duration of social interaction at family meals and positive atmosphere (Feunekes et al., 1995).

1.1.3. Family mealtime routines and Children's diet quality

Most studies that examined the impact of family mealtime routines on children's nutritional health outcomes are cross-sectional. The few longitudinal studies concentrated on ensuring temporal order of effects by using a panel design and collecting data at two measurement times, years apart. For example, Larson et al. (2007) showed that more frequent family meals in adolescence was associated with more fruit and vegetable intake and less soft drink consumption about 5 years later, in early adulthood. Metcalfe and Fiese (2018) reported higher fruit and vegetable intake among preschoolers after more involvement in food preparation 1 year earlier. To better understand consecutive day-to-day family mealtime routines, daily measurement designs are desirable. For example, Berge et al. (2014) evaluated video-recorded family meals over 8 consecutive days and found associations between positive family dynamics (i.e., warmth, group enjoyment, parental positive reinforcement) at family meals and reduced risk of being overweight in childhood.

1.1.4. Experimental manipulation of mealtime atmosphere

Research on causal relations between family mealtime routines and children's diet quality is very rare. One of the few exceptions studied whether experimentally induced noise caused distraction during the mealtime (Fiese et al., 2015). Indeed, the noise led to less positive communication between family members and children ate more cookies. Another recent experiment invited parent–child dyads twice to the lab and served a typical German evening meal (consisting of bread, cold cuts, cheese, fruits, and vegetables, etc.). In one condition, the dyads had as much time for their dinner as they usually take; in the other condition they had 50% more time. Longer meal duration increased children's consumption of fruits and vegetables but did not significantly increase their consumption of bread and cold cuts (Dallacker et al., 2017). Building on this study, we chose mealtime atmosphere—the second largest predictor next to duration—as a target routine for another first intervention attempt (cf. Dallacker et al., 2019).

1.2. Hypotheses and research questions

Our first goal was to describe the extent to which family mealtime routines are actually practiced: We expected (1) the seven target routines reported previously to also manifest in the everyday context of family meals. Although one can expect the seven target routines to play some role in family meal contexts, little is known about their prevalence and concurrence. Our second goal was to examine the interrelations between those seven mealtime routines. Based on the limited past evidence, we predicted (2a) a negative link between media consumption (TV and smartphone) during the meal and mealtime atmosphere and (2b) a positive link between mealtime duration and atmosphere during the meal. Furthermore, by their nature, home-made and freshly prepared foods, unlike pre-fabricated food, permit but do not necessitate parents to involve their children in the preparation of meals. We predicted (2c) that children's involvement in meal preparation is positively related a home-prepared meal. Given the general scarcity of theoretical models and empirical studies on the relation between different mealtime routines, our examination of the other links between the seven different family mealtime routines was inevitably exploratory.

Our third goal was to investigate the influence of the seven mealtime routines on diet quality. We did so in two different ways: First, we compared the relative influence of the routines within the same statistical model. Second, we implemented an intervention for mealtime atmosphere, and predicted a different influence on nutritional quality for different experimental groups. On the basis of the meta-analysis by Dallacker et al. (2019), we predicted (3) a small effect of all routines on children's fruit and vegetable intake.

2. Methods

2.1. Transparency and openness

We report all data exclusions, all manipulations, and all measures that were included in the study. In addition, all data, analysis code, and research materials are available at [https://osf.io/c9y3t/?view_only=cf732061e0084486be698adea8b1540a]. Data were analyzed using RStudio version 1.3.959 (RStudioTeam, 2020). The ethics commission of the University of Mannheim approved this study.

2.2. Design and procedure

Adult participants were recruited via telephone from forsa.omninet panel, an internet panel that is representative of the German population aged 14 and over. To be eligible, participants needed to have at least one child between 3 and 17 years old. Only one parent per family participated in the study. This parent was instructed to answer the questionnaire in relation to themselves and to one child of the family. If there was more than one child in the family, the parent was asked to answer with respect to the child with the most recent birthday (the 'index child'). After giving informed consent, participants answered an entry questionnaire and then were randomly assigned to one of three experimental groups (see details below). Over the next 7 consecutive days all participants answered identical questions about their mealtime routines every day between 6 p.m. and midnight. Participants could receive a maximum reward of €10 for taking part in the study: €1.50 for answering the first questionnaire and another €1 for each additional questionnaire answered, and if they answered all seven questionnaires, a bonus of €2.50.

2.3. Measures

2.3.1. Entry questionnaire

Participants reported the number of adults and children living in their household and were asked the following about the index child: age, gender, height, and weight, as well as daily portions of fruits and vegetables eaten during a usual week. Additionally, parents reported their own age, gender, relationship and employment status, educational qualifications, and household income after taxes. Parents also reported which family member was mainly responsible for meal planning/preparation and had the strongest influence on the nutrition of the family (answer options: myself, my partner, both, others).

2.3.2. Daily questionnaires

Meal Characteristics. Family meals are here defined as meals in which at least one parent eats breakfast, lunch, dinner, or any other meal together with at least one child (i.e., the index child). We thus took the substantial number of single-parent or working-parent households into account (Middleton et al., 2020). This definition is in line with theoretical frameworks focusing on what families *do* (e.g., how they eat) rather than how they *look* (e.g., their socioeconomic status). First, parents described the characteristics of the meal as follows: most important family meal of the day (answer options: breakfast, lunch, dinner, other meals, and no meal), meal participants (e.g., mother, father, others), location (e.g., at home, restaurant, other); and whether their child had eaten the same or a different dish from the adults (5-point scale of 1 = *ate something completely different* to 5 = *ate the same dish as the adults*). If they reported not having had a family meal, they received no further questions that day.

Mealtime Routines. Participants reported on different routines of their most important family meal of the day (based on the meta-analysis by Dallacker et al., 2019). Media consumption during the meal was assessed by asking participants if the TV was on during the meal (5-point Likert scale of 1 = *yes, all the time* to 5 = *no, at no time*; adapted from Horodynski et al., 2010). Equivalent questions were asked for smartphone use. Atmosphere during the meal was measured with four items (Cronbach's α = 0.82), asking about perceived mealtime atmosphere, parent's satisfaction with the meal, enjoyment of the meal, and child's mood during the meal on a 5-point Likert scale (1 = *very negative* to 5 = *very positive* or 1 = *not at all* to 5 = *much enjoyed/very satisfied*). Parental modeling was assessed in two ways: (1) Participants were asked if they had deliberately eaten fruit or vegetables during the meal to be a role model for their child (5-point Likert scale from 1 = *not at all* to 5 = *very much*, adapted from Musher-Eizenman & Holub, 2007); (2) they reported their own fruit and vegetable intake during the meal (from "0" to "4.5 or more portions" in steps of 0.5 portions; adapted from Harris & Ramsey, 2015). Involvement was measured by asking how the index child had helped or was involved in preparing the meal (5-point Likert scale from 1 = *did not help/was not involved at all* to 5 = *helped a lot/was very involved*; adapted from Chu et al., 2013); this question was only asked if the most important meal was eaten at home or a friend's/relative's house. Duration of a meal was self-measured and then reported in minutes (open answer). Quality of a meal was assessed by asking if the food was homemade (yes/no; adapted from Sweetman et al., 2011).

Fruit and Vegetable Intake. Parents were asked about the index child's fruit and vegetable intake during the meal (from "0" to "4.5 or more portions" in steps of 0.5 portions; adapted from Harris & Ramsey, 2015).

Control Variables. Parents reported whether and how many different types of fruit and vegetables were offered at the meal. Additionally, parents in the intervention and the active control group reported the extent to which they had focused their conversation exclusively on positive topics or had conversations about a random topic (5-point Likert scale from 1 = *not at all* to 5 = *very much*).

2.3.3. Final questionnaire

At the end of study, participants rated how typical the study week was regarding their child's eating behavior (6-point Likert scale from 1 = *very untypical* to 6 = *very typical*) and their own height and weight.

2.4. Experimental manipulation

We experimentally manipulated mealtime atmosphere by providing instructions that outline desired behaviors. Parents in the passive control group answered the daily questionnaires without further instructions. Parents in the active control group were additionally instructed to choose at least one topic of their liking to talk about during mealtime. Parents in the intervention group were instructed to strive to create a positive atmosphere during mealtime by talking about positive topics and by avoiding disciplining children during mealtime. Experimental group and the active control group received their instruction after finishing the entry questionnaire and obtained a reminder every study day as part of the invitation for the daily questionnaire.

2.5. Participants

A total of 351 parents took part in the study; 41 parents who completed fewer than two questionnaires over the study week were excluded. The final sample comprised 310 participants. Parents ranged in age from 18 to 76 (M = 41.6, SD = 7.0) and children from 3 to 17 years (M = 8.9, SD = 4.18). Gender distribution was similar for children and parents such that about half were girls/mothers. Of all parents, 58% reported not having a university degree. The BMI for parents and children ranged widely: children's z-BMI from −5.46 to 3.44 and parents' BMI from 17.26 to 48.44 (for detailed sample characteristics see Table 1).

2.6. Statistical analyses

When information on parents' or children's fruit and vegetable intake were missing, we assumed zero servings of fruit and vegetables for that day. To examine the frequency of mealtime practices, we first calculated frequency tables to analyze, which mealtime routines families put into practice. Next, we ran multilevel intercept-only models (with family on Level 2 and days on Level 1) to test within and between variance for all mealtime routines. To examine Hypothesis 2, we calculated correlations, separately for each of the consecutive 7 study days. Hypothesis 3 was tested using random-intercept models with children's fruit and vegetable intake during the meal as independent, and family mealtime routines as dependent variables; control variables were number of offered fruit and vegetable portions, weekend versus weekday, and intervention-group membership. As an additional test of Hypothesis 3, especially addressing mealtime atmosphere, we implemented two multilevel models with intervention group as the predictor and both, mealtime atmosphere and fruit and vegetable intake, as dependent variables. This allowed us to examine whether the experimental manipulation of mealtime atmosphere increased children's fruit and vegetable intake. Analyses were conducted using RStudio's lmerTest package for mixed models (Kuznetsova et al., 2020) and ggplot2 for figures (Wickham et al., 2021). Hypotheses were specified before data

Table 1
Sample characteristics.

Variable	Parent		Child	
	M	SD	M	SD
Answered daily questionnaires	5.76	1.34		
Age (in years)	41.61	7.00	8.93	4.18
BMI (kg/m^2)				
Female	25.28	4.98	−0.40[a]	
Male	26.51	3.57	−0.49[a]	
	n	%	*n*	%
Sex				
Female	167	53.87	162	52.25
Education				
Secondary	92	29.67		
Higher level/qualification for university entrance	69	22.26		
University	132	42.58		
Other	16	5.16		
Nutritional gatekeeper				
Me	140	45.16		
Partner	63	20.32		
Both	105	33.87		
Other	2	0.65		
Monthly household income				
Under 2000 euros	29	9.35		
2000–2999 euros	57	18.39		
3000 euros and more	187	60.32		

Note. $N = 310$. Participants who did not provide information are not included in the table; therefore, 100 − shown percentage values = percentage of missing responses.

[a] Body mass index (BMI) *z* scores, which indicate standard deviation from the mean of the population (age-adjusted and calculated based on The Child and Adolescent Health Survey reference data for 2003 to 2006; Neuhauser et al., 2013); 75% of children in this sample were healthy weight, 11% overweight, and 14% underweight.

collection and also the analytic plan was pre-specified.

3. Results

3.1. Descriptive statistics

Parents rated their child's eating behavior during the study week as "rather typical" ($M = 4.98$, $SD = 0.80$ on a 6-point scale). On average, families described dinner as the most important family meal. The family meals usually took place at home (see Table 2 for details).

3.2. Frequency of mealtime routines

For each family, we calculated the percentage of days on which they reported using a specific routine during their meals, and then calculated the average (percentage) use across all families. Fig. 1 shows that parents reported a positive atmosphere for most of the meals. In addition, TV and smartphones were off during almost all meals, and the vast majority of meals were prepared at home. For about half of the meals, both parents deliberately modeled behavior, and children were involved in the preparation. Nearly 1 of 4 meals had a considerably longer duration (i.e., at least 10% longer than the mode; 33 min in this sample). In addition, we also examined the number of routines used in a family meal: On average, a family uses more than four different routines per meal (M=4.62, SD= .78). Some family mealtime routines occur particularly often together (see contingency table in the supplemental materials), for example positive atmosphere and smartphone off. Thus, according to self-report data, the seven target family meal routines, drawn from the literature, do occur in families' lives, even though their frequencies differ substantially. Frequency data are comparable across all three study groups, with small differences in meal atmosphere and children's involvement (see supplementary material for routine use by intervention group).

Table 2
Mealtime characteristics and routines (mean value per family, averaged across all families).

		M	SD	%
Meal type	Breakfast			13.31
	Lunch			24.39
	Dinner			56.79
	Other			0.70
	None			
Others present at the meal	Mother			4.81
				91.34
	Father			74.13
	Other			18.00
Location	At home			89.97
	Restaurant			3.11
	Other			6.92
Same food as adults				75.03
Mealtime routines	Homemade (yes/no)			86.91
	Duration (min)	29.39	10.65	
	Atmosphere[a]	4.05	0.41	
	Involvement[a]	1.93	0.71	
	Modeling			
	Deliberately[a]	2.49	1.03	
	Fruit and vegetable intake[b]	1.10	0.76	
	TV use[a]	0.31	0.72	
	Smartphone use (from 1 to 5)	0.11	0.24	
Child's nutritional health	Fruit and vegetable intake[b]	0.95	0.66	

Note. Meal characteristics calculated for each family as frequency of characteristic divided by number of total answers for this item and then averaged over families. Means and standard deviations calculated for each family over the week and then averaged across families.

[a] Rated on a scale of 1–5.

[b] Number of fruit and vegetable portions.

Next, we calculated how the different routines varied within one family over 7 days versus between families using multilevel intercept-only models (see Fig. 2). All routines except parental modeling varied more within families than between families (within-family variance: 42.8%–95.5%; between-families variance: 4.5%–57.2%). To account for this large share of within-family variance, we use multilevel modeling in the following analyses.

3.3. Relation between mealtime routines

Table 3 shows the mean correlation between routines, averaged over all study days, as well as the respective minimum and maximum correlations (i.e., the highest and the lowest correlation on any of the study days). The highest mean correlation was observed between mealtime duration and atmosphere ($r = 0.25$), followed by mealtime atmosphere and child's involvement in meal preparation ($r = 0.15$). In general, the associations between different meal routines are rather small and even though they show a notable variability between the individual study days, the variability in correlations for weekdays versus weekends was very small (see supplementary material for individual correlation tables; to exclude bias due to experimental manipulation, graphs and tables for frequency and relations are also provided separately for the three groups in the Supplementary Materials. All results with the passive control group only are comparable in effect size and direction.).

3.4. Prediction of Children's fruit and vegetable intake

To test whether family mealtime routines predict children's fruit and vegetable intake, a random intercept model was specified. Fruit and vegetable intake (i.e., the sum of eaten portions of fruits and vegetables during the meal) was used as the dependent variable. Predictors were atmosphere, involvement, duration, modeling (deliberate modeling as well as the sum of parent's fruit and vegetable intake), homemade, TV

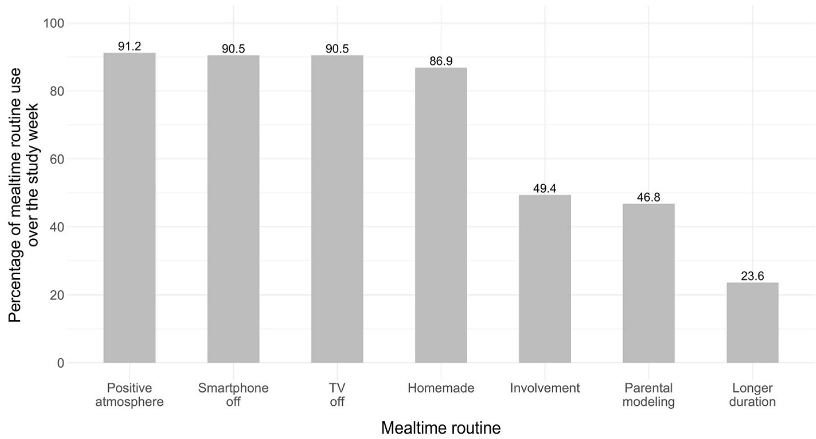


Fig. 1. Percentage of use of seven family mealtime routines averaged across all families.
Note. The percentage of use was calculated as frequency of routine use divided by number of total answers for an item (e.g., 7 = item was answered on all 7 days of the study). Smartphone off and TV off = All meals for which "never" (i.e., never on) was the chosen answer category; homemade = all meals where the answer to the item was "yes" (i.e., homemade); positive atmosphere = all meals with an item score >3; longer duration = all meals that took at least 10% longer than the mode (33 min in this sample); involvement = all meals for which the answer was at least "a little involved"; parental modeling = all meals for which the item assessing if fruits and vegetables were eaten deliberately was answered with at least "somewhat true."

Note. The percentage of use was calculated as frequency of routine use divided by number of total answers for an item (e.g., 7 = item was answered on all 7 days of the study). Smartphone off and TV off = All meals for which "never" (i.e., never on) was the chosen answer category; homemade = all meals where the answer to the item was "yes" (i.e., homemade); positive atmosphere = all meals with an item score >3; longer duration = all meals that took at least 10% longer than the mode (33 min in this sample); involvement = all meals for which the answer was at least "a little involved"; parental modeling = all meals for which the item assessing if fruits and vegetables were eaten deliberately was answered with at least "somewhat true."

and smartphone. Further, we controlled for the sum of offered portions of fruits and vegetables, weekday versus weekend, and intervention group membership. The results show a significant predictive effect of the implicit measure of parental modeling—parental fruit and vegetable intake ($p < .001$, $R^2 = 0.52$)—and positive mealtime atmosphere ($p < .001$, $R^2 = 0.10$) on fruit and vegetable intake of children (see Table 4). The coefficients remain largely unchanged in size, direction, and statistical significance when further controlling for children's age, gender, and BMI z score, or parent's educational level, household income, and being the nutritional gatekeeper.

3.5. Manipulation of mealtime atmosphere

Families in the active control group stated that, on average, in 76% of their meals they were able to implement the task of discussing a topic well or very well. Families in the intervention group were able to address only positive topics and avoid disciplining children well or very well in, on average, 65% of their meals. To analyze the effect of the mealtime atmosphere interventions, we computed a multilevel model. Group membership was dummy coded (with the intervention group as the baseline condition) and included in the model as a predictor, and atmosphere was the dependent variable. Results show no significant differences in atmosphere between the control groups and the intervention group. In addition, there was also no significant group difference in the children's fruit and vegetable intake (for a regression table see supplementary materials). We therefore refrained from testing a mediation model with group as predictor, fruit and vegetable intake as outcome, and mealtime atmosphere as mediator.

4. Discussion

Evidence-based family mealtime routines are regularly practiced in everyday family meal situations. The routines prove relatively distinct from each other. Some but not all the routines predict children's fruit and vegetable intake during family meals when compared to each other within the same model. The current work extends previous cross-sectional research on individual family mealtime routines with a daily assessment field study. Going beyond past research's narrow focus on one or two routines, the present study analyzed a total of seven routines.

All mealtime routines were reported to be practiced, even though frequency differed substantially. Specifically, we found that in contrast to media reports, the consumption of TV and smartphone use played a very small role at the family meal table, with reported use below 10%. Similarly, mealtime atmosphere was rather positive to very positive in over 90% of the meals per family. In addition, 87% meals were reported to be homemade. In contrast, children's involvement in meal preparation and parental modeling occurred, on average, considerably less frequently in about 50% of meals. Longer duration of a meal occurred in only about 25% of reported meals. Importantly, the average family used more than 4 mealtime routines per meal, which underlines the importance of studying different routines simultaneously. Overall, the use of routines is the rule rather than the exception. Importantly, these patterns of use emerged consistently across the three experimental groups.

Conducting the study across 7 consecutive days allowed us to examine the day-to-day differences in the practice of the different mealtime routines. Except for parental modeling, all routines showed much larger variability within than between families. This means that many differences in family meals will likely not be detected between families but rather within families over the course of a typical week. This

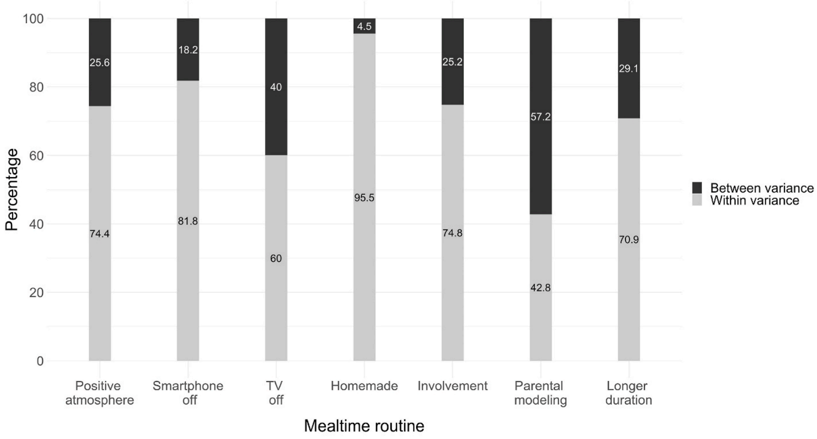


Fig. 2. Percentage of Within-Family and Between-Families Variance for All Seven Mealtime Routines
Note. Smartphone off and TV off = All meals for which "never" (i.e., never on) was the chosen answer category; homemade = all meals where the answer to the item was "yes" (i.e., homemade); positive atmosphere = all meals with an item score >3; longer duration = all meals that took at least 10% longer than the mode (33 min in this sample); involvement = all meals for which the answer was at least "a little involved"; parental modeling = all meals for which the item assessing if fruits and vegetables were eaten deliberately was answered with at least "somewhat true."

Percentage of Within-Family and Between-Families Variance for All Seven Mealtime Routines

Note. Smartphone off and TV off = All meals for which "never" (i.e., never on) was the chosen answer category; homemade = all meals where the answer to the item was "yes" (i.e., homemade); positive atmosphere = all meals with an item score >3; longer duration = all meals that took at least 10% longer than the mode (33 min in this sample); involvement = all meals for which the answer was at least "a little involved"; parental modeling = all meals for which the item assessing if fruits and vegetables were eaten deliberately was answered with at least "somewhat true."

Table 3
Correlations between mealtime routines averaged over all 7 study days.

Variable	1	2	3	4	5	6	7	8
1. TV								
2. Smartphone	.02							
	[-.04, .11]							
3. Atmosphere	-.05	.03						
	[-.14, .05]	[-.04, .08]						
4. Involvement	-.06	.03	.15$^+$					
	[-.18, .05]	[-.02, .06]	[.00, .21]					
5. Duration	-.05	.07	.25*	.10				
	[-.10, .00]	[-.04, .22]	[.19, .33]	[.04, .21]				
6. Quality	-.03	-.08	.02	.09	-.14$^+$			
	[-.12, .05]	[-.18, .03]	[-.09, .16]	[-.07, .17]	[-.27, −.06]			
7. Deliberate parental modeling	-.05	-.06	.03	.13	-.03	.05		
	[-.08, .07]	[-.14, .00]	[-.04, .12]	[-.07, .23]	[-.21, .10]	[-.06, .19]		
8. Veg and fruit parent	-.04	-.06	.18	.09	.17	.14	.13	
	[-.13, .04]	[-.13, .01]	[.10, .25]	[.02, .18]	[.05, .32]	[-.01, .24]	[.00, .27]	
9. Veg and fruit child	-.04	-.04	.20$^+$	.12	.16$^+$	.13	.06	.79*
	[-.10, .01]	[-.18, .08]	[.10, .25]	[.03, .26]	[.07, .28]	[-.03, .23]	[-.14, .20]	[.72, .85]

Note. Values in square brackets represent minimum and maximum correlations during the 7-day study period. Veg and fruit = Vegetable and fruit intake during the meal.*$p < .05$ on all 7 study days. $^+p < .05$ on 4 or more study days.

underlines the value designs with consecutive data collection in this research.

Another goal was to understand whether the family mealtime routines identified to date represent distinct or overlapping behaviors. The small correlations between the seven routines suggest that their distinct nature. In contrast to Hypothesis 2a and previous research (Trofholz et al., 2017), we found only minimal correlations between mealtime atmosphere and media consumption. The correlation between atmosphere and TV consumption across all survey days was very small but in the expected negative direction; the correlations with smartphone consumption were near zero. One likely explanation for these findings could be the little variance regarding norms and behaviors pertaining to media use at the meal table in our sample: In over 90% of the reported meals, TVs and smartphones were turned off. There are likely to be notable cultural differences. Even though family culture in Germany seem to mostly ban the use of media during meals, having the TV turned on during meals is very common in other European countries such as Greece and Portugal (Roos et al., 2014). Further, self-report of media use

Table 4
Prediction of Child's fruit and vegetable intake through mealtime routines.

Effect	Estimate	SE	95% CI LL	95% CI UL	p
Fixed effects					
Intercept	.11	.10	-.08	.31	.248
Duration	-.01	.03	-.06	.05	.787
Involvement	.04	.02	-.01	.08	.101
Atmosphere	.10	.02	.05	.14	<.001
Veg and fruit intake parent	.52	.03	.47	.58	<.001
Deliberate parental modeling	-.03	.02	-.08	.01	.156
Quality	.05	.09	-.13	.22	.593
Smartphone	-.02	.02	-.06	.03	.425
TV	-.01	.02	-.06	.04	.630
Offered	.22	.03	.16	.28	<.001
Intervention group	-.04	.07	-.18	.09	.526
Active control group	.04	.07	-.10	.17	.602
Weekend	-.02	.04	-.11	.07	.655
Random effects					
Within-family variance	.39	.62			
Between-family variance	.12	.34			

Note. Total N = 305. All continuous variables were scaled by dividing the centered columns by their standard deviation to allow comparison of coefficients. Group is dummy-coded with the passive control group as the baseline condition. Veg and fruit = Number of consumed portions of fruits and vegetables during the meal; offered = number of different types of fruit and vegetables offered; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. Conditional $R^2 = 0.552$.

and atmosphere could be biased by social desirability. Understanding when and why media use is negatively related to mealtime atmosphere would be an important next step.

Supporting Hypothesis 2b, we found the largest correlations between family mealtime routines for atmosphere and duration, corroborating past preliminary research (Feunekes et al., 1995; Vlahovic et al., 2012). Surprisingly and contrary to Hypothesis 2c, we found a very small relation between children's involvement in meal preparation and the meal being prepared at home. One may expect that the involvement of children in the preparation of dinner would be higher if the meal was homemade. A possible explanation could again be the small variance in meal preparation: Nearly all meals were prepared at home.

Two exploratory observations seem noteworthy: First, we found a comparably large correlation between meal atmosphere and the child's involvement in meal preparation. This is interesting, because involving children more in meal preparation could not only have direct effects on child nutrition, but also indirect beneficial effects via the fostering of the mealtime atmosphere. A lighter atmosphere may make family meals more enjoyable and thereby increase their frequency. Frequency of family meals and positive mealtime atmosphere, in turn, are related to better nutritional health in children (Dallacker et al., 2018). Second, even though medium to high correlations were observed between parents' and children's fruit and vegetable intake, the relation between deliberate parental modeling and the child's fruit and vegetable intake was small. A similar pattern emerges for Hypothesis 3: We found a notable, significant effect of parental modeling predicting children's fruit and vegetable intake only when operationalized as actual parental fruit and vegetable intake, not as deliberately performed modeling. This is relevant as the differentiation between actual behavior and deliberate modeling has not been considered in previous studies (see, e.g., Dallacker et al., 2019, for a meta-analysis).

Consistent with previous research and partially supporting Hypothesis 3, a more positive meal atmosphere predicted higher fruit and vegetable intake across the three experimental groups and independent of the experimental manipulation of atmosphere. Despite its predictive power in family meals, we still know little about what exactly constitutes a positive atmosphere. Does a positive atmosphere mean that everyone at the table is happy; that conversations are interesting, or that the food tastes good? A number of observational and self-report instruments differentiate aspects of mealtime atmosphere, such as emotional atmosphere, meal enjoyment, or positive social communication (Skafida, 2013; Trofholz et al., 2017). Our modest understanding of "positive atmosphere" might explain the failure in manipulating family atmosphere. For example, the active control group, instructed to talk about any topic, reported a more positive atmosphere than the intervention group, instructed to converse about positive things only. This finding might indicate that talking about something is better than not talking at all, or that families are naturally inclined or have learnt to raise enjoyable topics during family meals. It is also conceivable that an honest exchange about more serious topics can have a positive effect on the atmosphere at mealtimes if they have been discussed together as a family.

In contrast to Hypothesis 3 and the findings in Dallacker et al.'s (2019) meta-analysis, none of the other mealtime routines were predictive of children's fruit and vegetable intake during meals. We can think of several reasons for this lack of association. First, by covering a longer period, this study's setting differs from that of previous studies. Further, this is the first study to test all routines together in a single model, and, therefore, the influence of one mealtime routine is being controlled for all other routines. Third, more research across different settings and with potentially more fine-grained operationalizations of routines could further improve our understanding about what makes family meals healthy.

4.1. Limitations, strengths, and future research

Major strengths of this study are its large, diverse sample and the daily assessment design on up to 7 consecutive days. This study is a self-report online survey and relies on participants' recall of family meals and routines. While this ensures information about everyday family meal settings without potentially obtrusive observers or technology, self-reports can be subject to social desirability or perception bias. This might be especially the case for topics such as a positive meal atmosphere, for which our data suggest a positive ceiling effect. This should be considered when interpreting the results. The diary design, however, can help reduce recall biases, as the time between meal and survey is relatively short. This method complements and extends findings from previous studies that were based on cross-sectional questionnaires or one-time observations of families in the laboratory or their home.

We are not aware of external criteria for what constitutes a "long" meal duration, and therefore we evaluated the duration of meals with respect to the data in our current sample. While this is a sensible approach given the high variability within and between families, additionally asking participants for a subjective rating of mealtime duration (e.g., whether a meal was shorter or longer than usual) might be a helpful indicator for mealtime duration in future studies.

One limitation is that the children's point of view was not assessed in this study. Rather, their parents answered items on behalf of the children (e.g., about fruit and vegetable consumption, the mood at the table, or the use of media). Importantly, given the large age range of children participating in this study (3–17 years) this was the most reliable and coherent way to obtain data on children's behavior in the current study setting.

Our diary study focused on the mealtime routines obtained as predictors for nutritional health that Dallacker et al. (2019) obtained. We extended TV use during mealtimes by adding smartphone use. In future research it would be interesting to extend the list of routines. Candidates include the availability and frequency of fruit and vegetable portions at the family meal. While this variable was treated as a control variable in the current study, understanding what predicts the number of portions offered as well as also including other indicators of healthy nutrition could further advance this field of research.

Generally, experimental research and randomized control trials are needed to better understand the causal relations between family mealtime routines and characteristics and the nutritional health of the family members. One notable exception is the experiment by Fiese et al. (2015), finding detrimental effects of auditory noise (which could be one aspect of mealtime atmosphere) on children's nutrition.

5. Conclusion

Our goal was to contribute to a better understanding of the prevalence of family mealtime routines and their effects on healthy nutritional behaviors. We find them to be practiced in daily family meals, they represent distinct behaviors, and they partly predict children's nutritional health in the context of actual families. The research on the important social institution family meal is, however, still nascent. Much more needs to be done to better understand the routines by analyzing their individual components, to find causal evidence of their predictive power toward nutritional health using randomized control trials, and to refine theoretical frameworks of family systems for health promotion. The efforts promise high returns as family meals, as the cradle of eating behavior, are a promising and low-threshold intervention approach to improve children's nutrition and overall health.

Author contributions

Vanessa Knobl Conceptualization Formal analysis Visualization Writing: Original draft Mattea Dallacker Conceptualization Methodology Writing: Review and Editing Ralph Hertwig Conceptualization Writing: Review and Editing Jutta Mata Conceptualization Funding acquisition Methodology Project Administration Supervision Writing: Review and Editing.

Funding

This study was financially supported by an internal fund of the University of Mannheim.

Ethical statement

Hereby, I, Vanessa Knobl, consciously assure that for the manuscript 'Happy and healthy: How family mealtime routines relate to child nutritional health' the following is fulfilled:

1) This material is the authors' own original work, which has not been previously published elsewhere.
2) The paper is not currently being considered for publication elsewhere.
3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
5) The results are appropriately placed in the context of prior and existing research.
6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.
8) This study was approved by ethics commission of the University of Mannheim.

Declaration of competing interest

None.

Acknowledgements

We are grateful to Anita Todd for editing this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2022.105939.

References

Berge, J. M., Rowley, S., Trofholz, A., Hanson, C., Rueter, M., MacLehose, R. F., & Neumark-Sztainer, D. (2014). Childhood obesity and interpersonal dynamics during family meals. *Pediatrics, 134*(5), 923–932. https://doi.org/10.1542/peds.2014–1936

Breunig, V. C., Handel, M., & Kessler, B. (2020). *Massenkommunikation 1964-2020: Mediennutzung im Langzeitvergleich* (Vols. 7–8) pp. 410–432). Media Perspektiven.

Chu, Y. L., Farmer, A., Fung, C., Kuhle, S., Storey, K. E., & Veugelers, P. J. (2013). Involvement in home meal preparation is associated with food preference and self-efficacy among Canadian children. *Public Health Nutrition, 16*(1), 108–112. https://doi.org/10.1017/S1368980012001218

Dallacker, M., Hertwig, R., & Mata, J. (2018). The frequency of family meals and nutritional health in children: A meta-analysis: Family meals and children's health. *Obesity Reviews, 19*(5), 638–653. https://doi.org/10.1111/obr.12659

Dallacker, M., Hertwig, R., & Mata, J. (2019). Quality matters: A meta-analysis on components of healthy family meals. *Health Psychology, 38*(12), 1137–1149. https://doi.org/10.1037/hea0000801

Dallacker, M., Mata, J., & Hertwig, R. (2017). *Longer meal duration increases healthy eating in children. An experimental study*. Padua: EHPS.

Davison, K. K., Jurkowski, J. M., & Lawson, H. A. (2013). Reframing family-centred obesity prevention using the Family Ecological Model. *Public Health Nutrition, 16*(10), 1861–1869. https://doi.org/10.1017/S1368980012004533

Dwyer, R. J., Kushlev, K., & Dunn, E. W. (2018). Smartphone use undermines enjoyment of face-to-face social interactions. *Journal of Experimental Social Psychology, 78*, 233–239. https://doi.org/10.1016/j.jesp.2017.10.007

Feunekes, G. I. J., de Graaf, C., & van Staveren, W. A. (1995). Social facilitation of food intake is mediated by meal duration. *Physiology & Behavior, 58*(3), 551–558. https://doi.org/10.1016/0031-9384(95)00087-Y

Fiese, B. H., Jones, B. L., & Jarick, J. M. (2015). Family mealtime dynamics and food consumption: An experimental approach to understanding distractions. *Couple and Family Psychology: Research and Practice, 4*(4), 199–211. https://doi.org/10.1037/cfp0000047

Frank, M., Brettschneider, A.-K., Lage Barbosa, C., & Mensink, G. B. (2019). Prevalence and temporal trends of shared family meals in Germany. Results from EsKiMo II. *Ernahrungs Umschau, 66*(4), 60–67. https://doi.org/10.4455/eu.2019.013

Fulkerson, J. A., Loth, K., Bruening, M., Berge, J., Eisenberg, M. E., & Neumark-Sztainer, D. (2014). Time 2 tlk 2nite: Use of electronic media by adolescents during family meals and associations with demographic characteristics, family characteristics, and foods served. *Journal of the Academy of Nutrition and Dietetics, 114*(7), 1053–1058. https://doi.org/10.1016/j.jand.2013.10.015

Glanz, K., Metcalfe, J. J., Folta, S. C., Brown, A., & Fiese, B. (2021). Diet and health benefits associated with in-home eating and sharing meals at home: A systematic review. *International Journal of Environmental Research and Public Health, 18*(4). https://doi.org/10.3390/ijerph18041577. Article 1577.

Golan, M., & Weizman, A. (2001). Familial approach to the treatment of childhood obesity: Conceptual model. *Journal of Nutrition Education, 33*(2), 102–107. https://doi.org/10.1016/S1499-4046(06)60173-5

Harris, T. S., & Ramsey, M. (2015). Paternal modeling, household availability, and paternal intake as predictors of fruit, vegetable, and sweetened beverage consumption among African American children. *Appetite, 85*, 171–177. https://doi.org/10.1016/j.appet.2014.11.008

Horodynski, M. A., Stommel, M., Brophy-Herb, H. E., & Weatherspoon, L. (2010). Mealtime television viewing and dietary quality in low-income African American and Caucasian mother–toddler dyads. *Maternal and Child Health Journal, 14*(4), 548–556. https://doi.org/10.1007/s10995-009-0501-2

Kuznetsova, A., Brockhoff, P. B., Christensen, R. H. B., & Jensen, S. P. (2020). lmerTest: Tests in linear mixed effects models, 3.1-3) [Computer software] https://CRAN.R-project.org/package=lmerTest.

Larson, N. I., Neumark-Sztainer, D., Hannan, P. J., & Story, M. (2007). Family meals during adolescence are associated with higher diet quality and healthful meal patterns during young adulthood. *Journal of the American Dietetic Association, 107*(9), 1502–1510. https://doi.org/10.1016/j.jada.2007.06.012

Martin-Biggers, J., Spaccarotella, K., Berhaupt-Glickstein, A., Hongu, N., Worobey, J., & Byrd-Bredbenner, C. (2014). Come and get it! A discussion of family mealtime literature and factors affecting obesity risk. *Advances in Nutrition, 5*(3), 235–247. https://doi.org/10.3945/an.113.005116

Metcalfe, J. J., & Fiese, B. H. (2018). Family food involvement is related to healthier dietary intake in preschool-aged children. *Appetite, 126*, 195–200. https://doi.org/10.1016/j.appet.2018.03.021

Michaelson, V., Pilato, K. A., & Davison, C. M. (2021). Family as a health promotion setting: A scoping review of conceptual models of the health-promoting family. *PLoS ONE, 16*(4), Article e0249707. https://doi.org/10.1371/journal.pone.0249707

Middleton, G., Golley, R., Patterson, K., Le Moal, F., & Coveney, J. (2020). What can families gain from the family meal? A mixed-papers systematic review. *Appetite, 153*. https://doi.org/10.1016/j.appet.2020.104725. Article 104725.

Musher-Eizenman, D., & Holub, S. (2007). Comprehensive Feeding Practices Questionnaire: Validation of a new measure of parental feeding practices. *Journal of Pediatric Psychology, 32*(8), 960–972. https://doi.org/10.1093/jpepsy/jsm037

Neuhauser, H., Schienkiewitz, A., Rosario, A. S., Dortschy, R., & Kurth, B.-M. (2013). *Referenzperzentile für anthropometrische Maßzahlen und Blutdruck aus der Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (KiGGS)*. Robert Koch Institute. https://doi.org/10.25646/3179

Øverby, N. C., Hillesund, E. R., Røed, M., & Vik, F. N. (2020). Association between parental feeding practices and shared family meals. The Food4toddlers study. *Food & Nutrition Research, 64*. https://doi.org/10.29219/fnr.v64.4456

Robson, S. M., McCullough, M. B., Rex, S., Munafò, M. R., & Taylor, G. (2020). Family meal frequency, diet, and family functioning: A systematic review with meta-analyses. *Journal of Nutrition Education and Behavior, 52*(5), 553–564. https://doi.org/10.1016/j.jneb.2019.12.012

Roos, E., Pajunen, T., Ray, C., Lynch, C., Kristiansdottir, Á. G., Halldorsson, T. I., Thorsdottir, I., te Velde, S. J., Krawinkel, M., Behrendt, I., de Almeida, M. D. V., Franchini, B., Papadaki, A., Moschandreas, J., Ribič, C. H., Petrova, S., Duleva, V., Simčič, I., & Yngve, A. (2014). Does eating family meals and having the television on during dinner correlate with overweight? A sub-study of the pro greens project, looking at children from nine European countries. *Public Health Nutrition, 17*(11), 2528–2536. https://doi.org/10.1017/S1368980013002954

Rosemond, T. N., Blake, C. E., Shapiro, C. J., Burke, M. P., Bernal, J., Adams, E. J., & Frongillo, E. A. (2019). Disrupted relationships, chaos, and altered family meals in food-insecure households: Experiences of caregivers and children. *Journal of the Academy of Nutrition and Dietetics, 119*(10), 1644–1652. https://doi.org/10.1016/j.jand.2019.05.005

RStudio Team. (2020). *RStudio*. Integrated Development Environment for R (1.3.959) [Computer software]. RStudio, PBC. URL http://www.rstudio.com/.

Skafida, V. (2013). The family meal panacea: Exploring how different aspects of family meal occurrence, meal habits and meal enjoyment relate to young children's diets: The family meal panacea. *Sociology of Health & Illness, 35*(6), 906–923. https://doi.org/10.1111/1467-9566.12007

Sweetman, C., McGowan, L., Croker, H., & Cooke, L. (2011). Characteristics of family mealtimes affecting children's vegetable consumption and liking. *Journal of the American Dietetic Association, 111*(2), 269–273. https://doi.org/10.1016/j.jada.2010.10.050

Trofholz, A. C., Tate, A. D., Miner, M. H., & Berge, J. M. (2017). Associations between TV viewing at family meals and the emotional atmosphere of the meal, meal healthfulness, child dietary intake, and child weight status. *Appetite, 108*, 361–366. https://doi.org/10.1016/j.appet.2016.10.018

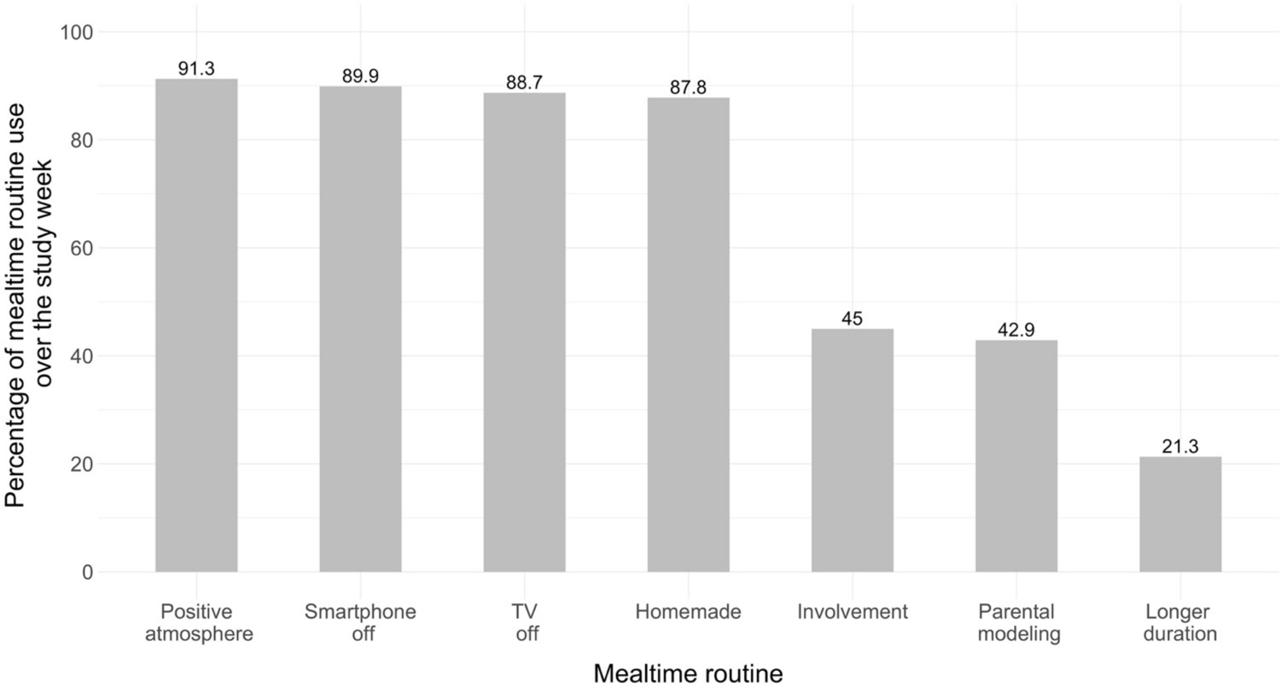
Vlahovic, T. A., Roberts, S., & Dunbar, R. (2012). Effects of duration and laughter on subjective happiness within different modes of communication: Happiness and mode of communication. *Journal of Computer-Mediated Communication, 17*(4), 436–450. https://doi.org/10.1111/j.1083-6101.2012.01584.x

Wickham, H., Chang, W., Henry, L., Pedersen, T. L., Takahashi, K., Wilke, C., Woo, K., Yutani, H., Dunnington, D., & RStudio. (2021). *ggplot2: Create elegant data visualisations using the grammar of graphics*, 3.3.4) [Computer software] https://CRAN.R-project.org/package=ggplot2.

Supplements

Figure 1a

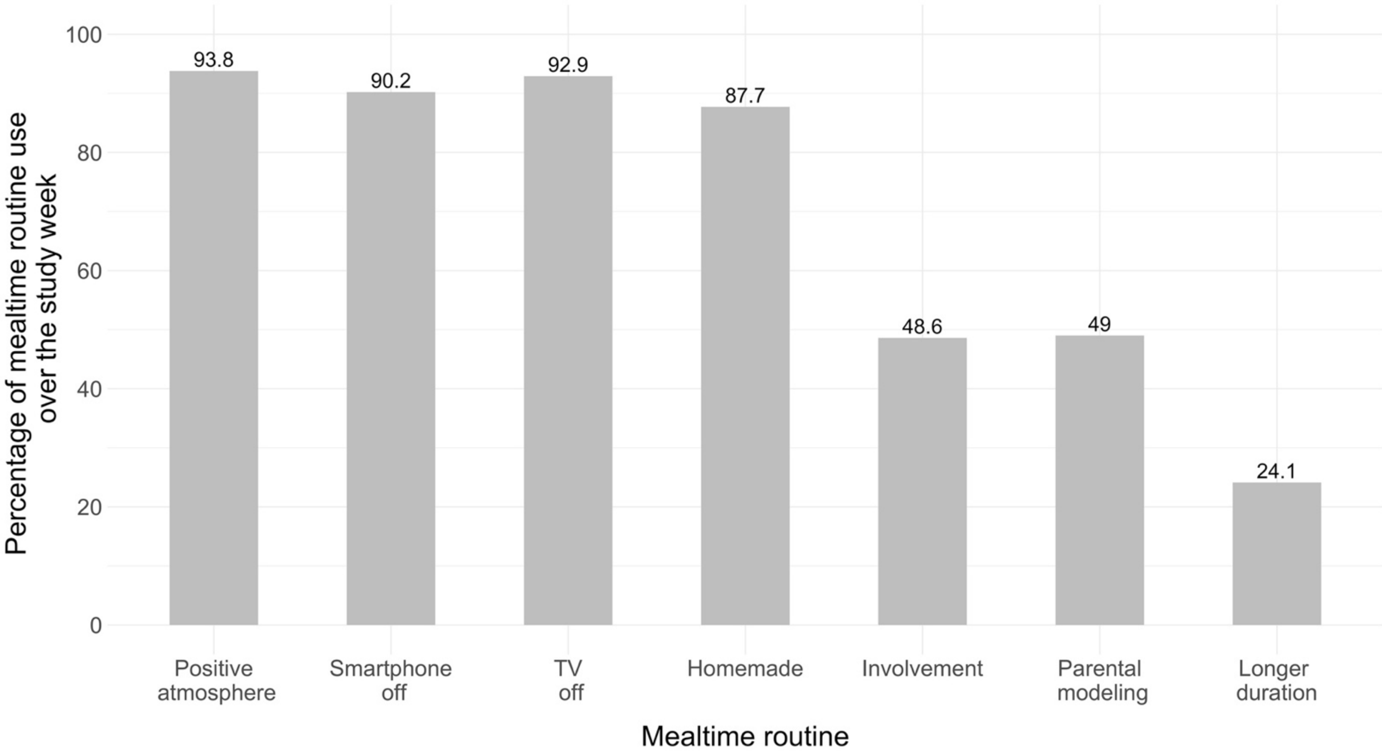
Frequency of 7 family mealtime routines families describe on average for passive control group



Note. Smartphone off/ TV off = all meals for which "never" was the chosen answer category; quality = all meals where the answer to the homemade-item was "yes"; positive atmosphere = all meals with an item-score > 3; longer duration=all meals which take at least 10% longer than the mode; involvement= all meals for which the answer was at least "little involved", parental modeling = all meals for which the item asking for eating fruits and vegetables deliberately were answered with at least "somewhat true".

Figure 1b

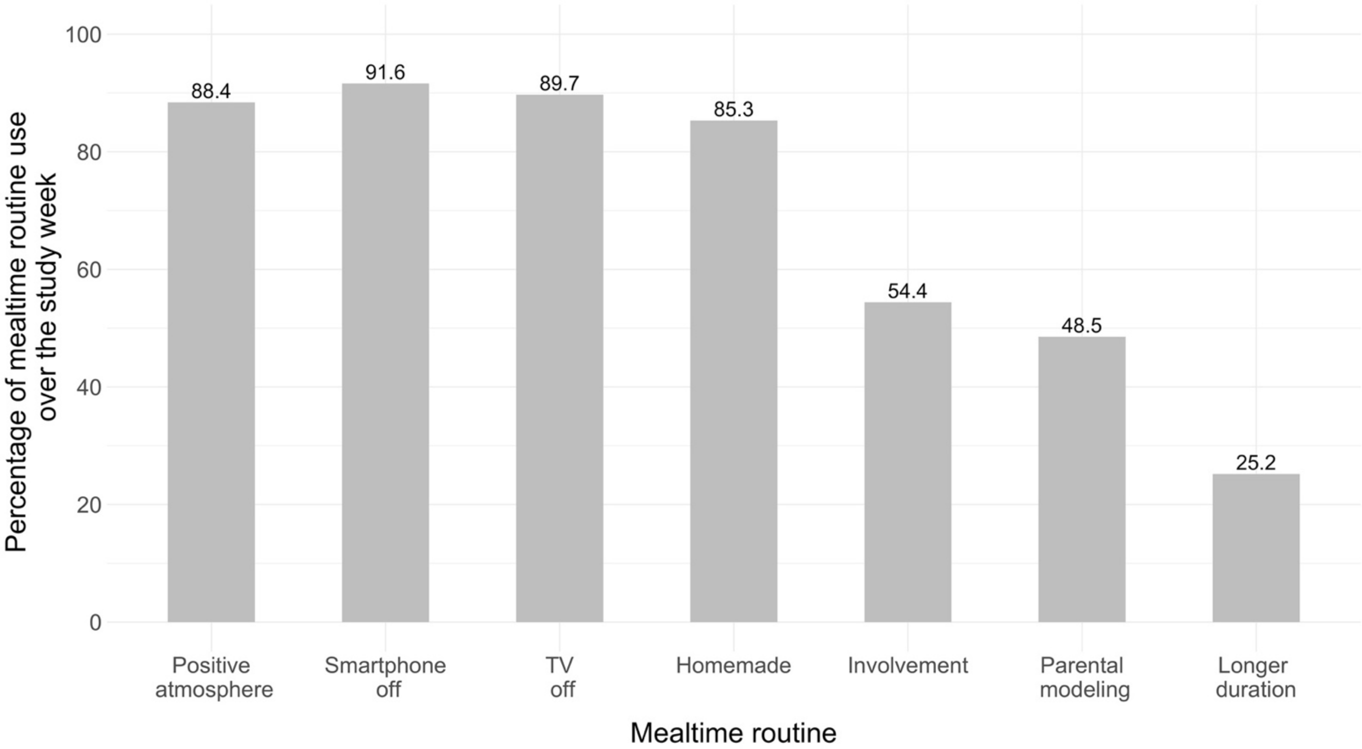
Frequency of 7 family mealtime routines families describe on average for active control group



Note. Smartphone off/ TV off = all meals for which "never" was the chosen answer category; quality = all meals where the answer to the homemade-item was "yes"; positive atmosphere = all meals with an item-score > 3; longer duration=all meals which take at least 10% longer than the mode; involvement= all meals for which the answer was at least "little involved", parental modeling = all meals for which the item asking for eating fruits and vegetables deliberately were answered with at least "somewhat true".

Figure 1c

Frequency of 7 family mealtime routines families describe on average for intervention group



Note. Smartphone off/ TV off = all meals for which "never" was the chosen answer category; quality = all meals where the answer to the homemade-item was "yes"; positive atmosphere = all meals with an item-score > 3; longer duration=all meals which take at least 10% longer than the mode; involvement= all meals for which the answer was at least "little involved", parental modeling = all meals for which the item asking for eating fruits and vegetables deliberately were answered with at least "somewhat true".

Table 3a

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 1

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.26	0.87								
2.Smartphone	1.12	0.39	-.03 [-.16, .10]							
3. Atmosphere	4.12	0.56	.00 [-.13, .13]	-.03 [-.16, .10]						
4. Involvement	2.05	1.07	-.04 [-.17, .10]	.06 [-.07, .20]	.20** [.07, .33]					
5. Duration	29.05	13.62	-.01 [-.14, .12]	-.00 [-.14, .13]	.26** [.13, .37]	.21** [.08, .33]				
6. Homemade	0.90	0.30	.05 [-.08, .18]	.03 [-.10, .16]	.12 [-.01, .25]	-.07 [-.20, .06]	-.06 [-.19, .07]			
7. Deliberate modeling	2.72	1.14	-.08 [-.24, .07]	-.07 [-.22, .09]	-.04 [-.20, .11]	-.07 [-.22, .09]	-.21** [-.35, -.05]	-.01 [-.16, .15]		
8. Veg and fruit parent	1.00	1.25	.03 [-.10, .16]	.00 [-.13, .13]	.25** [.12, .37]	.02 [-.12, .15]	.20** [.07, .32]	.12 [-.01, .25]	.00 [-.15, .16]	
9. Veg and fruit child	0.86	1.14	-.02 [-.15, .11]	.08 [-.05, .21]	.25** [.12, .37]	.03 [-.10, .17]	.14* [.01, .27]	.17** [.04, .30]	-.14 [-.29, .01]	.71** [.66, .77]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal. *$p < .05$. **$p < .01$.

Table 3b

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 2

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.42	1.19								
2. Smartphone	1.10	0.36	-.01 [-.14, .12]							
3. Atmosphere	4.10	0.63	-.07 [-.20, .06]	.07 [-.06, .20]						
4. Involvement	1.81	1.01	-.11 [-.24, .02]	.03 [-.10, .16]	.00 [-.13, .14]					
5. Duration	29.75	13.75	-.03 [-.15, .10]	.07 [-.06, .20]	.22** [.09, .34]	.04 [-.10, .17]				
6. Homemade	0.89	0.32	-.08 [-.20, .05]	-.05 [-.18, .08]	.16* [.03, .28]	.05 [-.09, .18]	-.07 [-.20, .06]			
7. Deliberate modeling	2.60	1.25	-.06 [-.21, .09]	.01 [-.14, .15]	-.02 [-.17, .13]	.12 [-.03, .27]	-.01 [-.15, .14]	-.03 [-.17, .12]		
8. Veg and fruit parent	1.04	1.22	-.08 [-.21, .05]	-.07 [-.19, .06]	.17** [-.04, .30]	.13 [-.00, .26]	.12 [-.00, .25]	.24** [.11, .36]	.10 [-.05, .24]	
9. Veg and fruit child	0.92	1.08	-.10 [-.23, .03]	-.03 [-.16, .10]	.20** [.07, .32]	.11 [-.02, .24]	.14* [.01, .26]	.23** [.10, .35]	.07 [-.08, .21]	.83** [.79, .86]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal. *$p < .05$. **$p < .01$.

Table 3c

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 3

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.31	1.04								
2. Smartphone	1.10	0.34	-.04 [-.16, .09]							
3. Atmosphere	4.09	0.70	-.06 [-.19, .07]	.08 [-.05, .21]						
4. Involvement	1.92	1.04	-.06 [-.19, .07]	.05 [-.09, .18]	.17* [.04, .29]					
5. Duration	30.62	17.73	-.10 [-.22, .03]	.07 [-.06, .19]	.33** [.21, .44]	.07 [-.06, .20]				
6. Homemade	0.88	0.33	.02 [-.11, .15]	-.05 [-.18, .08]	.02 [-.11, .15]	.14* [.01, .26]	-.08 [-.20, .05]			
7. Deliberate modeling	2.58	1.26	-.05 [-.20, .10]	-.14 [-.28, .01]	-.00 [-.15, .15]	.23** [.08, .37]	-.12 [-.27, .03]	.19* [.04, .33]		
8. Veg and fruit parent	1.06	1.30	-.13 [-.25, .00]	-.08 [-.20, .05]	.10 [-.02, .23]	.03 [-.10, .16]	.05 [-.07, .18]	.18** [.06, .30]	.17** [.02, .31]	
9. Veg and fruit child	0.93	1.07	-.03 [-.16, .10]	-.04 [-.17, .09]	.18** [.06, .30]	.05 [-.09, .18]	.07 [-.06, .19]	.11 [-.02, .23]	.11 [-.04, .25]	.79** [.74, .83]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.
* $p < .05$. ** $p < .01$.

Table 3d

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 4

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.21	0.84								
2. Smartphone	1.11	0.38	.09 [-.03, .22]							
3. Atmosphere	4.10	0.70	-.08 [-.21, .04]	-.04 [-.16, .09]						
4. Involvement	1.92	1.14	-.18** [-.30, -.05]	.01 [-.13, .14]	.16* [.03, .29]					
5. Duration	33.27	23.10	-.09 [-.22, .03]	.17** [.05, .29]	.23** [.11, .35]	.10 [-.03, .23]				
6. Homemade	0.81	0.40	-.09 [-.21, .04]	-.18** [-.30, -.06]	-.05 [-.18, .07]	.16* [.03, .29]	-.27** [-.38, -.15]			
7. Deliberate modeling	2.49	1.25	-.07 [-.21, .07]	-.14 [-.28, .01]	.03 [-.11, .18]	.23** [.09, .37]	-.02 [-.17, .12]	.14 [-.01, .28]		
8. Veg and fruit parent	1.19	1.29	-.02 [-.14, .11]	.01 [-.12, .14]	.16* [.04, .28]	.18** [.05, .31]	.08 [-.04, .20]	.23** [.11, .35]	.17* [.03, .30]	
9. Veg and fruit child	1.02	1.13	-.05 [-.17, .08]	-.03 [-.16, .09]	.21** [.08, .32]	.26** [.13, .38]	.07 [-.06, .19]	.23** [.10, .34]	.13 [-.01, .27]	.79** [.75, .83]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.
* $p < .05$. ** $p < .01$

Table 3e

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 5

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.30	0.99								
2. Smartphone	1.08	0.27	.03 [-.10, .15]							
3. Atmosphere	3.94	0.66	-.08 [-.20, .05]	.07 [-.05, .20]						
4. Involvement	1.86	1.13	-.11 [-.23, .02]	.05 [-.08, .17]	.19** [.06, .31]					
5. Duration	28.10	13.62	-.00 [-.13, .12]	.03 [-.10, .15]	.19** [.07, .30]	.10 [-.02, .23]				
6. Homemade	0.88	0.33	-.12 [-.24, .01]	-.16* [-.28, -.03]	.04 [-.08, .16]	.17* [.04, .29]	-.19** [-.30, -.06]			
7. Deliberate modeling	2.43	1.30	-.05 [-.19, .09]	.00 [-.14, .15]	.11 [-.04, .25]	.07 [-.08, .22]	.01 [-.14, .15]	.05 [-.10, .19]		
8. Veg and fruit parent	1.22	1.42	.04 [-.09, .16]	-.06 [-.18, .07]	.19** [.07, .31]	.10 [-.03, .22]	.20** [.08, .31]	.06 [-.07, .18]	.06 [-.09, .20]	
9. Veg and fruit child	1.08	1.21	.01 [-.11, .14]	-.06 [-.18, .07]	.24** [.12, .36]	.16* [.04, .28]	.16* [.04, .28]	.04 [-.08, .16]	.00 [-.14, .14]	.78** [.73, .82]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.
* $p < .05$. ** $p < .01$.

Table 3f

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 6

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.28	0.95								
2. Smartphone	1.10	0.33	.11 [-.02, .24]							
3. Atmosphere	3.98	0.65	.05 [-.08, .18]	.03 [-.10, .16]						
4. Involvement	1.98	1.16	.05 [-.08, .19]	-.02 [-.15, .11]	.21** [.08, .34]					
5. Duration	28.00	13.33	-.08 [-.21, .05]	-.04 [-.17, .09]	.20** [.07, .32]	.04 [-.09, .18]				
6. Homemade	0.90	0.30	-.01 [-.14, .12]	-.09 [-.21, .05]	-.09 [-.22, .04]	.13 [-.00, .26]	-.16* [-.29, -.03]			
7. Deliberate modeling	2.21	1.15	-.08 [-.23, .07]	-.02 [-.17, .13]	.12 [-.03, .27]	.22** [.07, .36]	.10 [-.05, .24]	-.06 [-.21, .09]		
8. Veg and fruit parent	1.08	1.37	-.02 [-.15, .11]	-.13 [-.25, .00]	.12 [-.01, .25]	.12 [-.01, .25]	.32** [.20, .43]	.14* [.01, .27]	.27** [.12, .40]	
9. Veg and fruit child	0.90	1.16	-.01 [-.14, .12]	-.18** [-.30, -.05]	.10 [-.03, .23]	.11 [-.02, .24]	.28** [.15, .39]	.17* [.04, .29]	.20** [.05, .34]	.85** [.82, .88]

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.
* $p < .05$. ** $p < .01$.

Table 3g

Means, standard deviations, and correlations between mealtime routines with confidence intervals for study day 7

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TV	1.29	0.96								
2. Smartphone	1.10	0.36	-.03 [-.16, .10]							
3. Atmosphere	4.01	0.68	-.14* [-.26, -.01]	.01 [-.12, .14]						
4. Involvement	1.88	1.11	.04 [-.09, .17]	.06 [-.07, .19]	.13 [-.01, .26]					
5. Duration	27.67	12.52	-.03 [-.16, .10]	.22** [.09, .34]	.30** [.18, .41]	.17* [.03, .29]				
6. Homemade	0.87	0.34	.04 [-.09, .17]	-.07 [-.20, .06]	-.07 [-.20, .06]	.08 [-.05, .21]	-.19** [-.31, -.06]			
7. Deliberate modeling	2.21	1.15	.08 [-.07, .22]	-.07 [-.22, .08]	.00 [-.14, .15]	.09 [-.06, .24]	.04 [-.11, .19]	.07 [-.08, .22]		
8. Veg and fruit parent	1.08	1.31	-.07 [-.20, .06]	-.09 [-.22, .04]	.24** [.11, .36]	.08 [-.05, .21]	.22** [.10, .34]	-.01 [-.14, .12]	.14 [-.01, .28]	
9. Veg and fruit child	0.96	1.20	-.06 [-.19, .07]	-.05 [-.18, .08]	.21** [.08, .33]	.14* [.00, .27]	.25** [.12, .37]	-.03 [-.16, .10]	.05 [-.10, .20]	.78** [.74, .82]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.
* $p < .05$. ** $p < .01$.

Table 3h

Correlations between mealtime routines averaged over weekdays (Mon-Fri) with minimum and maximum correlation.

Variable	1	2	3	4	5	6	7	8
1. TV								
2. Smartphone	.03 [-.02, .11]							
3. Atmosphere	-.05 [-.14, .09]	.05 [.02, .07]						
4. Involvement	-.04 [-.13, .07]	.04 [-.04, .09]	.15 [.02, .12]					
5. Duration	-.04 [-.16, .00]	.09 [-.03, .18]	.21 [.11, .31]	.09 [.01, .15]				
6. Homemade	-.04 [-.17, .06]	-.07 [-.11, .00]	.05 [-.02, .14]	.09 [.05, .13]	-.12 [-.17, .00]			
7. Deliberate modeling	-.05 [-.17, .02]	-.08 [-.15, .00]	.05 [-.08, .18]	.12 [-.03, .29]	-.01 [-.08, .05]	.05 [.01, .12]		
8. Veg and fruit parent	-.04 [-.12, .06	-.08 [-.01, -.07]	.18 [.13, .23]	.07 [.03, .14]	.22 [.08, .38]	.15 [.09, .19]	.11 [.04, .19]	
9. Veg and fruit child	-.03 [-.12, .14]	-.06 [-.12, .00]	.22 [.12, .28]	.10 [.02, .21]	.21 [.08, .31]	.11 [.04, .18]	.03 [-.08, .16]	.77 [.71, .82]

Note. Values in square brackets are min and max correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.

Table 3i

Correlations between mealtime routines averaged over weekend days (Sat & Sun) with minimum and maximum correlation.

Variable	1	2	3	4	5	6	7	8
1. TV								
2. Smartphone	-.03 [-.06, .01]							
3. Atmosphere	-.06 [-.09, -.03]	-.01 [-.06, .04]						
4. Involvement	-.11 [-.13, -.09]	.03 [.01, .05]	.14 [.07, .20]					
5. Duration	-.06 [-.06, -.06]	.07 [.04, .11]	.27 [.26, .28]	.10 [.09, .11]				
6. Homemade	-.02 [-.08, .05]	-.11 [-.13, -.10]	-.04 [-.06, -.03]	.13 [.12, .13]	-.20 [-.28, -.11]			
7. Deliberate modeling	-.05 [-.12, .01]	-.03 [-.04, -.20]	.00 [.00, .01]	.18 [.09, .27]	-.04 [-.04, -.03]	.10 [.09, .11]		
8. Veg and fruit parent	-.02 [-.09, .04]	.00 [-.01, .00]	.13 [.12, .13]	.16 [.08, .24]	.05 [.03, .07]	.11 [0.1, .12]	.16 [.07, .25]	
9. Veg and fruit child	-.04 [-.06, -.02]	.02 [-.01, .05]	.13 [.17, .18]	.19 [.14, .24]	.05 [.04, .05]	.17 [.12, .22]	.12 [.02, .21]	.83 [.82, .85]

*Note.*Values in square brackets are min and max correlation. Includes besides mealtime routines also child's fruit and vegetable intake. Veg = vegetable consumption during the meal. Fruit = fruit consumption during the meal.

Table 3j

Correlations Between Mealtime Routines Averaged Over All 7 Study Days for Intervention Group

Variable	1	2	3	4	5	6	7	8
1. TV								
2. Smartphone	0.02 [-.09, .21]							
3. Atmosphere	-.02 [-.23, .22]	.03 [-.11, .12]						
4. Involvement	-.05 [-.25, .09]	.10 [-.08, .32]	.16 [.03, .31]					
5. Duration	-.08 [-.14, .02]	.14 [.06, .27]	.24^{+} [.06, .33]	.13 [-.08, .37]				
6. Quality	.00 [-.10, .11]	-.12 [-.34, .10]	.05 [-.12, .18]	.12 [-.01, .20]	-.13 [-.30, .00]			
7. Deliberate modeling	-.04 [-.12, .10]	-.08 [-.22, .04]	-.02 [-.25, .13]	.06 [-.17, .24]	.05 [-.04, .24]	[-.14, .16]		
8. Veg and fruit parent	-.04 [-.19, .07]	-.01 [-.22, .26]	.18 [.01, .29]	.04 [-.06, .14]	.14 [.01, .40]	.15 [.04, .27]	.14 [.03, .28]	
9. Veg and fruit child	-.10 [-.26, .01]	-.04 [-.27, .21]	.22 [.12, .33]	.08 [-.11, .27]	.15 [.06, .25]	.18 [.07, .24]	.11 [-.08, .17]	.78* [.71, .87]

Note. Values in square brackets represent minimum and maximum correlations during the 7-day study period. Veg and fruit = Vegetable and fruit intake during the meal.
*p < .05 on all 7 study days. ^{+}p < .05 on 4 or more study days.

Table 3k

Correlations Between Mealtime Routines Averaged Over All 7 Study Days for Active Control Group

Variable	1	2	3	4	5	6	7	8
1. TV								
2. Smartphone	0.05 [-.08, .14]							
3. Atmosphere	-.10 [-.20, .08]	-.02 [-.17, .08]						
4. Involvement	-.13 [-.21, .08]	-.03 [-.11, .08]	.18 [.00, .36]					
5. Duration	.03 [-.10, .14]	.05 [-.12, .27]	.29+ [.15, .43]	.11 [-.04, .24]				
6. Quality	-.08 [-.22, .08]	-.08 [-.26, .05]	.02 [-.23, .24]	.07 [-.04, .22]	-.14 [-.36, .18]			
7. Deliberate modeling	.00 [-.14, .11]	-.11 [-.30, .00]	.04 [-.15, .12]	.18 [.05, .32]	-.03 [-.25, .07]	.09 [-.13, .23]		
8. Veg and fruit parent	.00 [-.14, .32]	-.07 [-.13, -.01]	.26+ [.13, .37]	.11 [-.01, .26]	.21 [-.07, .44]	.17 [-.10, .40]	.15 [.04, .29]	
9. Veg and fruit child	.00 [-.10, .24]	-.01 [-.12, .09]	.24+ [.06, .33]	.14 [.04, .25]	.18 [-.11, .32]	.15 [-.12, .4]	.04 [-.06, .25]	.83* [.78, .90]

Note. Values in square brackets represent minimum and maximum correlations during the 7-day study period. Veg and fruit = Vegetable and fruit intake during the meal.
**p < .05 on all 7 study days. +p < .05 on 4 or more study days.*

Table 3l

Correlations Between Mealtime Routines Averaged Over All 7 Study Days for Passive Control Group

Variable	1	2	3	4	5	6	7	8
1. TV								
2. Smartphone	.00 [-.11, .36]							
3. Atmosphere	-.05 [-.27, .10]	.07 [-.18, .17]						
4. Involvement	.01 [-.13, .28]	.02 [-.11, .18]	.10 [-.06, .18]					
5. Duration	-.07 [-.20, .16]	.00 [-.21, .29]	.21+ [-.03, .30]	.06 [-.07, .23]				
6. Quality	-.01 [-.12, .11]	-.04 [-.37, .11]	-.03 [-.17, .13]	.09 [-.22, .22]	-.11 [-.29, .10]			
7. Deliberate modeling	-.10 [-.28, .03]	.02 [-.09, .12]	.07 [-.08, .25]	.13 [-.11, .34]	-.14 [-.29, -.01]	.08 [-.03, .22]		
8. Veg and fruit parent	-.04 [-.21, .11]	-.10 [-.26, .06]	.08 [-.04, .22]	.11 [-.03, .26]	.14 [-.01, .35]	.11 [-.01, .29]	.09 [-.14, .30]	
9. Veg and fruit child	.01 [-.13, .17]	-.06 [-.18, .02]	.11 [-.04, .26]	.14 [-.02, .30]	.12 [.00, .25]	.08 [-.01, .26]	.04 [-.21, .22]	.77* [.64, .84]

Note. Values in square brackets represent minimum and maximum correlations during the 7-day study period. Veg and fruit = Vegetable and fruit intake during the meal.
**p < .05 on all 7 study days. +p < .05 on 4 or more study days.*

Table 6

Effects of group membership on mealtime atmosphere and child's fruit and vegetable

	Atmosphere					Fruit and vegetable intake				
	Estimate	*SE*	*CI*		*p*	*Estimate*	*SE*	*CI*		*p*
			LL	*UL*				LL	*UL*	
Fixed effects										
Intervention group (Intercept)	-.10	.06	-.22	.01	.086	.02	.06	-.09	.13	.768
Passive control group	.06	.09	-.11	.23	.501	-.10	.08	-.25	.06	.236
Active control group	.27	.09	.10	.44	.002	.04	.08	-.11	.20	.584
Random Effects										
Within family variance	.75	.87				.78	.88			
Between family variance	.24	.49				.22	.47			

Note. Total N= 310. Group is dummy-coded with intervention group as baseline condition. CI = confidence interval; *LL* = lower limit; *UL* = upper limit. Conditional R^2= .249 for atmosphere; R^2=.226 for fruit and vegetable intake.

Table 7

Contingency table of mealtime routines averaged over all 7 study days

Variable	1	2	3	4	5	6
1. TV off						
2. Smartphone off	80.88					
3. Positive atmosphere	86.50	87.56				
4. Involvement	51.91	52.24	51.41			
5. Longer duration	21.53	21.19	20.85	12.98		
6. Homemade	82.49	83.61	81.91	45.25	24.47	
7. Deliberate parental modeling	52.09	52.99	51.52	30.05	15.38	49.36

Note. % of all mealtimes, during which two mealtime routines occur together. Smartphone off and TV off = All meals for which “never” (i.e., never on) was the chosen answer category; homemade = all meals where the answer to the item was “yes” (i.e., homemade); positive atmosphere = all meals with an item score >3; longer duration = all meals that took at least 10% longer than the mode (33 min in this sample); involvement = all meals for which the answer was at least “a little involved”; parental modeling = all meals for which the item assessing if fruits and vegetables were eaten deliberately was answered with at least “somewhat true.”

Manuscript 3 – Hard to guess: Do parents' estimates of sugar, salt, and fat relate to family health?

Manuscript submitted for publication:

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2024). Hard to guess: *Do parents' estimates of sugar, salt, and fat relate to family health?* [Manuscript submitted for publication].

Aside from minor changes to the format, the manuscript included in this dissertation reflects the manuscript that was submitted for publication.

Abstract

Background: Knowledge about nutrients is essential for parents to provide healthy foods for their children. Previous studies have shown that parents greatly misestimate the sugar content of foods. Does this pattern also apply to other nutrients such as salt and fat? And how does estimation accuracy relate to parental numeracy, awareness of nutrients while grocery shopping, and family health?

Methods: A diverse sample of 508 parents estimated the added sugar, salt, and fat content of nine representative foods products. They did a short numeracy test and reported on various indicators of their own and their children's (6–12 years) health—including tooth decay and cardiovascular disease—and their use of nutritional information when grocery shopping. Height and weight of children and parents were measured.

Results: Parents misestimated the amount of nutrients (i.e., sugar, salt, and fat) by significantly more than 50% (M_{sugar}=77.75%, M_{salt}=242.27%, M_{fat}=69.67%, all $p < .001$). Parents with better numeracy estimated salt content more accurately (β = -0.10, p = .026). The more frequently parents paid attention to fat when grocery shopping, the more accurately they estimated fat (β = -0.10, p = .020). More frequent use of nutrition tables was related to higher accuracy in fat (β = -0.10, p = .028) and sugar (β = -0.11, p = .012) estimates. Surprisingly, there was no statistically significant correlation between the underestimation of nutrients and indicators of family health.

Conclusion: Parents considerably misestimated added sugar, salt, and fat in foods. Predictors of misestimation varied by nutrient. Range and direction of misestimation depended on nutrients and food products, with implications for the interpretation of previous studies and future research. Although knowledge alone is insufficient for healthy food-decisions, it is an easy starting point for policy measures aimed at helping parents make informed and healthy food choices for their families.

1. Introduction

Sugar, salt, and fat are omnipresent in our diets, but their overconsumption contributes to diet-related diseases. Excess sugar raises risks of weight gain, cardiovascular diseases, diabetes, and tooth decay (Malik et al., 2010; Moores et al., 2022; L. P. Santos et al., 2022). High salt intake increases cardiovascular risks by 6% per additional gram (Filippini et al., 2022; Wang et al., 2020). Similarly, reducing saturated and trans fats improves blood pressure, lipid levels, and cardiovascular outcomes (Hooper et al., 2020; Te Morenga & Montez, 2017).

Children and adolescents are particularly vulnerable, as eating habits form early (Mahmood et al., 2021) and childhood diseases often persist into adulthood (Simmonds et al., 2016). The World Health Organization (WHO) therefore recommends limiting added sugars and saturated fats to 10% of daily energy intake (World Health Organization, 2015, 2023), and salt to 2 g per day (World Health Organization, 2012). However, children and adolescents in Germany consume on average 1.5 times the recommended sugar and saturated fats (Libuda et al., 2014; Perrar et al., 2019) and triple the salt intake (Remer et al., 2022).

Parents strongly influence their children's nutrition as role models (Knobl et al., 2022; Mahmood et al., 2021) and decision-makers for family (Knobl & Mata, 2024). Food literacy—the knowledge, skills, and behaviors to make informed food choices—is essential for a healthy diet (Vidgen & Gallegos, 2014), including knowledge about commonly eaten family foods. Several studies have shown misestimations of nutrients: König et al. (2019) and Groß et al. (2024) found that students on average *overestimated* the sugar content, while Dallacker et al. (2018) showed that 74% of parents *underestimated* sugar. König et al. (2019) reported small correlations of misestimation with participants' body mass index (BMI), and Dallacker et al. (2018) specifically attributed this effect to underestimation.

1.1 Research Gaps

Why did parents mostly underestimate sugar content, while students often overestimate it? This difference may stem from demographic differences (as noted in König et al., 2019)—students, who are generally younger and more educated than average parents, may be more aware of sugar and its detrimental consequences, possibly prompting overestimation. Measurement methods also varied: Dallacker et al. (2018) used sugar cubes, whereas König et al. (2019) and Groß et al. (2024) asked for estimates in grams. Also, food items differed between studies, likely influencing estimates, in line with initial findings suggesting variation between under- and overestimation by food product (Dallacker et al, 2018; König et al., 2019). For salt, the one study we are aware of (Moran et al., 2017) found people tend to underestimate content; no study has yet assessed fat estimates in foods. A second indicator, knowledge about the relative ranking of products—does one product contain more salt or sugar than another?—known as mapping ability (following Brown & Siegler, 1993, 2001) has also not been examined in previous estimation studies.

Also, research on predictors of estimation accuracy is limited. The current study tested *awareness of specific nutrients* and *general numeracy* as possible predictors: Regular exposure to nutritional information such as labels, may improve intuitive estimation skills as a seeding intervention, where learning about one product aids in estimating others (Groß et al., 2024). General numeracy, the ability to understand and work with numbers (Schwartz, 1997), is also relevant: Dallacker et al. (2016) found a small correlation between numeracy and portion size estimations; Huizinga et al. (2009) reported that numeracy levels relate to the accuracy of portion size estimations, although this effect vanished when literacy was included in the model. Notably, research linking estimation accuracy to health outcomes has focused primarily on BMI.

1.2 Research Questions

We addressed the following research questions (RQs): (RQ1) How well can parents estimate nutrients of different foods? Given inconsistent evidence regarding the direction of any estimation bias (i.e., over- vs. underestimation), we hypothesized that parents *misestimate* the amount of sugar (Hypothesis [H] 1a) and salt (H1b) by more than 50%, which serves as our effect size of interest.[1] Given the scarce research on fat estimation, we explored whether parents misestimate fat amounts at all (Exploratory Question 1 [EQ1]). (RQ2) How does parents' underestimation of nutrients relate to health outcomes in parents and children? Based on evidence linking underestimation (of sugar) to higher BMIs, we hypothesized that the more parents underestimate the amount of (a) sugar, (b) salt, and (c) fat in foods, the more likely they are to experience nutrition-related health conditions themselves (H2) and have children with such conditions (H3). We additionally explored these relationships focusing on absolute misestimation, relative to systematic underestimation. (RQ3) What skills or behaviors predict parents' estimation skills? We hypothesized that parents' (a) general numeracy, (b) frequency of nutrition table use, and (c) attention to nutrients in foods during grocery shopping are positively associated with estimation skills for sugar (H4a–c), salt (H5a–c), and fat (H6a–c).

[1]Based on children eating 1.5 times the amount of sugar recommended (Perrar et al., 2019) and dose–response relationships between salt overconsumption and health consequences starting at 1.5 times the amount of salt recommended (Filippini et al., 2022).

2. Method

2.1 Data Transparency

This study was preregistered on OSF registries (https://osf.io/pwy6k/?view_only=6c06c9ed3e734f619afc67f64995366e). All data, analysis code, and supplemental material are freely available at https://osf.io/6tc74/?view_only=1bc0289ad030456993106704d1b5871e. This study was approved by the ethics committee of the Max Planck Institute for Human Development, Germany. Participants gave informed consent to participate in the study.

2.2 Design and Procedure

Adult participants were recruited via telephone by IPSOS, an independent opinion and social research institute. Eligible families were visited by an interviewer who guided them through a 45-min questionnaire and measured their weight and height at the end of the survey. To be eligible, participants needed to have at least one child aged between 6 and 12 years. Only the parent responsible for meal planning answered the questionnaire—both, with respect to themselves and the child with the most recent birthday.

2.3 Measures

2.3.1 Participant Characteristics

Participants reported their own and their child's age, gender, health conditions, diet, and allergies, as well as their own education, job situation, income, marital status, and household size.

2.3.2 Health Conditions of Parents and Children

Parents reported if they or their child had any of the following health conditions (yes/no): overweight, lipid metabolism disorder, Type 2 diabetes, hypertension, tooth decay, and other diseases. For "other diseases," participants' descriptions were reviewed if they were clearly related to diet; however, none were. Any "yes" response to specific diseases was coded as a "health condition." Additionally, parents and children were measured and weighed, and their BMI calculated as kg/m^2 (zBMI for children).

2.3.3 Numeracy

Parents solved three items based on the Basic Numeracy Scale (Schwartz, 1997): (1) A person taking drug A has a 1% chance of having an allergic reaction. If 1,000 people take drug A, how many would you expect to have an allergic reaction? ___ person(s) out of 1,000. (2) A person taking drug B has a 1 in 1,000 chance of having an allergic reaction. What percentage of people taking drug B will have an allergic reaction? ___ %. (3) Imagine you flip a coin 1,000 times. How many times do you think the coin will show "heads" within these 1,000 tosses? ___ times out of 1,000. A numeracy score was calculated using the total sum of correct responses (0–3 points).

2.3.4 Awareness of Specific Nutrients in Food Products

Parents reported on a 5-point Likert scale (never, rarely, occasionally, often, always) how often they use nutrition tables when buying or eating food. They also indicated on a 4-point Likert scale (always, most of the time, rarely, never) how often they consider sugar, fat, or salt in a product before buying it.

2.3.5 Estimation Task

The computer-based estimation task, based on Dallacker et al. (2018), used grams as measurement unit instead of sugar cubes to align with previous studies. Parents were first informed about WHO recommendations regarding added sugar, salt, and fat—ensuring standardization of their knowledge—and shown a picture of a teaspoon containing 10% of the recommended maximum amounts: 5 g of sugar, 0.6 g of salt, and 6.5 g of fat. They then estimated the amounts of added sugar, salt, and fat in pictures of nine different foods and beverages (e.g., "How many grams of added sugar do you think are in this glass of apple juice?"). Item selection was based on a master's thesis and was representative of the dietary habits of adults in Germany, as documented in the National Nutrition Survey (Nationale Verzehrsstudie, NVS; Max Rubner-Institut, 2008; Pfau et al., 2016), referencing foods commonly perceived as unhealthy (e.g., sugary, salty, fatty) and viewed as healthier (e.g., not sugary, salty, fatty). Portion sizes were derived either from the NVS average daily portions or from standard prepackaged portions. The products presented were apple juice, cola, 3.5% milk, chocolate bar, strawberry yogurt, pizza, cheesecake, sausage, and butter, shown in random order. Parental estimates were scored on the deviation between estimated and actual grams of sugar as well as salt and fat, weighting all food products equally. Four scores were calculated: (a) an absolute mean deviation score which reflected total misestimation across all items,

$$\frac{1}{Number\ food\ items} \sum_{i=1}^{Number\ food\ items} |estimated\ value_i - true\ value_i|$$

and (b) a signed mean deviation score to also capture over- and underestimation, with i being the respective food item.

$$\frac{1}{Number\ food\ items} \sum_{i=1}^{Number\ food\ items} estimated\ value_i - true\ value_i$$

Both mean deviation scores were calculated additionally as relative scores (as a percentage) for maximum comparability between nutrients, food products, and previous studies:

(c) absolute mean deviation score (as a percentage)

$$\frac{1}{Number\ food\ items} \times \frac{\sum_{i=1}^{Number\ food\ items} |estimated\ value_i - true\ value_i|}{\sum_{i=1}^{Number\ food\ items} true\ value_i} \times 100$$

(d) signed mean deviation score in (as a percentage)

$$\frac{1}{Number\ food\ items} \times \frac{\sum_{i=1}^{Number\ food\ items} estimated\ value_i - true\ value_i}{\sum_{i=1}^{Number\ food\ items} true\ value_i} \times 100$$

2.4 Participants

A total of 508 parents participated, age range 23 to 59 (*M* = 39.2 years, *SD* = 6.6) and children 6 to 12 (*M* = 9.2 years, *SD* = 2.1). The gender distribution was balanced for children, but 89% of parents were mothers. Of all parents, 92% reported not having a university degree and 84% worked at least part-time. On average, parents were slightly overweight (M_{BMI} = 26.34 kg/m^2, Mdn_{BMI} = 24.69), and children slightly heavier than average children their age (M_{zBMI} = 0.17, Mdn_{zBMI} = 0.32). Regarding health outcomes, 55% of parents reported having at least one conditions, whereas only about 9% of the children had any of these conditions (Table 1 for detailed sample characteristics).

2.5 Statistical Analyses

Missing values were highest for income (19%), but 0% for all outcome and predictor variables. We excluded 9 parents and 4 children who reported a height of less than 100 cm, and removed one parent with a BMI > 90 and 24 children with a zBMI 4 *SD* above or below the norm. Missing values were excluded from the respective analysis using pairwise deletion.

For testing H1, we used directional one-sample *t* tests to examine whether the absolute mean deviation score was significantly greater than 50% for added sugar and salt. Given that statistical assumptions for *t* tests were not met, we calculated and report Wilcoxon rank tests. For EQ1, we explored the absolute mean deviation score for fat and calculated a confidence interval. Additional to these preregistered analyses, we explored parents' mapping ability—that is, how participants ranked the nutrient value of foods in comparison to the other nutrients, calculating Spearman rank correlations between true and estimated nutrient values.

For H2 and H3 we analyzed only participants who on average underestimated the respective nutrient examined. Linear regression analyses used BMI and zBMI as outcomes, while logistic regression analyzed the presence of any health condition, with the signed mean deviation score as the predictor in both analyses types. We then conducted these analyses using also the absolute mean deviation score including all participants.

For H4, H5, and H6, we ran three linear regressions using general numeracy, frequency of nutrition table use, and attention to the amount of the respective nutrient in foods as predictors, with absolute mean deviation scores for sugar, salt, and fat as dependent variables. Additionally, we examined the correlations between the three predictors, numeracy, use of nutrition tables, and awareness of nutrients. For deviation scores as percentages (H1, EQ1) or underestimation (H2, H3), calculations included only food items containing the respective nutrient (e.g., yogurt for sugar and fat, but not salt). Data were analyzed using R Version 4.3.2 (R Core Team, 2023), using the package psych (v2.3.9; Revelle, 2023) for the main analyses.

3. Results

3.1 RQ1: How Well Can Parents Estimate Nutrients of Different Foods?

Supporting H1, parents misestimated both, added sugar (M = 78%, SD = 61%, Hodges-Lehmann estimator as median measure, HL = 64%, , confidence interval, CI, [62%, Inf], V= 102022, $p < .001$) and salt content (M = 242%, SD = 376%, HL = 162%, CI [148%, Inf]V= 125622, $p < .001$) by more than 50%. Parents, on average, misestimated fat content by 70% (*Mdn* = 52%, SD = 60%, 95%, CI [64%, 75%]).

The range of the absolute deviation score differed between nutrients: Most parents misestimated fat and sugar content by approximately ±100% (total $range_{sugar}$= 10.56 – 460.03; total $range_{fat}$= 14.76 – 433.92), while deviations for salt were considerably broader (total $range_{salt}$ = 26.00 – 4,008.82; Figure 1). We found moderate correlations between absolute mean deviation scores for sugar, salt, and fat. Sugar and fat estimation accuracy correlated at r =.48, while salt estimation accuracy showed weaker associations with sugar (r = .21) and fat (r = .26).

When focusing on mapping abilities, we observed moderate mean Spearman rank correlations for sugar (ρ = .51), salt (ρ = .62), and fat (ρ = .69). Looking at estimation direction, descriptively 58% of parents underestimated added sugar, 57% underestimated fat, and 39% underestimated salt across all food products containing the respective nutrient (Table 2). The direction varied also between different food products: approximately 85% of parents underestimated added sugar in apple juice by 14.37 grams (42%) an average, whereas only about 27% underestimated added sugar in pizza. Parents who overestimated the added sugar in pizza did so by an average of 16.17 grams (314%). High sugar products were more likely to be underestimated than overestimated (ρ_{sugar} = -.45). For salt and fat, correlations between true amount and underestimation were rather small (ρ_{salt}= -.06, ρ_{fat}= -.11). See Table 3 for detailed information on nutrient estimations and deviations by food.

3.2 RQ2: Parents' Underestimation of Nutrients and Health Outcomes

Surprisingly, no significant associations were found between parents' BMI or children's zBMI and underestimation of added sugar, salt, or fat (see Table 4). A significant relation was found between parents' BMI and misestimation of added sugar (absolute mean deviation score), but in an unexpected direction: Parents who estimated more accurately had a higher BMI, $F(1, 496) = 4.979$, $\beta = 0.59$, $p = .026$, $R^2 = .01$.

Analogously, we found no statistically significant associations between any self-reported health condition in parents or children and underestimation of added sugar, salt, or fat (see Table 4), not supporting H2 and H3. When using the absolute mean deviation score as a predictor, higher misestimation of fat was significantly associated with a higher chance of children having any health condition (β = 0.30, odds ratio = 1.35, 95% CI [1.06, 1.68], p = .011).

3.3 RQ3: Predictors of Parental Estimation Skills

Descriptively, parents reported paying slightly more attention to sugar (M = 2.19, SD = 0.81) and fat (M = 2.15, SD = 0.81) when grocery shopping than to salt (M = 1.75, SD = 0.78). We found a ceiling effect in general numeracy, with all parents scoring at least 2 on the 3-point numeracy scale. The predictor measures of awareness (attention to the three nutrients and frequency of using nutrition labels) were highly correlated with each other (ranging from .58 to .71) but were only weakly related to general numeracy (around .10; see Table S2).

Tests for H4–H6 yielded mixed results: For added sugar, frequency of nutrition table use significantly affected absolute mean deviation, $F(1, 506) = 6.301$, $\beta = -0.11$, $p = .012$, $R^2 = .01$, while there was no effect for attention, $F(1, 506) = 2.380$, $\beta = -0.07$, $p = .123$, $R^2 = .004$) or numeracy, $F(1, 506) = 0.198$, $\beta = -0.02$, $p = .657$, $R^2 < .001$. For salt, general numeracy significantly predicted absolute mean deviation, $F(1, 506) = 4.977$, $\beta = -0.10$, $p = .026$, $R^2 = .01$, but not attention, $F(1, 506) = 1.593$, $\beta = 0.05$, $p = .308$, $R^2 = .003$) or frequency of nutrition table use, $F(1, 506) = 0.009$, $\beta = -0.004$, $p = .923$, $R^2 < .001$). Finally, for fat, attention, $F(1, 506) = 5.445$, $\beta = -0.10$, $p = .020$, $R^2 = .01$, and frequency of nutrition table use, $F(1, 506) = 4.852$, $\beta = -0.10$, $p = .028$, $R^2 = .01$, significantly predicted absolute mean deviation, but not general numeracy, $F(1, 506) = 1.169$, $\beta = -0.05$, $p = .280$, $R^2 = .002$). These results support H4b, H5a, and H6b and c (see Figure 2). The effects remain stable when controlling for parents' education and BMI but the relation between numeracy and the estimation accuracy of salt was no longer statistically significant when income was controlled (see Table S3–6).

4. Discussion

Most parents struggle to accurately estimate nutrient content in foods, with the extent and direction of misestimation—overestimating or underestimating—varying between nutrient type and food. We found no associations between underestimation and health outcomes. Although numeracy and awareness are potential predictors, their effects differ by nutrient type.

As hypothesized, parents frequently misestimated the sugar, salt, and fat content in various foods with deviations exceeding 50% from the actual content, supporting our hypotheses. This supports previous studies (Dallacker et al., 2018; König et al., 2019; Moran et al., 2017). Interestingly, accuracy in estimating one nutrient did not predict accuracy for others. Salt estimation seemed to be particularly challenging, highlighting the need to expand research beyond sugar estimation.

Descriptively, parents tended to underestimate sugar content, consistent with Dallacker et al. (2018), although this trend was less pronounced in the current sample. Comparing the three food items used in both studies, the proportion of parents underestimating was similar for cola, but lower for pizza and yogurt. A similar underestimation pattern was observed for fat, marking an important extension of the literature, as this study is among the first to explore parental fat estimation skills. Salt was less frequently underestimated, probably because of its smaller quantities, resulting in a narrow range between 0 and the true value. Despite a weaker correlation between true and estimated salt content, the broad range in estimates suggests salt is the most difficult nutrient to estimate accurately.

The direction of misestimation varied by product. For example, although cola and apple juice contain similar amounts of sugar, parents underestimated apple juice’s sugar content by 15 g but overestimated cola’s by 10 g, possibly reflecting a "health halo" effect (see, e.g., Provencher et al., 2009), where apple juice is perceived as healthier. Regarding fat, only milk and butter were consistently underestimated, suggesting parents expect less fat in natural or minimally processed products. Despite poor accuracy in estimating absolute amounts of fat, sugar and salt, parents showed medium to nearly high agreement in actual ranking of the products in sugar, salt, and fat, indicating mapping ability might be easier for parents and closer to their everyday grocery decisions.

Contrary to our hypotheses, we found no relations between parents' underestimation of sugar, salt, or fat and the BMI of either parents or children, which contrasts with previous evidence (Dallacker et al., 2018). Notably, we excluded parents who overestimated or correctly estimated nutrient content in these analyses, which reduced our sample size. One possible explanation is that participants with higher BMIs may be more aware of food nutrients, owing to previous weight loss efforts (I. Santos et al., 2017), which could have reduced the effect. This fits with the explorative finding that parents with lower BMI had less accurate estimation skills. Future studies could explore moderators like past weight loss attempts or other measures of nutritional knowledge. Moreover, food literacy involves more than nutritional knowledge, including factors like access to healthy food, cooking skills, and mindful eating (Vidgen & Gallegos, 2014). We also found no effect of parental underestimation on the likelihood of nutrition-related health conditions, likely due to limited variability in these conditions. We found a significant effect for absolute misestimation of fat and likelihood of children having a nutrition-related health condition, though the small number of affected children calls for caution in interpretation. Age did not predict health conditions, but for children these may emerge later in life.

Several factors may explain the mixed findings on how numeracy and awareness affect nutrient estimation accuracy: Salt had the widest estimation range, indicating that it was the hardest to estimate. This may explain why numeracy significantly impacted salt estimation accuracy but not for sugar or fat. Numeracy was also generally high among participants, limiting its predictive power. Nutrition label use or attention to nutrients did not predict salt estimation accuracy. Parents paid less attention to salt compared to sugar or fat, suggesting they are less mindful of salt when shopping or reading nutrition labels, which makes awareness a weaker predictor. Presenting information improved sugar and fat estimation accuracy, suggesting consumers focus more on these nutrients when reading labels. Awareness measures predicted fat estimation, while only nutrition table use improved sugar estimation. This fits with previous studies on seeding interventions (Groß et al., 2024) and suggest that policy interventions on how nutrient information is presented could help parents make healthier food choices, especially in supermarkets.

4.1 Limitations, Strengths, and Future Research

This study examined parental estimations of sugar, salt, and fat content across various food products in a diverse, educationally varied sample. The notable differences in estimation accuracy between foods is central when interpreting previous study findings and planning future research. A key contribution is our quantification and statistical testing of what constitutes a meaningful misestimation. The study also expanded existing research by exploring parents' mapping ability and identifying predictors of nutrient estimation accuracy. Our large sample, including parents with lower education levels, enhances the generalizability of our findings. In-home interviews ensured high data quality and controlled conditions for data collection. Although BMI was measured objectively, this approach has limitations, including potential data entry errors. Extending this research to clinical samples could enhance our understanding further, especially given the limited variance observed in health outcomes among children. We used grams as the measurement unit to align with previous studies, but the selection of food products—despite efforts to be representative of food habits in Germany—was specific to this study. Although this study was limited by the specific food products used, future research could benefit from including a wider range of products to better understand parental understanding of nutrient content.

4.2 Conclusion

Accurately estimating sugar, salt, and fat in foods is challenging for most parents. Providing nutrient information in daily life can help them develop intuitive knowledge and apply it across different food products. While knowledge alone is not enough, it is an easy starting point for policy measures that support parents in making informed and healthier food choices for their families.

Acknowledgments

We are grateful to Nina König for preparing a representative selection of food items and Anita Todd for editing this manuscript.

Author Contributions

Vanessa Knobl	Conceptualization Formal analysis Visualization Writing: Original draft
Mattea Dallacker	Conceptualization Methodology Writing: Review and editing Project Administration
Ralph Hertwig	Conceptualization Writing: Review and editing Funding acquisition
Jutta Mata	Conceptualization Methodology Supervision Writing: Review and Editing

AI-assisted technologies were used only in the writing process to improve the readability and language of the manuscript.

Funding

This study did not receive external funding.

References

Brown, N. R., & Siegler, R. S. (1993). Metrics and mappings: A framework for understanding real-world quantitative estimation. *Psychological Review*, *100*(3), 511–534. https://doi.org/10.1037/0033-295X.100.3.511

Brown, N. R., & Siegler, R. S. (2001). Seeds aren't anchors. *Memory & Cognition*, *29*(3), 405–412. https://doi.org/10.3758/BF03196391

Dallacker, M., Hertwig, R., & Mata, J. (2018). Parents' considerable underestimation of sugar and their child's risk of overweight. *International Journal of Obesity*, *42*(5), 1097–1100. https://doi.org/10.1038/s41366-018-0021-5

Dallacker, M., Hertwig, R., Peters, E., & Mata, J. (2016). Lower parental numeracy is associated with children being under- and overweight. *Social Science & Medicine*, *161*, 126–133. https://doi.org/10.1016/j.socscimed.2016.06.006

Filippini, T., Malavolti, M., Whelton, P. K., & Vinceti, M. (2022). Sodium intake and risk of hypertension: A systematic review and dose–response meta-analysis of observational cohort studies. *Current Hypertension Reports*, *24*(5), 133–144. https://doi.org/10.1007/s11906-022-01182-9

Groß, J., Loose, A. M., & Kreis, B. K. (2024). A simple intervention can improve estimates of sugar content. *Journal of Applied Research in Memory and Cognition*, *13*(2), 282–291. https://doi.org/10.1037/mac0000122

Hooper, L., Martin, N., Jimoh, O. F., Kirk, C., Foster, E., & Abdelhamid, A. S. (2020). Reduction in saturated fat intake for cardiovascular disease. *Cochrane Database of Systematic Reviews*, *2020*(8), Article CD011737. https://doi.org/10.1002/14651858.CD011737.pub3

Huizinga, M. M., Carlisle, A. J., Cavanaugh, K. L., Davis, D. L., Gregory, R. P., Schlundt, D. G., & Rothman, R. L. (2009). Literacy, numeracy, and portion-size estimation skills. *American Journal of Preventive Medicine*, *36*(4), 324–328. https://doi.org/10.1016/j.amepre.2008.11.012

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2022). Happy and healthy: How family mealtime routines relate to child nutritional health. *Appetite*, *171*, Article 105939. https://doi.org/10.1016/j.appet.2022.105939

Knobl, V., & Mata, J. (2024). Intersecting perspectives: Advocating for sustainable family meals across generations. *Appetite*, *201*, Article 107618. https://doi.org/10.1016/j.appet.2024.107618

König, L. M., Ziesemer, K., & Renner, B. (2019). Quantifying actual and perceived inaccuracy when estimating the sugar, energy content and portion size of foods. *Nutrients*, *11*(10), Article 2425. https://doi.org/10.3390/nu11102425

Libuda, L., Alexy, U., & Kersting, M. (2014). Time trends in dietary fat intake in a sample of German children and adolescents between 2000 and 2010: Not quantity, but quality is the issue. *British Journal of Nutrition*, *111*(1), 141–150. https://doi.org/10.1017/S0007114513002031

Mahmood, L., Flores-Barrantes, P., Moreno, L. A., Manios, Y., & Gonzalez-Gil, E. M. (2021). The influence of parental dietary behaviors and practices on children's eating habits. *Nutrients*, *13*(4), Article 1138. https://doi.org/10.3390/nu13041138

Max Rubner-Institut (2008). *Nationale Verzehrsstudie II Ergebnisbericht Teil 2.* Available at: https://www.bmel.de/SharedDocs/Downloads/Ernaehrung/NVS_ErgebnisberichtTeil2.pdf?__blob=publicationFile [29.11.2024].

Max Rubner-Institut. (2020). *Bundeslebensmittelschlüssel (BLS) Version 3.02* [Database]. Max Rubner-Institut, Federal Research Institute of Nutrition and Food. https://www.blsdb.de/

Malik, V. S., Popkin, B. M., Bray, G. A., Després, J.-P., Willett, W. C., & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and Type 2 diabetes. *Diabetes Care*, *33*(11), 2477–2483. https://doi.org/10.2337/dc10-1079

Moores, C. J., Kelly, S. A. M., & Moynihan, P. J. (2022). Systematic review of the effect on caries of sugars intake: Ten-year update. *Journal of Dental Research*, *101*(9), 1034–1045. https://doi.org/10.1177/00220345221082918

Moran, A. J., Ramirez, M., & Block, J. P. (2017). Consumer underestimation of sodium in fast food restaurant meals: Results from a cross-sectional observational study. *Appetite*, *113*, 155–161. https://doi.org/10.1016/j.appet.2017.02.028

Neuhauser, H., Schienkiewitz, A., Rosario, A. S., Dortschy, R., & Kurth, B.-M. (2013). *Referenzperzentile für anthropometrische Maßzahlen und Blutdruck aus der Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (KiGGS)*. Robert Koch Institute. https://doi.org/10.25646/3179

Perrar, I., Schadow, A. M., Schmitting, S., Buyken, A. E., & Alexy, U. (2019). Time and age trends in free sugar intake from food groups among children and adolescents between 1985 and 2016. *Nutrients*, *12*(1), Article 20. https://doi.org/10.3390/nu12010020

Pfau, C., Ehnle-Lossos, M., Goos-Balling, E., Demuth, I., & Gose, M. (2016). *Reformulierung: Häufig im Lebensmitteleinzelhandel gekaufte industriell vorgefertigte Produkte und ihre Energie- und Nährwertgehalte, insbesondere Fett, Zucker und Salz.* Available at: https://www.mri.bund.de/fileadmin/MRI/News/Dateien/EV_Bericht_Reformulierung.pdf [29.11.2024].

Provencher, V., Polivy, J., & Herman, C. P. (2009). Perceived healthiness of food. If it's healthy, you can eat more! *Appetite*, *52*(2), 340–344.

https://doi.org/10.1016/j.appet.2008.11.005

R Core Team. (2023). *R: A language and environment for statistical computing* (Version 4.3.2) [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Remer, T., Hua, Y., Esche, J., & Thamm, M. (2022). The DONALD study as a longitudinal sensor of nutritional developments: Iodine and salt intake over more than 30 years in German children. *European Journal of Nutrition*, *61*(4), 2143–2151. https://doi.org/10.1007/s00394-022-02801-6

Revelle, W. (2023). *psych: Procedures for personality and psychological research* (Version 2.3.9) [R package]. Northwestern University. https://CRAN.R-project.org/package=psych

Santos, I., Sniehotta, F. F., Marques, M. M., Carraça, E. V., & Teixeira, P. J. (2017). Prevalence of personal weight control attempts in adults: A systematic review and meta-analysis. *Obesity Reviews*, *18*(1), 32–50. https://doi.org/10.1111/obr.12466

Santos, L. P., Gigante, D. P., Delpino, F. M., Maciel, A. P., & Bielemann, R. M. (2022). Sugar sweetened beverages intake and risk of obesity and cardiometabolic diseases in longitudinal studies: A systematic review and meta-analysis with 1.5 million individuals. *Clinical Nutrition ESPEN*, *51*, 128–142. https://doi.org/10.1016/j.clnesp.2022.08.021

Schwartz, L. M. (1997). The role of numeracy in understanding the benefit of screening mammography. *Annals of Internal Medicine*, *127*(11), Article 966. https://doi.org/10.7326/0003-4819-127-11-199712010-00003

Simmonds, M., Llewellyn, A., Owen, C. G., & Woolacott, N. (2016). Predicting adult obesity from childhood obesity: A systematic review and meta-analysis. *Obesity Reviews*, *17*(2), 95–107. https://doi.org/10.1111/obr.12334

Te Morenga, L., & Montez, J. M. (2017). Health effects of saturated and trans-fatty acid intake in children and adolescents: Systematic review and meta-analysis. *PLOS ONE*, *12*(11), Article e0186672. https://doi.org/10.1371/journal.pone.0186672

Vidgen, H. A., & Gallegos, D. (2014). Defining food literacy and its components. *Appetite*, *76*, 50–59. https://doi.org/10.1016/j.appet.2014.01.010

Wang, Y.-J., Yeh, T.-L., Shih, M.-C., Tu, Y.-K., & Chien, K.-L. (2020). Dietary sodium intake and risk of cardiovascular disease: A systematic review and dose-response meta-analysis. *Nutrients*, *12*(10), Article 2934. https://doi.org/10.3390/nu12102934

World Health Organization. (2012). *Guideline: Sodium intake for adults and children*. https://iris.who.int/handle/10665/77985

World Health Organization. (2015). *Guideline: Sugars intake for adults and children*. https://apps.who.int/iris/handle/10665/149782

World Health Organization. (2023). *Total fat intake for the prevention of unhealthy weight gain in adults and children: WHO guideline*. https://iris.who.int/bitstream/handle/10665/370421/9789240073654-eng.pdf

Table 1

Sample Characteristics and Descriptives of Predictors and Outcomes

Variable	Parent			Child		
	M (range)	*SD*	*N*	*M* (range)	*SD*	*N*
Age (in years)	39.2 (23–59)	6.59	497	9.2 (6–12)	2.10	508
Monthly income (in euros)	3,140.4 (900–11,000)	1,325.71	412			
Household size						
Adults	1.8 (1–4)	0.52	508			
Children	1.7 (1–9)	0.86	508			
BMI/zBMI[a]	26.34 (18.29–61.05)	5.98	498	0.17[a] (-3.51–3.57)	1.1	480
Attention			508			
Sugar	2.19 (1–4)	0.81				
Salt	1.75 (1–4)	0.78				
Fat	2.15 (1–4)	0.81				
Frequency of nutrition table use	2.28 (1–5)	1.06	508			
General Numeracy	2.21 (2–3)	0.41	508			
	n	%	*N*	*n*	%	*N*
Gender			508			508
Female	450	88.6		252	49.6	
Male	58	11.4		256	50.4	
Nonbinary	0	0		0	0	
Marital status			508			
Single	49	9.6				
Living with partner	66	13.0				
Married	321	63.2				
Widowed/divorced/living separated	72	14.2				
Education: Highest qualification earned[b]			508			
None/primary	3	0.6				
Secondary	365	71.9				
Upper secondary	99	19.5				
Bachelor’s degree or higher	41	8.1				
Employment situation			508			
Fully employed	182	35.8				

Variable	Parent			Child		
	M (range)	*SD*	*N*	*M* (range)	*SD*	*N*
Part-time/hourly/temporary	246	48.4				
Temporarily not working/unemployed	36	7.1				
Pension/retired	1	0.2				
Homemaker	39	7.7				
In vocational training/apprenticeship	3	0.6				
In school/educational training	1	0.2				
Health conditions			508			508
Overweight	97	19.1		28	5.5	
Lipid metabolism disorder	9	1.8		0	0	
Diabetes Type 2	9	1.8		0	0	
Hypertension	31	6.1		2	0.4	
Tooth decay	79	15.6		16	3.1	
Other diseases	19	3.7		14	2.8	
Diet style			508			508
Omnivore	476	93.7		498	98.0	
Vegetarian	17	3.3		9	1.8	
Vegan	3	0.6		0	0	
Low carb	9	1.8		0	0	
Other	3	0.6		1	0.2	
Allergies (yes)	31	6.1	508	15	3.0	508

Note. [a] Body mass index (BMI) z scores, which indicate standard deviation from the mean of the population (age-adjusted and calculated based on The Child and Adolescent Health Survey reference data for 2003 to 2006; Neuhauser et al., 2013). Values over 4 and under -4 were defined as unrealistic values and therefore excluded. [b] For education, categories refer to highest qualification earned: None = no diploma; secondary = high school diploma with/without job training; upper secondary = high school diploma that qualifies for university entrance in Germany ([Fach-]Abitur); bachelor's degree or higher = college or university degree.

Table 2

Percentage of Parents Underestimating Sugar, Salt, and Fat

Food item	Percentage of parents underestimating		
	Sugar	Salt	Fat
Apple juice (330 ml)	85.43	—	71.26
Cola (330 ml)	58.46	—	—
Milk 3.5% (330 ml)	—	62.40	76.97
Chocolate bar (51 g)	83.66	48.03	36.61
Cheesecake (175 g)	52.76	26.97	49.80
Strawberry yogurt (250 g)	65.35	—	54.72
Pizza (355 g)	26.97	39.76	50.00
Sausage (100 g)	30.71	18.11	46.06
Butter (15 g)	—	—	66.54
Overall	57.62	39.05	56.50

Note. Percentages listed and calculation of the overall score are based on the food products that contain the nutrient and are therefore capable of being underestimated. Since no participant made a correct estimate for those products, the complementary percentage (100% − percentage above) corresponds to the percentage of parents who overestimated. Sugar = Added sugar.

Table 3

True and Estimated Values and Signed Deviation Scores for All Food Products

Food Item	True amount (g)			Estimated amount (g) *M* (*SD*)			Signed deviation (g) *M* (*SD*)			Signed deviation (%) *M* (*SD*)		
	Sugar	Salt	Fat	Sugar	Salt	Fat	Sugar	Salt	Fat	Sugar	Salt	Fat
Apple juice (330 ml)	34.5	0	0.33	20.13 (25.69)	0.91 (5.98)	1.34 (3.84)	-14.37 (25.69)	0.91 (5.98)	1.01 (3.84)	-41.66 (74.46)	—	307.42 (1,162.29)
Cola (330 ml)	34.98	0	0	45.73 (49.15)	0.90 (2.68)	2.51 (7.05)	10.75 (49.15)	0.9 (2.68)	2.51 (7.05)	30.73 (140.5)	—	—
Milk 3.5% (330 ml)	0	0.36	1.55	5.51 (12.13)	1.31 (4.75)	11.22 (20.72)	5.51 (12.13)	0.94 (4.75)	-0.33 (20.72)	—	260.08 (1,309.51)	-2.87 (179.38)
Chocolate bar (51 g)	30.59	0.21	8.47	22.46 (11.48)	1.42 (3.27)	12.77 (9.11)	-8.13 (11.48)	1.21 (3.27)	4.3 (9.11)	-26.57 (37.54)	576.79 (1,556.07)	0.81 (107.57)
Cheesecake (175 g)	20.76	0.19	15.75	25.72 (19.13)	1.81 (3.26)	23.00 (19.96)	4.96 (19.13)	1.62 (3.26)	7.25 (19.96)	23.91 (92.15)	852.13 (1,713.60)	46.04 (126.74)
Strawberry yogurt (250 g)	16.83	0	7.25	17.86 (19.58)	1.19 (2.4)	0.96 (16.07)	1.03 (19.58)	1.19 (2.4)	3.71 (16.07)	6.12 (116.35)	—	51.18 (221.71)
Pizza (355 g)	5.15	3.55	26.98	21.32 (28.04)	8.22 (14.44)	34.58 (34.07)	16.17 (28.04)	4.67 (14.44)	7.6 (34.07)	314 (544.37)	131.51 (406.87)	28.17 (126.3)
Sausage (100 g)	0.25	1.66	25.00	6.57 (9.52)	5.57 (6.38)	27.09 (17.17)	6.32 (9.52)	3.91 (6.38)	2.09 (17.17)	2527.56 (3,808.87)	235.48 (384.39)	8.35 (68.69)
Butter (15 g)	0	0	12.48	1.61 (2.71)	1.39 (1.69)	10.08 (4.10)	1.61 (2.71)	1.38 (1.69)	-2.4 (4.1)	—	—	-19.26 (32.86)
Overall means	—	—	—	18.55 (13.72)	2.52 (3.14)	14.84 (9.55)	2.65 (13.72)	1.86 (3.14)	2.86 (9.55)	77.75[a] (61.45)	242.27[a] (375.72)	69.67[a] (60.01)

Note. The true amount of added sugar, salt and fat is calculated based on the German Nutrient Database (Bundeslebensmittelschlüssel; Max Rubner-Institut, 2020) and producer information. For details, see Table S1 in the Supplemental Material. Sugar = Added sugar.

[a] Signed mean deviation score as a percentage was calculated on the basis of mean deviations in grams (first calculating the mean over all food products in grams, then translating this to percentage deviation). When calculating overall percentage deviation by averaging the individual food product percentages, products that contain very little of the nutrients are weighted more, because percentage deviation is therefore greater on average, which is not intended.

Table 4

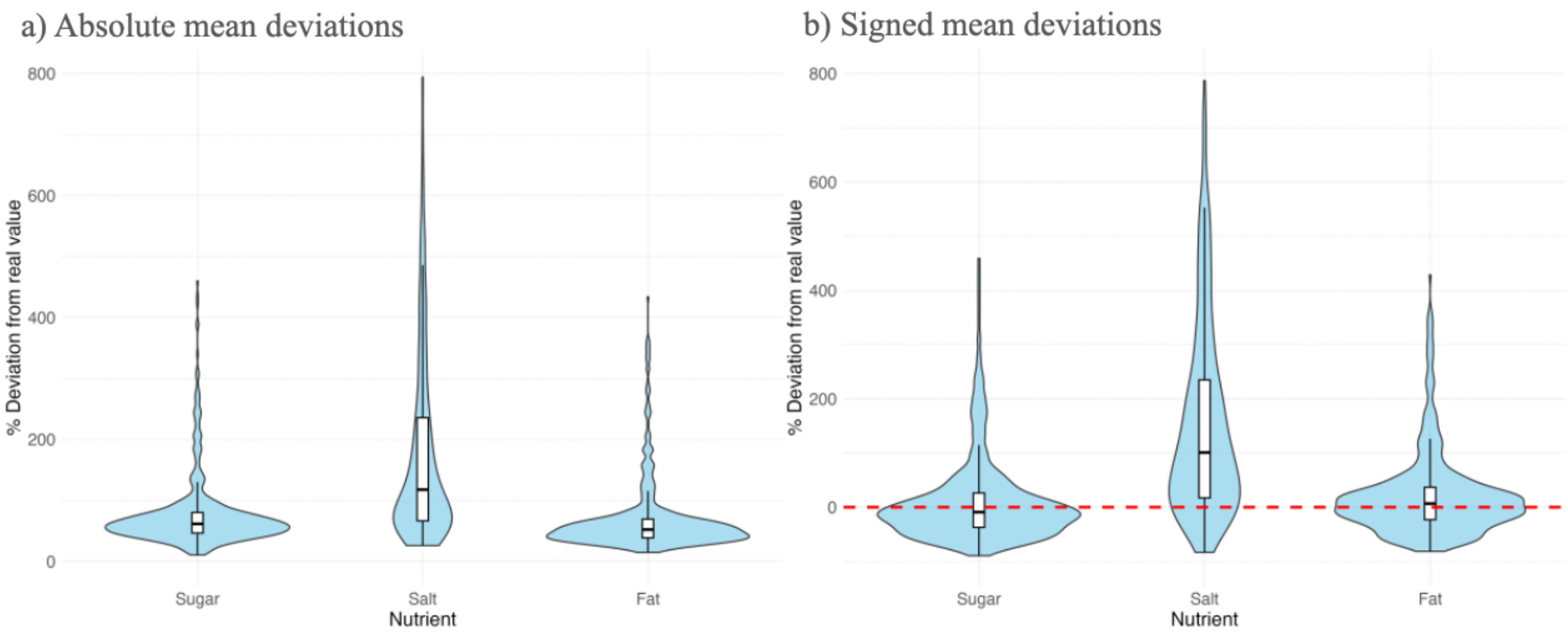
Overview of Linear and Logistic Regression Results for Hypotheses 2 and 3

Predictor	Outcome variable	β / OR	95% CI	p value	R^2 (adjusted) / Nagelkerke R^2	Type of regression
Sugar underestimation	BMI parent	β = -0.23	-.96, 0.50	.538	-.002	Linear
	zBMI child	β = 0.03	-0.11, 0.16	.706	<.001	Linear
	Health condition Parent (Yes/No)	OR = 1.15	0.90, 1.47	.255	.006	Logistic
	Health condition child (Yes/No)	OR = 1.18	0.72, 2.00	.525	.004	Logistic
Salt underestimation	BMI parent	β = 0.26	-0.74, 1.26	.604	.003	Linear
	zBMI child	β = -0.06	-0.37, 0.24	.677	.002	Linear
	Health condition parent (Yes/No)	OR = 2.28	0.31, 18.10	.422	.010	Logistic
	Health condition child (Yes/No)	OR = 0.46	0.13, 1.42	.184	.080	Logistic
Fat underestimation	BMI parent	β = 0.42	-0.39, 1.24	.307	.005	Linear
	zBMI child	β = 0.05	0.11, 0.20	.554	.002	Linear
	Health condition parent (Yes/No)	OR = 1.05	0.80, 1.40	.725	<.001	Logistic
	Health condition child (Yes/No)	OR = 1.40	0.81, 2.61	.253	.016	Logistic

Note. A negative estimate would go align with the hypotheses' direction, which means that a more negative relative deviation score is related to higher BMI or higher probability for health conditions. BMI = Body mass index; zBMI = standard deviation from the mean of the population for respective age and gender ; CI = confidence interval; OR = odds ratio; sugar = added sugar.

Figure 1

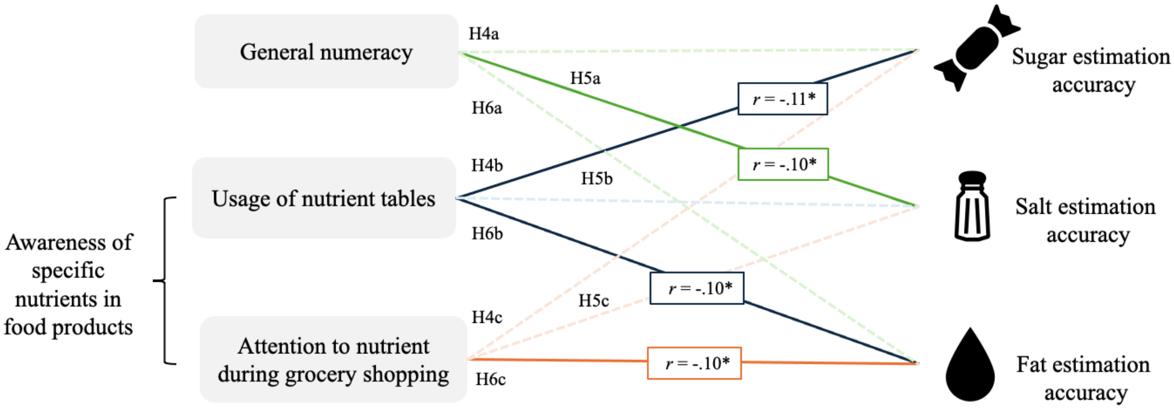
Absolute and Signed Mean Deviation Scores of Sugar, Salt and Fat



Note. Calculation of absolute and signed mean deviation score as a percentage is based on calculation in grams (first calculating mean over all food products in grams, then translating this to percentage deviation). When calculating overall percentage deviation by averaging the individual food product percentages, products that contain very little of the nutrients are weighted more, because percentage deviation is therefore greater on average, which is not intended. Some outliers are cut from the graph for salt because of the extensive range, for better visualization. The volumes of the violins indicate number of participants having the respective mean deviation score. The boxplot visualizes the median (central line in the box), the interquartile range (represented by the height of the box), and the range of typical values (whiskers). Sugar = Added sugar.

Figure 2

General Numeracy and Awareness as Predictors for Estimation Accuracy



Note. Sugar = Added sugar. H = hypothesis. Asterisk indicates a p-value < .05

Supplementals

Table S1
Calculation of true values as eSupplement:
https://osf.io/jhwer?view_only=cf732061e0084486be698adea8b1540a

Table S2

Means, standard deviations, and correlations of predictors with confidence intervals

Variable	*M*	*SD*	1	2	3	4
1. Numeracy Score	2.21	0.41				
2. Nutrition Tables	2.28	1.06	.09 [.00, .17]			
3. Attention Sugar	2.19	0.81	.14 [.06, .23]	.62 [.57, .67]		
4. Attention Salt	1.75	0.78	.01 [-.07, .10]	.58 [.52, .63]	.61 [.55, .66]	
5. Attention Fat	2.15	0.81	.09 [-.00, .17]	.70 [.65, .74]	.71 [.66, .75]	.61 [.55, .66]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. Nutrition Tables= Usage frequency of nutrition tables. Sugar=Added sugar

Table S3
Regression Model for H4b with control variables

	Absolute deviation sugar		
Predictors	*Estimates*	*std. Beta*	*p*
(Intercept)	-0.48	-0.46	0.633
Nutrition Tables	-0.11	-0.10	**0.037**
Income	-0.05	-0.05	0.386
BMI Parent	-0.13	-0.13	**0.008**
Education: secondary	0.45	0.44	0.657
Education: upper secondary	0.53	0.52	0.602
Education: bachelor or higher	0.52	0.52	0.610
Observations	406		
R^2 / R^2 adjusted	0.030 / 0.016		

Table S4
Regression Model for H5a with control variables

	Absolute deviation salt		
Predictors	*Estimates*	*std. Beta*	*p*
(Intercept)	-0.02	0.00	0.642
Numeracy Score	-0.07	-0.07	0.130
Income	0.05	0.05	0.268
Observations	412		
R^2 / R^2 adjusted	0.009 / 0.004		

Table S5

Regression Model for H6b with control variables

	Absolute deviation fat		
Predictors	*Estimates*	*std. Beta*	*p*
(Intercept)	-0.62	-0.60	0.543
Nutrition Tables	-0.11	-0.10	**0.037**
Income	0.06	0.06	0.286
BMI Parent	-0.08	-0.09	0.087
Education: secondary	0.63	0.61	0.541
Education: upper secondary	0.65	0.63	0.531
Education: bachelor or higher	0.48	0.47	0.645
Observations	406		
R^2 / R^2 adjusted	0.021 / 0.006		

Table S6

Regression Model for H6c with control variables

	Absolute deviation fat		
Predictors	*Estimates*	*std. Beta*	*p*
(Intercept)	-0.62	-0.61	0.542
Attention for Fat	-0.12	-0.12	**0.020**
Income	0.05	0.05	0.350
BMI Parent	-0.08	-0.08	0.107
Education: secondary	0.63	0.61	0.538
Education: upper secondary	0.66	0.65	0.521
Education: bachelor or higher	0.45	0.44	0.665
Observations	406		
R^2 / R^2 adjusted	0.024 / 0.009		

Manuscript 4 – Intersecting perspectives: Advocating for sustainable family meals across generations

Published article:

Knobl, V., & Mata, J. (2024). Intersecting perspectives: Advocating for sustainable family meals across generations. *Appetite*, 201, 107618. https://doi.org/10.1016/j.appet.2024.107618

.

Appetite 201 (2024) 107618

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Intersecting perspectives: Advocating for sustainable family meals across generations

Vanessa Knobl [a,*], Jutta Mata [a,b,c]

[a] University of Mannheim, Department of Social Sciences, Health Psychology, Germany
[b] Max Planck Institute for Human Development, Center for Adaptive Rationality, Germany
[c] University of Mannheim, Mannheim Center for Data Science, Germany

A R T I C L E I N F O

Keywords:
Adolescents
Reverse socialization
Family meal
Diet
Sustainability

A B S T R A C T

Adolescents in Germany eat fewer animal products than their parents, often for sustainability reasons. We investigated how adolescents differ from their parents' generation in sustainability food-choice motives, consumption of animal products, and corresponding behaviors such as advocating for and influencing decisions towards more sustainable family meals. In an online questionnaire, an educationally diverse sample of 500 adolescents ($M = 17.9$ years, range = 15–20) and 500 adults of their parents' generation ($M = 52.2$ years, range = 45–60) reported food-choice motives, their own and their family's diet style, how they advocate for sustainable food decisions at family meals (e.g., less meat), and how they influence different steps in family meal planning (e.g., grocery shopping). The two generations did not differ in sustainable food motives and mean consumption frequency of meat and animal products, but adolescents reported three times more often than their parents' generation to never eat meat. At shared family meals they advocated for eating plant-based substitutes ($d = 0.27$, $p < 0.001$) and other animal products ($\beta = -0.15$, $p = 0.02$) more often than their parents' generation, but not for eating less meat. Adolescents advocated more frequently for sustainable food decisions at shared meals the more important sustainability motives were to them ($\beta = 0.53$, $p < 0.001$), and the less meat ($\beta = -0.35$, $p < 0.001$) and fewer other animal products ($\beta = -0.11$, $p = 0.015$) they consumed. Adolescents motivated towards sustainability have the potential to impact the family's dietary choices through reverse socialization processes. These findings challenge current theories that suggest only parents influence their children, neglecting the role of adolescents as potential agents of change for improved family and planetary health.

1. Introduction

One of the most important influences on the climate crisis is livestock farming, which contributes between 11% and 19% to the worldwide greenhouse gas emissions produced by humans (Food and Agriculture Organization of the United Nations, 2022; Xu et al., 2021). The EAT-Lancet Commission therefore has advocated reducing consumption of meat and other animal products to improve planetary and human health (Willett et al., 2019). Although this planetary health diet may not be optimized for all regions of the world and all micronutrients (Beal et al., 2023), scientists agree on the necessity of reducing animal products in the Western diet. In Germany, such a reduction can already be observed (Bundesministerium für Ernährung und Landwirtschaft [BMEL], 2019, 2021, 2023): Especially adolescents and young adults have been continuously eating less meat over the past 5 years. Whereas in 2019, 8% of 14- to 29-year-olds declared eating vegetarian or vegan, 21% reported doing so in 2023. This corresponds to a twofold increase in vegetarians and vegans compared to the general population, and a 2.5-fold increase compared to their parents' generation (age 45–59 years). Plant-based substitutes are also well accepted in the younger age group: For example, 100% of vegans but also 60% of flexitarians and 34% of omnivores reported liking dairy substitutes (Zühlsdorf et al., 2021).

Adolescents and young adults state that climate change is a major motivation for this behavior: About 40% critically question their meat consumption for climate reasons whereas only 4% see no need to reduce their meat intake (Zühlsdorf et al., 2021). Recent population-based surveys from Germany have assessed general attitudes toward the environment and sustainability across age groups. Adolescents and young adults age 14–29 years reported the highest pro-climate attitudes

* Corresponding author. University of Mannheim, Chair of Health Psychology, L13, 17, 68161, Mannheim, Germany.
E-mail address: knobl@uni-mannheim.de (V. Knobl).

https://doi.org/10.1016/j.appet.2024.107618
Received 7 February 2024; Received in revised form 5 June 2024; Accepted 31 July 2024
Available online 3 August 2024
0195-6663/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

compared to all other age groups and received a higher readiness-to-change score when asked about adopting sustainable behavior, including nutrition, than their parents' generation (40–60 years; mean difference of 0.5 to > 1 scale point on a scale of 1–10; Belz et al., 2022, p.40).

Importantly, adolescents do not eat as individuals. They often live with parents and siblings and eat many of their meals in a family context (e.g., 80% of 12- to 17-year-old adolescents reported often eating dinner with their families; Frank et al., 2019). Accordingly, to reduce their meat consumption, that is, to eat in line with their own motives and values regarding food, they need to engage in the family-meal decision process. Given that motives and values in adolescents often differ from those of their parents' generation, they will often need to overcome obstacles to achieve their goals. And they do. Adolescents do not just eat what has been put on the table; they take an active role in meal planning, for example, by deciding what types of restaurants the family goes to (Chen et al., 2016), bringing new products from outside (e.g., school, peers) into the family (Ayadi & Bree, 2010; Williams et al., 2019), and encouraging the family to try meat substitutes for dinner (Pater et al., 2022). Although parents remain nutritional gatekeepers, adolescents take the opportunity to actively change family food choices. This is in line with family systems theory, which sees families as self-regulating systems with the ability to make adaptive changes. If one part of the system changes its attitudes or behavior, this change affects all parts of the system (Baptist & Hamon, 2022).

Researchers and nongovernmental organizations have suggested that children are optimal agents for communicating climate change information to their parents, especially when other types of awareness campaigns do not achieve the desired goal (Lawson et al., 2018; UNESCO, 2020). This process is called "reverse socialization" (Gentina & Muratore, 2012) and has been examined in the context of consumer socialization theory: Usually children learn from previous generations, but there are also cases where knowledge, skills, and attitudes related to consumption are passed from young to old. One well-known example is adolescents teaching their parents about technology (Watne et al., 2011), but initial studies have also shown an influence of children and adolescents on their parents' general pro-environmental behavior (e.g., car use; Kong & Jia, 2023; Singh et al., 2020) and environmental literacy (Liu et al., 2022).

Older research on children influencing nutrition in the family context indicated that family meals become less healthy when adolescents are allowed to participate in the decision-making process, because they choose more foods with high sugar and high fat content (De Bourdeaudhuij & Van Oost, 1998; Nørgaard & Brunsø, 2011). Thus, this research does not suggest that children influence their parents in the direction of a sustainable diet in the sense of the planetary health diet, as this is primarily based on the consumption of fruits, vegetables, whole grains, and legumes (Willett et al., 2019). However, adolescents could be sustainability agents—not necessarily for eating more fruits and vegetables, but potentially for eating fewer animal products and replacing them with other products instead. For example, McKeown and Nelson (2018) found that, given free choice, adolescents would eat few fruits and vegetables and would be more likely to eat high-carbohydrate foods, which could potentially also be a replacement for animal products. Other authors showed that although adolescents are more likely to choose unhealthy foods, when they themselves suggest omitting unhealthy products (such as candy and soft drinks), this has a great impact on their family's behavior (De Bourdeaudhuij & Van Oost, 1998). In addition, younger adults are more open to trying protein alternatives (e.g., in one survey, 62% of 14- to 29-year-olds had bought meat and dairy alternatives more than once before, but only 35% of people age 45 to 59; BMEL, 2023; Clark & Bogdan, 2019) and children reported that they had been suggesting meat substitutes for joint family dinners (Pater et al., 2022). Understanding adolescents' motivation is central to comprehending under what circumstances they influence family meals and to what extent (Beatty & Talpade, 1994). For example, personal motivation worked as one predictor of adolescents' perceived and also actual influence on family meal decisions regarding fish consumption (Olsen & Ruiz, 2008). Also, adolescents who abstained from consuming animal products often did so for political reasons and should therefore have had a high personal motivation (Zühlsdorf et al., 2021).

1.1. Research gaps

The literature mentioned above clearly demonstrates that a larger percentage of people in adolescence are concerned about the adverse effects of meat consumption on climate change than in their parents' generation and that—also because of frequent family meals—adolescents can potentially be important agents of change. Yet, although recent surveys have addressed adolescents' preferences or adolescents' openness to introducing alternatives to meat, few studies have explicitly tested how differences in sustainability food-choice motives translate into food choices, such as consumption of animal products, between generations. Further, it is unclear how and under what circumstances a preference for more sustainable, healthy nutrition in adolescents leads to advocating for less consumption of meat or other animal-based foods at the family table (e.g., getting involved in family meal planning, grocery shopping, meal preparation). Also, little attention has been paid to generational differences in sustainability food-choice motives and eating by gender, age, and education.

1.2. Hypotheses

On the basis of the theoretical considerations and research described above, we hypothesized that (1) sustainability food-choice motives play a more important role in adolescents' food choices than in the food choices of their parents' generation and that (2a) adolescents consume meat and (2b) other animal products less often than their parents' generation. Further, we assumed that adolescents advocate more for lessening consumption of meat (3a) and other animal-based products (3b) and increasing consumption of plant-based substitutes (3c) at joint family meals than their parents' generation. Focusing on adolescents' motivation for engaging in family meal planning, we hypothesized that (4a) the less adolescents consume animal products themselves, the more they advocate for sustainable family meal decisions and (4b) the more they report more general involvement in family meal planning.

1.3. Exploratory questions (EQs)

Additional to testing our hypotheses, we explored how the generations differ in (EQ 1a) their recognition of the importance of various food-choice motives, (EQ 1b) their advocacy of different food groups, and (EQ 1c) their influence on several steps of meal planning (e.g., grocery shopping, menu planning). Further, we asked (EQ 2) if differences in age (i.e., younger adolescents vs. older adolescents/young adults), gender, and education relate to differences in sustainability food-choice motives and eating behavior in both generations. Last, we examined (EQ 3) if endorsement of sustainability food-choice motives relates to the frequency of advocating for more sustainable foods and higher involvement in family meal planning.

2. Methods

2.1. Data transparency

This study was preregistered on OSF registries (https://osf.io/w6f8k/). All data, analysis code and supplemental material are freely available at https://osf.io/3pkzt/?view_only=797754991d1e41f89d21366225111bd2.

This study was approved by the ethics commission of the University of Mannheim (EK Mannheim 35/22). Participants gave informed consent to participate in the study.

2.2. Design and procedure

Participants were 500 adolescents as well as 500 unrelated adults of their parents' generation recruited via the respondi access panel, an established German market research service provider with vast expertise in conducting scientific surveys. To be eligible, adolescents had to be between 14 and 20 years old (we recognize that people are usually called adults from 18 years of age on; yet the majority of them fall in the age range of adolescence and to distinguish this age group from their parents' generation we refer to them as "adolescents" throughout the manuscript). Living at home was not a requirement, but they could not yet have children of their own, so that joint family meals referred to eating together with their parents. Adults, on the other hand, had to have at least one child and needed to be between 45 and 60 years old. Potential participants were excluded if they stated they never ate with their family. Participants responded to a 5-min questionnaire. They received compensation in the form of points for participation, which they could exchange for cash or vouchers as part of their respondi-panel membership.

2.3. Measures

2.3.1. Participant characteristics

Participants reported their age, gender (male, female, nonbinary), and education (current type of schooling/highest level of academic education). Additionally, adolescent participants were asked about the age of their parents, and participants of their parents' generation about the age of their oldest child. Participants further reported on their family-meal frequency (on a 5-point scale with answer options "[nearly] every day," "3–5 times a week," "1–2 times a week," "less than once a week," "never").

2.3.2. Food-choice motives

To assess different food-choice motives, participants were asked to rate 19 items on eating motives, for example, "I eat what I eat … because it is healthy" or "because it is fast to prepare." Answers were given on a 5-point Likert scale from "never applies" to "always applies" with an additional answer option "I don't understand" (adapted from the short version of The Eating Motivation Survey; Renner et al., 2012). Three additional items on sustainability and one item on animal welfare were assessed (e.g., "I eat what I eat … because it is good for the environment" or "because animals don't have to suffer"; adapted from the Vegetarian Eating Motives Inventory; Hopwood et al., 2020). Cronbach's alpha for the three additional items on sustainability was 0.93 for adolescents and 0.92 for adults of their parent's generation. A mean score for those three sustainability items was calculated ('sustainability motive score').

2.3.3. Diet style

Participants were asked about their personal diet style regarding sustainability using a survey question with different items based on the recommendations for sustainable diets of the German Nutrition Society (Renner et al., 2021) and answers given by participants in the Eurobarometer 93.2 survey (European Commission Brussels, 2021), who reported on important aspects of sustainable diets. We asked participants how many days a week the following statements applied to them: Eating meat, eating other animal products (e.g., milk, cheese, eggs), eating plants (fruits, vegetables, grains, legumes, nuts), eating organically produced food, eating food that is grown in the region and is in season, eating food wrapped in a lot of plastic, and throwing away food. The possible answers for all options were "never," "1x," "2–4x," "at least 5x," and "always" with a fallback option "I don't understand" (adapted from questionnaire options of the German Consumer Expert Council [(Sachverständigenrat für Verbraucherfragen, Berlin, 2021). Further, one item was constructed to assess the consumption of plant-based substitutes (trying "new" plant-based foods [e.g., tofu, oat milk, soy meat]). The same question with all food groups was asked for their family's diet style to assess baseline consumption (e.g., if the entire family eats vegetarian, the participant cannot advocate for eating less meat.

2.3.4. Family-meal advocating for sustainable food decisions

To record self-reported advocacy for specific food groups and, participants were first given the study's definition of a family meal ("A joint family meal occurs when at least one parent and one child eat together"). Next, they rated eight statements on a 5-point Likert scale (from "never" to "always" plus an additional option "I do not understand," formulated in parallel to the diet-style item). The statements started with the stem "When we eat meals together as a family, I advocate for …" followed by "eating less meat", "eating less of other animal products (e.g., milk, cheese, eggs)", "eating more plants (fruits, vegetables, grain, legumes, nuts)", "trying 'new' plant-based foods (e.g., tofu, oat milk, soy meat)", "eating more organically produced food", "eating more food that is grown in the region and is in season", "eating less food wrapped in a lot of plastic" and "throwing away less food." A higher score means more frequent advocating for sustainable eating. A mean score for all advocating items were calculated to gain an initial understanding for overall advocacy frequency related to sustainable eating in the context of family meals ('overall advocating score').

2.3.5. Influence on meal planning

To capture to what extent and at what step participants influence meal planning, we used items based on Perrea et al. (2012) who—based on a diary study design—empirically identified and analyzed the individual steps of a mealtime planning process. Participants were asked to rate the following six items (on a 5-point Likert scale from "never" to "always" plus the additional response option "I don't understand"): "I influence what we eat together as a family … when planning a specific meal," "when planning the groceries," "at the supermarket during shopping," "during the preparation of the meal," "while we are sitting at the table eating," "at another step." A mean score over all process steps were calculated to gain an initial understanding for overall influence frequency ('general influence score').

2.4. Participants

See Table 1 for detailed sample characteristics. The age of the adolescents' generation sample responding to our survey was on average 4 years younger than the age of the oldest child of the parents' generation sample ($M = 21.88$, $SD = 8.10$). Yet, given that they were asked about their oldest child and most families in Germany have more than one child (Statistisches Bundesamt, 2020), it is reasonable to assume that the sampled adults represented the parent generation of the adolescent survey participants reasonably well. The parent-aged respondents in our sample were on average 3 years younger than the parents of the adolescent survey participants ($M_{Parent1} = 49.60$, $SD_{Parent1} = 6.64$; $M_{Parent2} = 49.92$, $SD_{Parent2} = 6.67$). Yet given the large variability in age (from 33 to 74 years) and that the adolescent participants did not have to be the oldest child of a family, we again assumed that the parent-generation survey participants represented the adolescent respondents' parents' generation reasonably well.

2.5. Statistical analyses

Data quality was ensured through early exclusion of speeders (defined as participants who needed less than 2 min for the entire questionnaire) during data collection by the access panel. This means that the 500 adolescents and 500 adults in our sample all took a reasonable amount of time to complete the survey. Number of missing values per outcome variable varied between 0% for meat consumption frequency to 10% for general influence score ($Mdn = 1.3\%$). Participants with missing values were excluded from the respective analysis (pairwise deletion). The assumptions for statistical tests were checked and

Table 1
Sample characteristics.

Variable	Adolescents'generation		Parent's generation	
	M	*SD*	*M*	*SD*
Age	17.93	1.21	52.19	4.65
	n	%	*n*	%
Gender				
Female	356	71.20	312	62.40
Male	135	27.00	186	37.20
Other	9	1.80	2	<0.01
Education: Highest qualification earned				
None/still in school	270	54.00	1	0.20
Secondary school diploma	69	30.00[a]	250	50.00
Higher level/qualification for university entrance	148	64.30[a]	94	18.80
College/University degree	10	4.30[a]	147	29.40
Other	3	1.30[a]	8	1.60
Family-meal frequency				
(Nearly) every day	297	59.40	312	62.40
3–5 times a week	114	22.80	96	19.20
1–2 times a week	89	17.80	92	18.40
Less that 1–2 times a week	0	0	0	0

Note. N = 1000 (500 per generation). For education, categories refer to highest qualification earned: None = no diploma/still in school; Secondary = high school diploma; Higher/Qual = high school diploma that qualifies for university entrance in Germany ('(Fach-)Abitur'); College/University = college or university degree. Numbers above bars are number of participants in each category.

[a] Calculated only for 230 adolescents who had already finished school for an easier comparison to adult proportions.

Welch's *t*-test was used when no variance homogeneity can be assumed.

For Hypothesis 1, we tested for generational difference in the sustainability motive score using a *t*-test. To test Hypothesis 2a and b, we also conducted *t* tests. As the categories depicting dietary style are strictly ordinal rather than metrically scaled, we conducted an additional χ^2 test of independence to examine whether generational affiliation and consumption of animal products are related, which was not preregistered. To address Hypothesis 3a–c, we compared the generations using *t* tests. For each of the parts of Hypothesis 3, we additionally used an equivalent linear regression model to include the families' consumption frequency of meat, other animal products, and plant-based substitutes as a control variable. For Hypothesis 4a and b, we examined only adolescents. For each hypothesis, we conducted a regression model with (a) the overall advocating score and (b) the general influence score as dependent variables. We included the consumption of meat and other animal products first as continuous predictors. In addition to these preregistered analyses, we tested Hypothesis 4a and b with the consumption of meat and other animal products as categorial predictors using for each a one-way analysis of variance (ANOVA) with Tukey post hoc tests.

We descriptively compared the importance of all food-choice motives by using the mean value of each item to form a ranking for both generations (EQ 1a). Additionally, we investigated which food category and for which meal planning step the generations reported having the most impact (EQ 1b and c). Further, we looked at our main outcome variables separated for age, gender, and education to identify potential patterns (EQ 2). We also conducted two regression models parallel to our test of Hypothesis 4a and b using the sustainability motive score as a predictor for the advocating and general influence score (EQ 3). An overview table with information on all hypotheses, exploratory questions and results can be found in supplemental materials. Data were analyzed using RStudio version 2023.03.0 + 386 (Posit team, 2023), using the packages *psych* (v2.3.9; Revelle, 2023), *car* (Fox & Weisberg, 2019) and *effecsize* (Ben-Shachar et al., 2020) for the main analyses.

3. Results

For Details on means, standard deviations, and correlation coefficients for investigated variables see Tables 2a and 2b.

3.1. H1: No differences in sustainability food-choice motives between generations

We did not find significant differences in the sustainability food-choice motives between generations, $t_{Welch}(948.16) = -1.24$, $p = .892$ (one-sided), *MD* = -0.08, 95% confidence interval (CI) [−0.20], $d = 0.08$, and thus Hypothesis 1 was not supported by our data.

Table 2a
Means and standard deviations of sustainable food motive items, items measuring advocating for sustainable family meals, and influence on mealtime planning.

	Adolescents' generation			Parents' generation			p-value
	M	SD	N	M	SD	N	
Sustainable food motives							
Because it is sustainable.	3.00	1.16	493	3.13	1.05	483	
Because it is good for the environment.	2.98	1.18	490	2.98	1.12	477	
Because it has less of an impact on the environment.	2.97	1.15	486	3.06	1.11	477	
Sustainable food motive score	2.98	1.09	483	3.06	1.01	469	0.892
Advocating for sustainable family meals							
… less meat.	3.04	1.37	497	3.08	1.23	499	0.667
… less other animal products.	2.34	1.20	499	2.30	1.11	499	0.265
… trying “new” plant-based foods.	2.79	1.38	499	2.43	1.29	500	<0.001
… eating plants.	3.23	1.25	498	3.57	1.16	499	
… eating organically produced food.	2.88	1.23	497	3.07	1.25	499	
… eating food that is grown in the region and is in season.	3.06	1.17	498	3.07	1.10	499	
… eating food wrapped in a lot of plastic.	3.24	1.25	497	3.36	1.25	498	
… throwing away food.	3.60	1.23	498	4.00	1.25	497	
Overall advocating score	3.03	0.94	491	3.18	0.82	496	
Influence on mealtime planning							
… when planning a specific meal.	3.53	1.07	498	4.16	0.94	497	
… when planning the groceries.	3.50	1.11	497	4.21	0.93	497	
…. at the supermarket during shopping	3.53	1.15	497	4.16	0.95	497	
… during the preparation of the meal.	3.26	1.12	497	3.99	1.08	496	
… while we are sitting at the table eating.	3.46	1.14	492	3.82	1.12	496	
… at another step.	3.21	1.09	451	3.57	1.07	458	
General influence score	3.39	0.76	443	3.99	0.81	457	

Note. All items were measured on a 5-point Likert scale. Anchor points were for sustainable food motive items from “never applies” to “always applies”and for advocating as well as for influence items from “never” to “always”. P-values only shown for comparisons that are tested inferential statistical as part of the hypotheses. Sustainable food motive score = mean score for 3 sustainability items; Overall advocating score = mean score for all advocating for sustainable family meals items; General influence score = mean score for all Influence on mealtime planning items.

Table 2b
Correlations of sustainable food motive score, overall advocating score and general influence score.

Adolescents' generation	sustainable food motive score	overall advocating score	general influence score
Sustainable food motive score	1		
Overall advocating score	0.54	1	
General influence score	0.27	0.44	1
Parents' generation			
Sustainable food motive score	1		
Overall advocating score	0.56	1	
General influence score	0.22	0.28	1

Note. *Sustainable food motive score= mean score for 3 sustainability items; Overall advocating score=mean score for all advocating for sustainable family meals items; General influence score= mean score for all Influence on mealtime planning items.*

3.2. H2: Adolescents eat more often no meat at all

On average, there was no significant difference in the frequency of meat consumption between generations, $t_{Welch}(922.65) = -0.25$, $p = 0.399$ (one-sided), $MD = 0.016$, 95% CI [0.09], $d = 0.02$. However, looking at the distribution instead of the mean (Fig. 1), we found that adolescents were more than three times as likely to never eat meat than their parents' generation. They also stated more frequently that they always eat meat. The χ^2 test of independence shows that generation and meat consumption were interdependent, $\chi^2(4) = 72.198$, $p < 0.001$, $\varphi = 0.26$. For other animal products, we found neither a significant difference in means of generations, $t(998) = 0.52$, $p = 0.699$ (one-sided), $MD = 0.032$, 95% CI [, 0.13], $d = 0.03$, nor a significant dependence on consumption frequency and generation, $\chi^2(4) = 8.441$, $p = 0.077$.

3.3. H3: Adolescents advocate for other animal products and new plant-based products

Adolescents were significantly more likely to advocate for trying more new plant-based products at shared meals, $t(997) = 4.26$, $p < 0.001$ (one-sided), $MD = 0.36$, 95% CI [0.22], $d = 0.27$. This effect also held when we controlled for the consumption of new plant-based products in the family. Contrary to our expectations, we did not find a mean difference for advocating eating less meat, $t_{Welch}(980.6) = -0.44$, $p = 0.669$, (one-sided), $MD = -0.04$, 95% CI [−0.17], $d = 0.03$, or less of other animal products, $t(996) = 0.63$, $p = 0.265$ (one-sided), $MD = 0.05$, 95% CI [−0.07], $d = 0.04$. When we additionally controlled for the amount of other animal products consumed in the family, adolescents were significantly more likely than their parents' generation to advocate for reducing the amount of other animal products consumed, $\beta = -0.15$, $F(2,991) = 38.07$, $p = 0.02$, $R^2 = 0.07$, indicating a suppressor effect which describes the increase of the model's predictive power through inclusion of an additional predictor. We did not find this effect for meat consumption when we controlled for family consumption, $\beta = -0.12$, $F(2,991) = 37.33$, $p = 0.148$, $R^2 = 0.07$.

3.4. H4: Adolescents consuming less animal products advocate for more sustainable family meals

Focusing only on adolescents, a negative linear trend of the relationship between frequency of meat consumption and reported advocacy of sustainable food decisions at family meals was observed (see Fig. 2).

The linear regression model with overall advocating score as the dependent variable and consumption of meat and other animal products as the two predictors showed a significant effect for both predictors (meat: $\beta = -0.35$, $p < 0.001$; other animal products: $\beta = -0.11$, $p = 0.015$), $F(2,488) = 50.6$, $R^2 = 0.17$. Adolescents who ate less meat and less of other animal products advocated more for sustainable family meal decisions.

The additionally conducted ANOVAs showed a significant effect for meat, $F(4,486) = 23.93$, $p < 0.001$) and other animal products, $F(4,486) = 9.52$, $p < 0.001$. For meat, post hoc tests indicated that advocacy clearly differed between the three frequency categories of meat consumption (i.e., never, sometimes [1x; 2–4x], often [at least 5; always]). For other animal products, the pattern was less clear and suggests that major differences could be found between those eating other animal products never, 1x, or 2–4x per week versus those eating them at least 5x or always (see Tables S1 and S2 in the Supplemental Materials for statistical details of the post hoc tests).

The frequency of consuming meat or other animal products did not

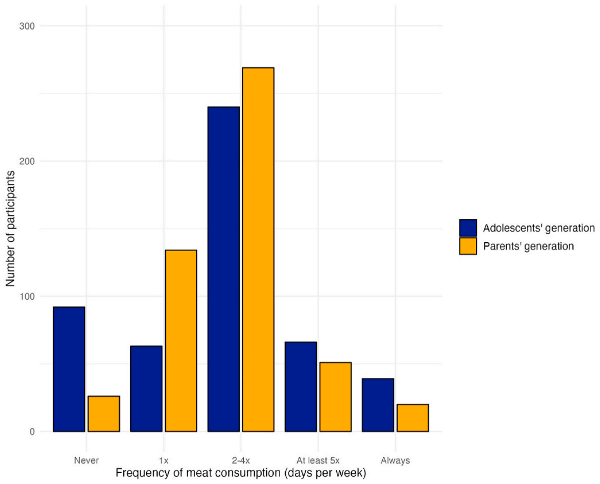


Fig. 1. Meat Consumption Frequency for Both Generations
Note. $N = 500$ per generation.

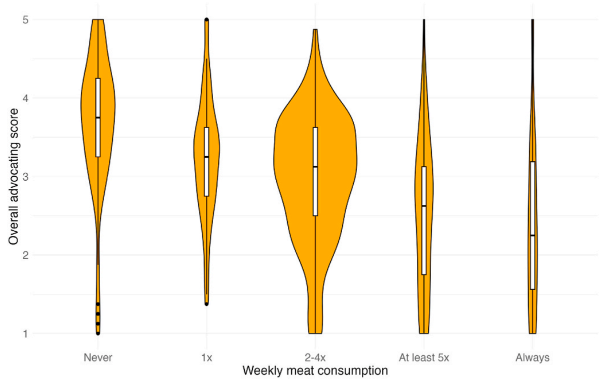


Fig. 2. Adolescents Advocating for Sustainable Food Decisions at Family Meals by Weekly Meat Consumption Frequency
Note. Overall advocating score is the sum score of all items that measure frequency of advocating for more sustainable family meals (less meat, less of other animal products, more plants, trying "new" plant-based foods, more organically produced food, more food that is grown in the region and is in season, less food wrapped in a lot of plastic, throwing away less food). Violins show density of distribution per category in orange, medians and quartiles blue. $N = 491$ owing to missing values.

predict the general influence score (mean score of reported influence on all meal-planning step items)—neither in the continuous analyses (meat: $\beta = -0.04$, $p = 0.42$; other animal products: $\beta = -0.01$, $p = 0.844$), $F(2,440) = 0.49$, nor in the additional categorical analyses to account for the categorical nature of the predictors, meat: $F(4,438) = 0.661$, $p = 0.661$; other animal products: $F(4,438) = 0.32$, $p = 0.864$.

3.5. EQ 1a: Habits for adolescents, naturalness for parents?

We found both similarities and clear differences in food-choice motives between adolescents and their parents' generation: Both generations rated taste as the most important motive, closely followed by enjoyment. The two least important motives were also similar—eating because of being sad and because others like it. The clearest differences were found in the motive "naturalness," which adolescents rated as considerably less important than their parents' generation (Rank 15 vs. 8). On the other hand, habit played a more important role for adolescents (Rank 3 vs. 9). Table 3 shows mean scores and ranks of all food-choice motives for the two generations.

3.6. EQ 1b and 1c: Parents report more influence in general

Descriptively, adolescents reported a slightly lower advocating for sustainable food decisions at family meals than their parents' generation (overall M = 3.03 vs. 3.18)but rated their advocacy specifically for eating less of other animal products and for trying "new" plant-based foods more highly than their parents' generation did (see Table 2a for details). Both generations reported that their most frequent advocacy was for avoiding food waste ($M = 3.60$ for adolescents and $M = 4.0$ for parents' generation).

The parents' generation reported greater general influence on meal planning when eating together as a family (overall $M_{\text{adults}} = 3.99$ vs. $M_{\text{adolescents}} = 3.39$) and more frequent influence than adolescents on every individual meal-planning step. Separately by generation, adolescents reported most frequently having an influence during grocery shopping and when planning a specific meal, their parents' generation when planning the groceries (see Table 2a).

Table 3
Ratings of eating behavior motives.

Motive: I eat what I eat …	Adolescents' generation			Parents' generation		
	M	*SD*	Rank	*M*	*SD*	Rank
Because it tastes good.	4.42	0.77	1	4.46	0.70	1
Because I enjoy it.	3.72	0.97	2	3.94	0.94	2
Because I am accustomed to eating it.	3.60	0.93	3	3.37	1.05	9
Because it belongs to certain situations.	3.54	1.09	4	3.51	1.12	6
Because I need energy.	3.54	1.09	4	3.74	1.03	4
Because it is quick to prepare.	3.52	0.94	6	3.45	0.97	7
Because it is healthy.	3.38	1.02	7	3.79	0.91	3
Because it is inexpensive.	3.28	1.03	8	2.98	1.05	13
Because it is social.	3.23	1.12	9	3.63	1.03	5
Because the presentation is appealing (e.g., packaging).	3.06	1.12	10	3.06	1.15	11
Because it is sustainable.	3.00	1.16	11	3.13	1.05	10
Because it is good for the environment.	2.98	1.18	12	2.98	1.12	13
Because it has less of an impact on the environment.	2.97	1.15	13	3.06	1.11	11
Because animals do not have to suffer.	2.91	1.36	14	2.90	1.24	15
Because it is natural (e.g., not genetically modified).	2.81	1.20	15	3.40	0.97	8
Because it would be impolite not to eat it.	2.79	1.20	16	2.21	1.12	17
Because it is low in calories.	2.68	1.27	17	2.90	1.12	15
Because I am sad.	2.66	1.30	18	1.87	1.10	19
Because others like it.	2.25	1.15	19	1.89	1.14	18

Note. $N > 450$ for all items (per group); participants indicated the importance of every food-choice motive on a 1-to-5 scale (no participant chose the option "I don't understand"); the ranking was formed separately for the generations based on their mean values: The food-choice motive with the highest mean importance is ranked 1, the one with the lowest mean importance is ranked 19. If two motives have the same mean, both are given the same rank.

3.7. EQ 2: Gender as an important factor

For the central outcome variables sustainability motive score, meat consumption, and overall advocating score, we found some notable differences in terms of gender and education: Women were more likely not to eat meat than men, especially among adolescents (adolescents: 24% women vs. 4% men; parents' generation: 7% women vs. 3% men) whereas men were more likely to always eat meat (adolescents: 4% women vs. 19% men; parents' generation: 3% women vs. 6% men). In addition, both adolescent women and women of their parents' generation reported more frequently advocating for sustainable family meal decisions than men ($M_{\text{adolescents}}$: 3.16 for women vs. 2.68 for men; M_{adults}: 3.3 for women vs. 2.98 for men). To account for these differences and the fact that our adolescent sample has a higher proportion of women, we additionally calculated all generational comparisons reported above with gender as a control variable; the results remain comparable with regard to size and direction. Descriptively, we also found a trend toward higher education being associated with never eating meat and more advocating for sustainable family meal decisions (see Fig. 3 for meat consumption; for sustainability food-choice motives and advocating, see Figs. S1 and S2 in the Supplemental Materials).

3.8. EQ 3: Importance of sustainable motives predict reported advocating

Exploratory analyses showed that sustainable motives are predictive for the overall advocating score ($\beta = 0.53$), $F(1,474) = 194.8$, $p < 0.001$, $R^2 = 0.29$, as well as for the general influence score on meal planning ($\beta = 0.27$), $F(1,430) = 36.07$, $p < 0.002$, $R^2 = 0.08$.

4. Discussion

This study explored generational differences in animal product consumption, food-choice motives, and advocating for sustainable family meal decisions. It also examined predictors of advocating for sustainable family meals in adolescents. The generations did not differ in overall meat consumption frequency, but adolescents more often reported clear-cut behaviors: Adolescents were about three times as likely not to eat meat but also twice as likely to eat meat daily compared to their parents' generation. Adolescents were more likely than their parents' generation to advocate for trying new plant-based substitutes at family meals and especially reported more advocating for sustainable family meals when they themselves engaged in less consumption of animal products and reported higher endorsement of sustainable food values.

Contrary to our hypotheses, there was no significant difference between the generations in importance of sustainability food-choice motives. One possible explanation is the item wording we used: Two out of three items addressed the environment more generally, not specifically climate change. Still, previous surveys also found higher endorsement of pro-climate attitudes and readiness-to-change among younger generations (Belz et al., 2022). Other aspects of environmental awareness (e.g., environmental attitudes, environmental behavior) were more important in their parents' generation (Belz et al., 2022). This indicates that "environmental motives" in themselves are a very broad concept in which certain aspects can be more important for one generation than another. To better understand the potential of adolescents and young adults as actors for future climate protection, research could differentiate aspects of environmental awareness that are relevant in the everyday lives of adolescents versus not.

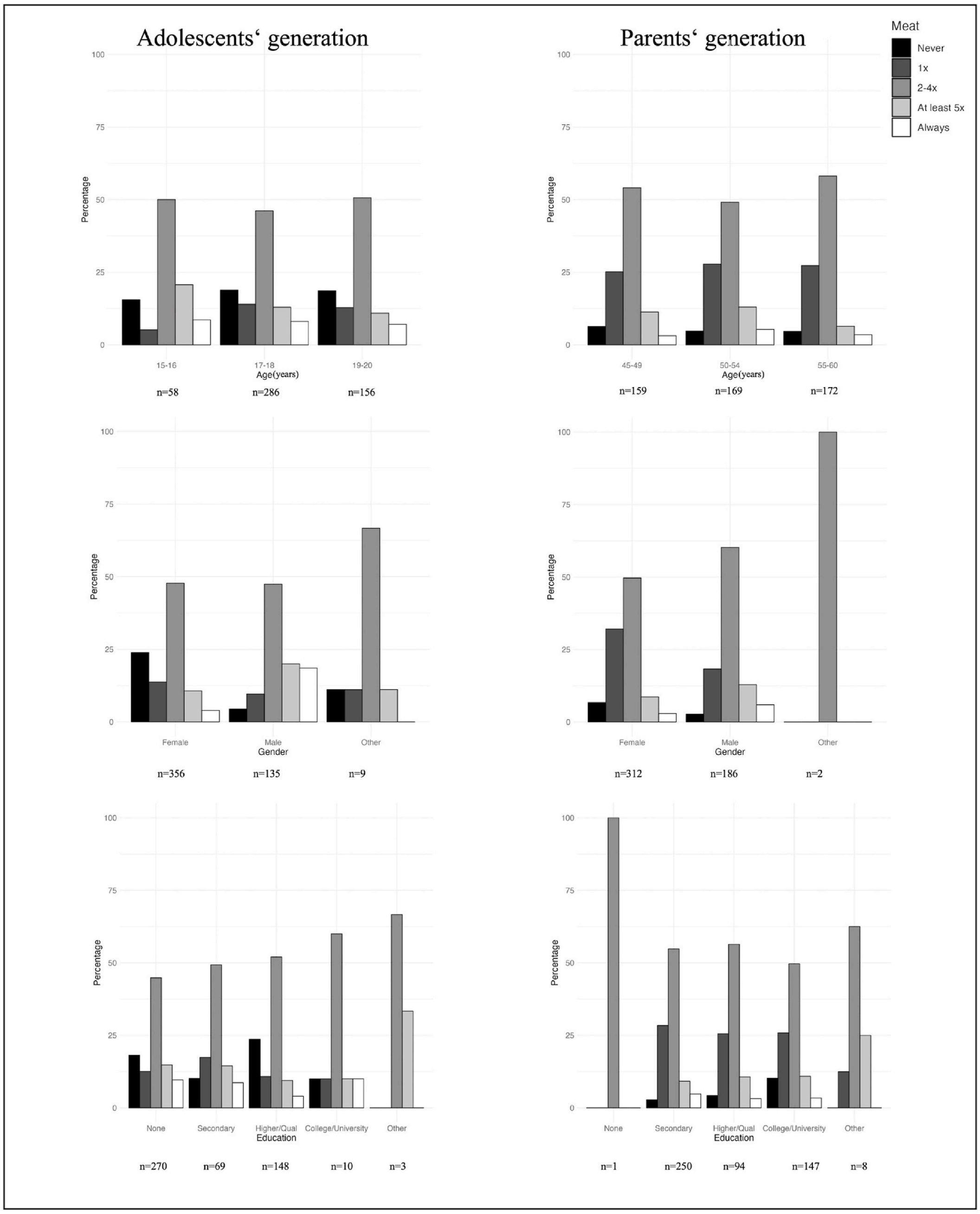


Fig. 3. Meat Consumption Patterns by Age, Gender, and Education
Note. For education, categories refer to highest qualification earned: None = no diploma/still in school; Secondary = high school diploma; Higher/Qual = high school diploma that qualifies for university entrance in Germany ('(Fach-)Abitur'); College/University = college or university degree. Numbers above bars are number of participants in each category.

Not finding significant mean differences in meat and other animal product consumption frequency between generations was unexpected. Importantly, substantial differences between the generations emerged when examining the distribution in meat consumption frequency: That over 18% of the adolescents reported not eating meat (compared to 5% in their parents' generation) is consistent with the high numbers of vegetarians and vegans in Germany in this age group (Heinrich-Böll--Stiftung & Bund für Umwelt und Naturschutz Deutschland (Hrsg.), 2021; Zühlsdorf et al., 2021). This suggests that young people are more likely to be represented at the ends of the scale and decide for or against meat consumption more decisively than their parents' generation, making the mean a less useful measure to explore consumption patterns. One explanation for this decisive choice of adolescents is that adolescence is a crucial phase for the development and change of social identity (Tanti et al., 2011). Having a vegetarian identity and belonging to this group is gaining importance (Nezlek & Forestell, 2020; Rosenfeld et al., 2020). In summary, it is too simple to assume that young people on average consume animal products less or more often than their parents' generation. Further investigation of patterns and a closer look at underlying processes such as social identity could further advance our understanding of sustainable diets across generations.

Again, not supporting our hypotheses, adolescents were not more likely than their parents' generation to report advocating for less consumption of meat at shared meals - descriptively, it was the other way around with parents advocating more. One probable explanation is that they did so for health reasons: Eating a lot of meat (especially red meat) has many negative health consequences, including cardiovascular diseases and higher cancer risk (Wolk, 2017). Previous research showed that healthiness of the meal is important to parents (Russell et al., 2015; Søndergaard & Edelenbos, 2007)—which we also found in the current study ("healthy" as a food-choice motive ranked seventh for adolescents vs third for their parents' generation). Of note, participants of the parents' generation reported higher advocacy than adolescents on all advocating items—this merits further investigation to better understand whether this is a measurement issue, answer bias, or part of parents' role as nutritional gatekeepers.

As predicted, adolescents advocated more for eating less other animal products and trying plant-based substitutes at shared meals than adults of their parents' generation. This fits with previous research showing that children and adolescents are more likely to bring new products from outside into the family system (Ayadi & Bree, 2010; Williams et al., 2019) and that especially dairy substitutes are highly popular (Zühlsdorf et al., 2021). This finding is particularly interesting for future research and practice because it provides empirical evidence about the types of foods adolescents advocate for. Also, it shows what types they do not care about, potentially because they are less important for them, or because another family member is responsible for that aspect of the meal. Plant-based substitutes as a product parents feel less responsible for, as they consider plant-based substitutes for instance to be unhealthier, may be a lever for adolescents (Erhardt & Olsen, 2021). It is important to consider plant-based substitutes for meat in the context of sustainable diets. Although they do not classically reflect the planetary health diet (Willett et al., 2019), their increased consumption may reduce the overall consumption of animal products eaten in the family.

Adolescents who reported less consumption of animal products themselves also advocated for more sustainable food choices. We found an even stronger predictive effect for sustainable food values on family meal planning. These findings are in line with previous work showing that adolescents have a personal motivation to bring their own values into the family (Olsen & Ruiz, 2008). Interestingly, participants' own behavior—the consumption of animal products—had no predictive effect at all on their reported influence on general meal planning, whereas sustainability food-choice motives did. One explanation for this finding is that there may be other reasons for reduced meat consumption beyond sustainability (e.g., health, taste) that do not cause such a strong need for advocating, weakening the effect. Another explanation is that strong importance of sustainable food values may lead adolescents to attempt to influence family meal planning in line with these values, whereas their eating behavior itself may differ from these values, for instance, to compromise with their families to avoid conflicts.

4.1. Strengths, limitations, and future research

This study specifically compared adolescents and their parents' generation regarding their sustainability food-choice motives, consumption of animal products, and corresponding behaviors such as advocating for and influencing more sustainable family meals in a large, diverse sample. Our research question focused on generational differences and overarching patterns rather than on specific families, which needs to be considered when interpreting the data. Two further methodological aspects are worth noting: First, we restricted the number of additional control variables in the models. Although we compared differences between age, gender, and education descriptively and tested all generational comparisons again while controlling for gender, we did not control for age and education. For one, no striking differences were found for age and—even more important—half of the adolescents had not finished school yet, which made educational comparisons of little informative value. In addition, we wanted to keep the statistical models as simple as possible. We did not assess other potentially interesting variables such as political attitudes. Given the broad sampling strategy of the access panel we used, we expected diverse political views to be represented in the sample. Second, we measured diet style in categories (never, 1x a week, 2–4x a week, etc.) and not linearly (e.g., on how many days of the week do you eat meat?). This has advantages and disadvantages: When asking participants to report their eating behavior as the number of days per week, statistical methods that require a metric scale level could be used. At the same time, respondents often have problems differentiating whether they eat different foods five or six times a week (Egele et al., 2023); therefore using categories as in the current study can lead to more precise answers. We also found that for the prediction of advocacy frequency, three categories for the consumption of meat (never, sometimes, often) and two for consuming other animal products (sometimes, often) were enough. A more fine-grained measurement would not have provided additional information to predict frequency of advocacy.

The same applies to the fact that we did not measure the quantity of meat consumption, but the frequency. It is very challenging for participants to retrospectively add up the quantity of various meat products (e.g., sausage, steak, ham cubes) over a period of time, because they need to both, remember all instances of eating meat and be able to estimate the amount on their plates which is generally difficult, but especially for dishes such as soups or stews, or when eating out. To measure the quantity somewhat reliably, at least an experience sampling design would be required, which would go beyond the aims of the current survey. Measuring the frequency can only be a proxy for quantity, this needs to be taken into consideration when interpreting the results.

4.2. Conclusion

Adolescents do not on average eat more sustainably than their parents' generation, but they are more likely to make clear-cut choices such as becoming vegetarian. Adolescents for whom sustainability food-choice motives are important advocate for them at shared meals; they also bring new plant-based products to family meals. Shared family meals provide adolescents the opportunity to become agents of change and in a reverse socialization process contribute to more sustainable and healthy family diets.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Vanessa Knobl: Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Jutta Mata:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

I have shared the link to the data in the manuscript and the Attach file step

Acknowledgements

We are grateful to Anita Todd for editing this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107618.

References

Ayadi, K., & Bree, J. (2010). An ethnography of the transfer of food learning within the family. *Young Consumers, 11*(1), 67–76. https://doi.org/10.1108/17473611011026028

Baptist, J., & Hamon, R. R. (2022). Family systems theory. In K. Adamsons, A. L. Few-Demo, C. Proulx, & K. Roy Hrsg (Eds.), *Sourcebook of family Theories and methodologies (S. 209–226)*. Springer International Publishing. https://doi.org/10.1007/978-3-030-92002-9_14.

Beal, T., Ortenzi, F., & Fanzo, J. (2023). Estimated micronutrient shortfalls of the EAT–Lancet planetary health diet. *The Lancet Planetary Health, 7*(3), e233–e237. https://doi.org/10.1016/S2542-5196(23)00006-2

Beatty, S. E., & Talpade, S. (1994). Adolescent influence in family decision making: A replication with extension. *Journal of Consumer Research, 21*(2), 332. https://doi.org/10.1086/209401

Belz, J., Follmer, R., Hölscher, J., Stieß, I., Sunderer, G., & Birzle-Harder, B. (2022). Umweltbewusstsein in Deutschland 2020: Ergebnisse einer repräsentativen Bevölkerungsumfrage. *Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz (BMUV)*. https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/ubs_2020_0.pdf.

Ben-Shachar, M., Lüdecke, D., & Makowski, D. (2020). effectsize: Estimation of effect size indices and standardized parameters. *Journal of Open Source Software, 5*(56), 2815. https://doi.org/10.21105/joss.02815

Bundesministerium für Ernährung und Landwirtschaft. (2019). Deutschland, wie es isst—Der BMEL-Ernährungsreport 2019 https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/Ernaehrungsreport2019.pdf?_blob=publicationFile.

Bundesministerium für Ernährung und Landwirtschaft. (2021). *Deutschland, wie es isst · Der BMEL-Ernährungsreport 2021*. https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/ernaehrungsreport-2021.pdf?_blob=publicationFile&v=6.

Bundesministerium für Ernährung und Landwirtschaft. (2023). Deutschland, wie es isst – Der BMEL-Ernährungsreport 2023 https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/ernaehrungsreport-2023.pdf?_blob=publicationFile&v=4.

Chen, Y.-S., Lehto, X., Behnke, C., & Tang, C.-H. (2016). Investigating children's role in family dining-out choices: Evidence from a casual dining restaurant. *Journal of Hospitality Marketing & Management, 25*(6), 706–725. https://doi.org/10.1080/19368623.2016.1077368

Clark, L. F., & Bogdan, A.-M. (2019). The role of plant-based foods in Canadian diets: A survey examining food choices, motivations and dietary identity. *Journal of Food Products Marketing, 25*(4), 355–377. https://doi.org/10.1080/10454446.2019.1566806

De Bourdeaudhuij, I., & Van Oost, P. (1998). Family members' influence on decision making about food: Differences in perception and relationship with healthy eating. *American Journal of Health Promotion, 13*(2), 73–81. https://doi.org/10.4278/0890-1171-13.2.73

Egele, V. S., Klopp, E., & Stark, R. (2023). Evaluating self-reported retrospective average daily fruit, vegetable, and egg intake: Trustworthy—sometimes. *Applied Psychology: Health and Well-Being, 15*(3), 1130–1149. https://doi.org/10.1111/aphw.12430

Erhardt, J., & Olsen, A. (2021). Meat reduction in 5 to 8 years old children—a survey to investigate the role of parental meat attachment. *Foods, 10*(8), 1756. https://doi.org/10.3390/foods10081756

European Commission, Brussels. (2021). *Eurobarometer 93.2 (2020)*. Köln: GESIS Datenarchiv. https://doi.org/10.4232/1.13706

Food and Agriculture Organization of the United Nations. (2022). GLEAM v3 Dashboard. *Shiny Apps*. https://foodandagricultureorganization.shinyapps.io/GLEAMV3_Public/.

Fox, J., & Weisberg, S. (2019). *An R companion to applied regression* (3rd ed.). Thousand Oaks CA: Sage https://socialsciences.mcmaster.ca/jfox/Books/Companion/.

Frank, M., Brettschneider, A.-K., Lage Barbosa, C., & Mensink, G. B. (2019). Prevalence and temporal trends of shared family meals in Germany. Results from EsKiMo II. *Ernahrungs Umschau, 66*(4), 60–67. https://doi.org/10.4455/eu.2019.013

Gentina, E., & Muratore, I. (2012). Environmentalism at home: The process of ecological resocialization by teenagers: Ecological resocialization by teenagers. *Journal of Consumer Behaviour, 11*(2), 162–169. https://doi.org/10.1002/cb.373

Heinrich-Böll-Stiftung, & Bund für Umwelt und Naturschutz Deutschland (Hrsg.). (2021). *Fleischatlas: Daten und Fakten über Tiere als Nahrungsmittel (1. Auflage). Heinrich-Böll-Stiftung*.

Hopwood, C. J., Bleidorn, W., Schwaba, T., & Chen, S. (2020). Health, environmental, and animal rights motives for vegetarian eating. *PLoS One, 15*(4), Article e0230609. https://doi.org/10.1371/journal.pone.0230609

Kong, X., & Jia, F. (2023). Intergenerational transmission of environmental knowledge and pro-environmental behavior: A dyadic relationship. *Journal of Environmental Psychology, 89*, Article 102058. https://doi.org/10.1016/j.jenvp.2023.102058

Lawson, D. F., Stevenson, K. T., Peterson, M. N., Carrier, S. J., Strnad, R., & Seekamp, E. (2018). Intergenerational learning: Are children key in spurring climate action? *Global Environmental Change, 53*, 204–208. https://doi.org/10.1016/j.gloenvcha.2018.10.002

Liu, J., Chen, Q., & Dang, J. (2022). New intergenerational evidence on reverse socialization of environmental literacy. *Sustainability Science, 17*(6), 2543–2555. https://doi.org/10.1007/s11625-022-01194-z

McKeown, A., & Nelson, R. (2018). Independent decision making of adolescents regarding food choice. *International Journal of Consumer Studies, 42*(5), 469–477. https://doi.org/10.1111/ijcs.12446

Nezlek, J. B., & Forestell, C. A. (2020). Vegetarianism as a social identity. *Current Opinion in Food Science, 33*, 45–51. https://doi.org/10.1016/j.cofs.2019.12.005

Nørgaard, M. K., & Brunsø, K. (2011). Family conflicts and conflict resolution regarding food choices: Family conflicts regarding food choices. *Journal of Consumer Behaviour, 10*(3), 141–151. https://doi.org/10.1002/cb.361

Olsen, S. O., & Ruiz, S. (2008). Adolescents' influence in family meal decisions. *Appetite, 51*(3), 646–653. https://doi.org/10.1016/j.appet.2008.05.056

Pater, L., Kollen, C., Damen, F. W. M., Zandstra, E. H., Fogliano, V., & Steenbekkers, B. L. P. A. (2022). The perception of 8- to 10-year-old Dutch children towards plant-based meat analogues. *Appetite, 178*, Article 106264. https://doi.org/10.1016/j.appet.2022.106264

Perrea, T., Brunsø, K., Altintzoglou, T., Einarsdóttir, G., & Luten, J. (2012). Decomposing the (seafood versus meat) evening meal decision-making sequence: Insights from a diary study in Norway, Iceland and Denmark. *British Food Journal, 114*(11), 1533–1557. https://doi.org/10.1108/00070701211273018

Posit team. (2023). RStudio: Integrated development environment for R. *Posit Software, PBC* [Software] http://www.posit.co/.

Renner, B., Arens-Azevedo, U., Watzl, B., Richter, M., Virmani, K., & Linseisen, J. (2021). DGE position statement on a more sustainable diet. *Ernahrungs Umschau, 68*(7), 144–154. https://doi.org/10.4455/eu.2021.030

Renner, B., Sproesser, G., Strohbach, S., & Schupp, H. T. (2012). Why we eat what we eat. The Eating Motivation Survey (TEMS). *Appetite, 59*(1), 117–128. https://doi.org/10.1016/j.appet.2012.04.004

Revelle, W. (2023). *psych: Procedures for psychological, psychometric, and personality research*. Evanston, Illinois: Northwestern University. R package version 2.3.9 https://CRAN.R-project.org/package=psych.

Rosenfeld, D. L., Rothgerber, H., & Tomiyama, J. A. (2020). From mostly vegetarian to fully vegetarian: Meat avoidance and the expression of social identity. *Food Quality and Preference, 85*, Article 103963. https://doi.org/10.1016/j.foodqual.2020.103963

Russell, C. G., Worsley, A., & Liem, D. G. (2015). Parents' food choice motives and their associations with children's food preferences. *Public Health Nutrition, 18*(6), 1018–1027. https://doi.org/10.1017/S1368980014001128

Sachverständigenrat für Verbraucherfragen, Berlin. (2021). *Nachhaltiger Konsum: Repräsentativbefragung zu Kenntnissen, Akzeptanz, Verhalten, Erwartungen und Einstellungen im Kontext von SDG 12 (ZA5549 Datenfile Version 1.0.0)*. Köln: GESIS Datenarchiv. https://doi.org/10.4232/1.13730

Singh, P., Sahadev, S., Oates, C. J., & Alevizou, P. (2020). Pro-environmental behavior in families: A reverse socialization perspective. *Journal of Business Research, 115*, 110–121. https://doi.org/10.1016/j.jbusres.2020.04.047

Søndergaard, H. A., & Edelenbos, M. (2007). What parents prefer and children like – investigating choice of vegetable-based food for children. *Food Quality and Preference, 18*(7), 949–962. https://doi.org/10.1016/j.foodqual.2007.03.009

Statistisches Bundesamt. (2020). *Kinder in Hauptwohnsitzhaushalten: Deutschland, Jahre, Geschlecht, Geschwisterzahl, Familienformen*. https://www-genesis.destatis.de/genesis/online?operation=abruftabelleBearbeiten&levelindex=0&levelid=1700588035301&auswahloperation=abruftabelleAuspraegungAuswaehlen&auswahlverzeichnis=ordnungsstruktur&auswahlziel=werteabruf&code=12211-0402&auswahltext=&werteabruf=starten#abreadcrumb.

Tanti, C., Stukas, A. A., Halloran, M. J., & Foddy, M. (2011). Social identity change: Shifts in social identity during adolescence. *Journal of Adolescence, 34*(3), 555–567. https://doi.org/10.1016/j.adolescence.2010.05.012

UNESCO. (2020). Education for sustainable development: A roadmap. https://doi.org/10.54675/YFRE1448.

Watne, T., Lobo, A., & Brennan, L. (2011). Children as agents of secondary socialisation for their parents. *Young Consumers, 12*(4), 285–294. https://doi.org/10.1108/17473611111185841

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., … Murray, C. J. L. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

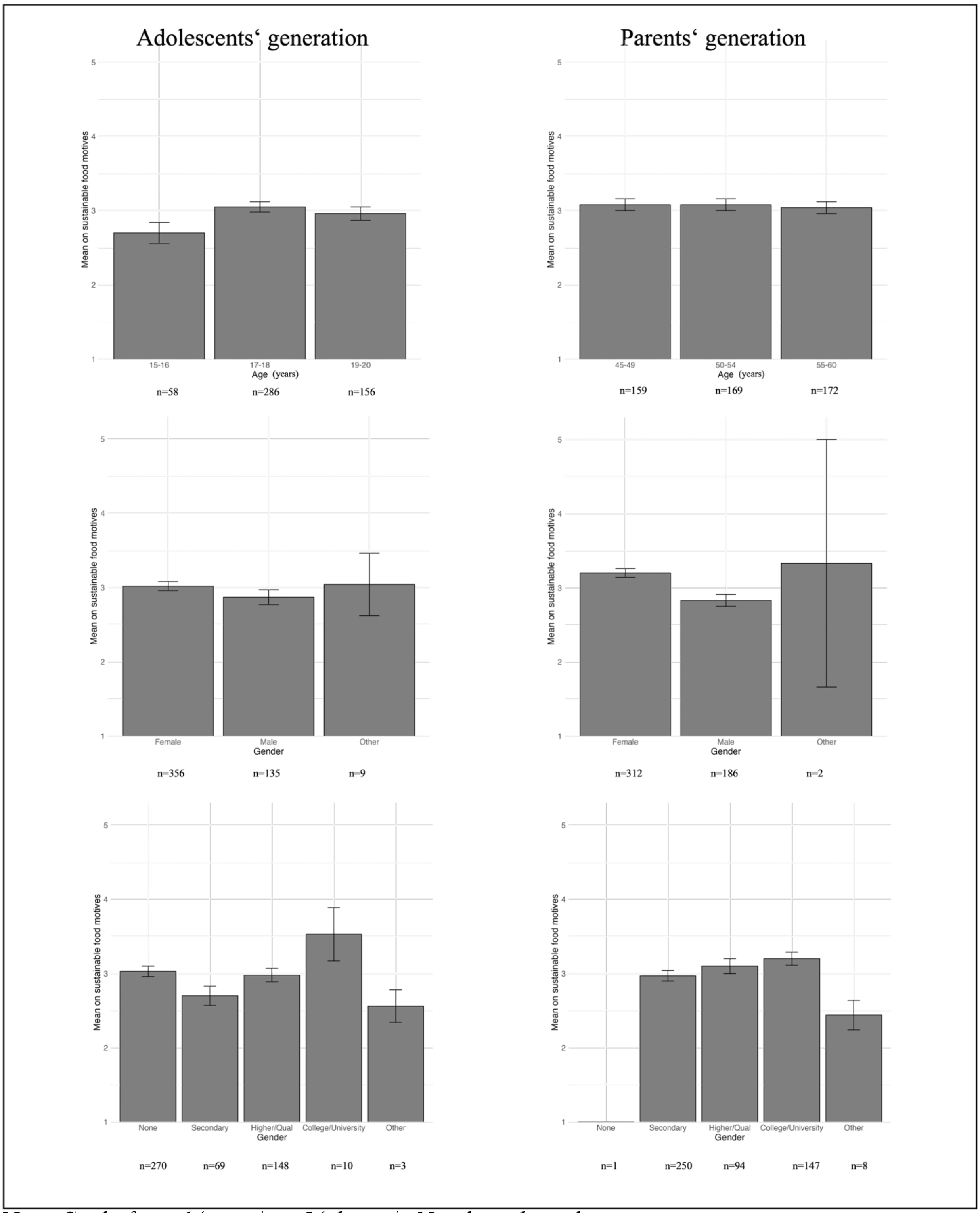
Williams, L., Magee, A., Kilby, C., Maxey, K., & Skelton, J. A. (2019). A pilot summer day camp cooking curriculum to influence family meals. *Pilot and Feasibility Studies, 5*(1), 147. https://doi.org/10.1186/s40814-019-0528-0

Wolk, A. (2017). Potential health hazards of eating red meat. *Journal of Internal Medicine, 281*(2), 106–122. https://doi.org/10.1111/joim.12543
Xu, X., Sharma, P., Shu, S., Lin, T.-S., Ciais, P., Tubiello, F. N., Smith, P., Campbell, N., & Jain, A. K. (2021). Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. *Nature Food, 2*(9), 724–732. https://doi.org/10.1038/s43016-021-00358-x
Zühlsdorf, A., Jürkenbeck, K., Schulze, M., & Spiller, A. (2021). *Jugendreport zur Zukunft nachhaltiger Ernährung*. Göttingen, Germany: University of Göttingen.

Supplementals

Figure S1

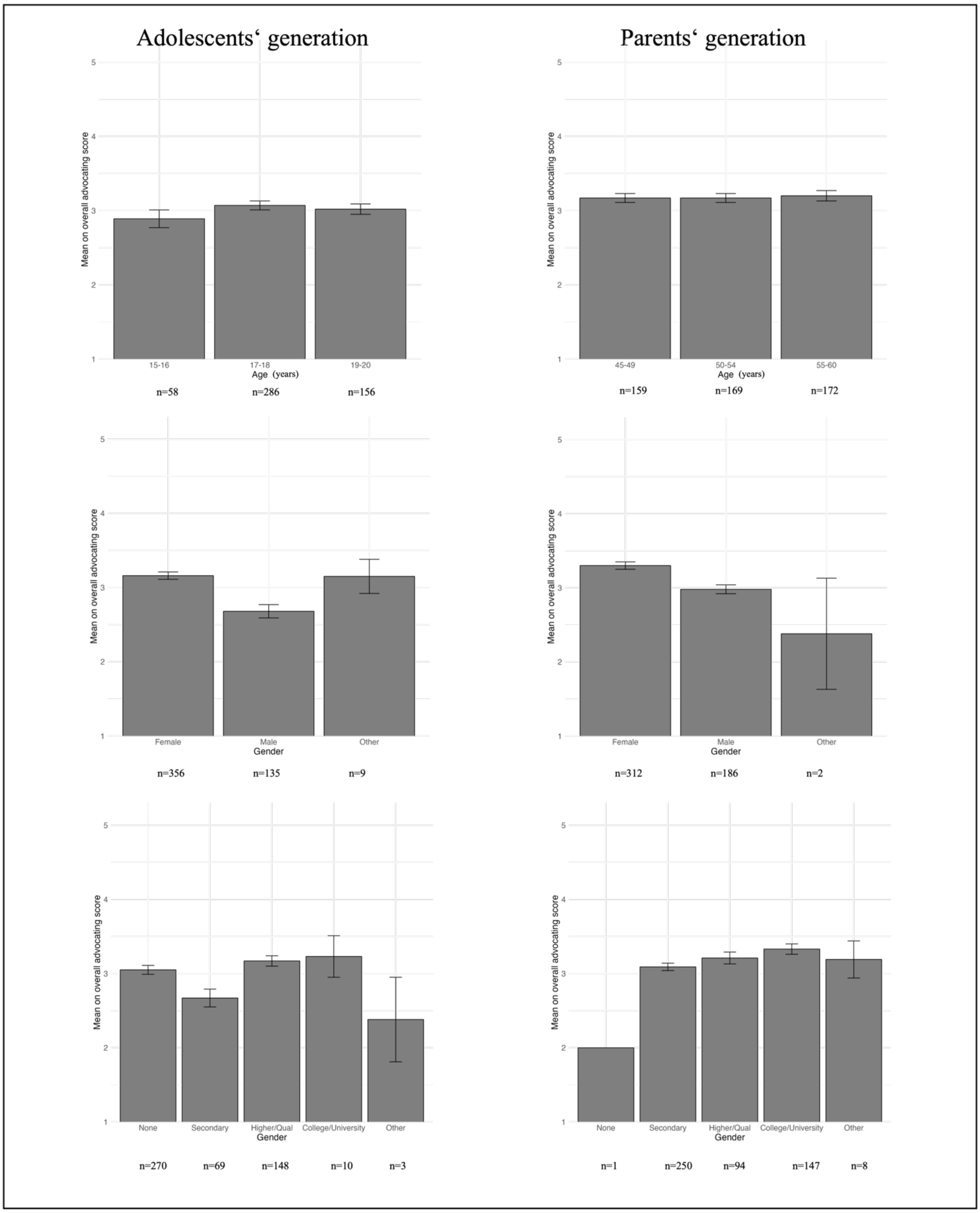
Sustainable food motive scores for age-, gender- and education groups



Note. Scale from 1(never) to 5(always). Number above bars = n

Figure S2

Overall advocating score for sustainable family meal decisions for age-, gender- and education group



Note. Scale from 1(never) to 5(always). Number above bars = n

Table S1
Statistical Parameter of Post Hoc Tests for Meat Consumption Frequency

Comparisons	Difference	*p-value*	95% CI	
			LL	*UL*
Never – 1x	.44	.019	.05	.83
Never – 2x-4x	.69	<.001	.40	.99
Never – at least 5x	1.13	<.001	.74	1.52
Never – always	1.28	<.001	.83	1.74
1x – 2x-4x	.25	.237	-.08	.59
1x – at least 5x	.69	<.001	.27	1.11
1x – always	.84	<.001	.36	1.33
2x-4x – at least 5x	.44	.003	.11	.77
2x-4x – always	.59	<.001	.18	1.00
At least 5x – always	.15	.909	-.33	.63

Notes. Tukey Post Hoc Test was conducted to explore which frequency categories of consumption differ significantly in how often adolescents advocate for sustainable family meals. N=491

Table S2
Statistical Parameter of Post Hoc Tests for Consumption Frequency of other animal products

Comparisons	Difference	*p-value*	95% CI	
			LL	*UL*
Never – 1x	.65	.321	-.29	1.58
Never – 2x-4x	.70	.171	-.16	1.55
Never – at least 5x	1.01	.011	.16	1.87
Never – always	1.23	<.001	.37	2.08
1x – 2x-4x	.05	.999	-.42	.52
1x – at least 5x	.37	.203	-.10	.84
1x – always	.58	.008	.10	1.06
2x-4x – at least 5x	.32	.017	.04	.60
2x-4x – always	.53	<.001	.23	.83

At least 5x – always	.21	.273	-.08	.50

Notes. Tukey Post Hoc Test was conducted to explore which frequency categories of consumption differ significantly in how often adolescents advocate for sustainable family meals. N=491

Overview table of Hypotheses, Exploratory Questions and Results

Number	Hypotheses/Explorative Question	Results
H1	Sustainability food-choice motives play a more important role in adolescents' food choices than in the food choices of their parents' generation.	No significant differences between generations (t_{Welch}(948.16) = -1.24, *p* = .892, d=0.08.)
H2a	Adolescents consume meat less often than their parents' generation.	No significant difference in mean frequency of meat consumption (t_{Welch}(922.65) = -.25, *p* = .399), but adolescents more likely to *never* and *always* eat meat.
H2b	Adolescents consume other animal products less often than their parents' generation.	No significant difference in consumption frequency between generations (*t*(998) = .52, *p* = .602, *d* = 0.03.
H3a	Adolescents advocate more for lessening consumption of meat at joint family meals than their parents' generation.	No significant difference in advocating frequency between generations (t_{Welch}(980.6) = -.44, *p* = .663, *d* = 0.03).
H3b	Adolescents advocate more for lessening consumption of other animal-based products at joint family meals than their parents' generation.	Significant effect when controlling for amount of other animal products eaten, which indicates suppressor effect (β = -.15, *p* = .02).
H3c	Adolescents advocate more for increasing consumption of plant-based substitutes at joint family meals than their parents' generation.	Significant difference in the expected direction (*t*(997) = 4.26, *p* < .001, *d* = 0.27).
H4a	The less adolescents consume animal products themselves, the more they advocate for sustainable family meal decisions.	Significant predictive effect in the expected direction for meat (β = -.35, *p* < .001) and other animal products (β = -.11, *p* = .015).
H4b	The less adolescents consume animal products themselves, the more they report general involvement in family meal planning.	No significant effect for meat (β = -.04, *p* = .42) or other animal products (β = -.01, *p* = .844).

EQ1a	How do the generations differ in their recognition of the importance of various food-choice motives?	Most important differences in ‘naturalness’ (more important for parents) and ‘habits’ (more important for adolescents).
EQ1b	How do the generations differ in their advocacy of different food groups?	Parent’s generation reported greater influence in general. Adolescents reported more influence on eating less other animal products and trying ‘new’ plant-based products.
EQ1c	How do the generations differ in their influence on several steps of meal planning?	Parent’s generation reported greater influence in general. Adolescents reported most frequently having an influence during grocery shopping and when planning a specific meal.
EQ2	Do differences in age, gender, and education relate to differences in sustainability food-choice motives and eating behavior in both generations?	Women were more likely to not eat meat and reported more frequent advocating for sustainable family meal decisions.
EQ3	Does endorsement of sustainability food-choice motives relate to the frequency of advocating for more sustainable foods and higher involvement in family meal planning?	The more important sustainability motives are for adolescents, the more frequent they advocate for sustainable family meal decisions ($\beta = .53$), $p < .001$) and report influencing the meal planning ($\beta = .27$, $p < .002$).

Manuscript 5 – Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption

Published Article:

Mata, J., **Knobl, V.**, & Takezawa, M. (2025). Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption. *Appetite*, Article 107916. https://doi.org/10.1016/j.appet.2025.107916

Appetite 208 (2025) 107916

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption[☆]

Jutta Mata [a,b,*], Vanessa Knobl [a], Masanori Takezawa [c,d,e]

[a] Health Psychology, School of Social Sciences, University of Mannheim, Germany
[b] Mannheim Center for Data Science, University of Mannheim, Germany
[c] Department of Behavioral Science, Hokkaido University, Sapporo, Japan
[d] Center for Experimental Research in Social Sciences, Hokkaido University, Sapporo, Japan
[e] Center for Human Nature, Artificial Intelligence, and Neuroscience, Hokkaido University, Sapporo, Japan

A R T I C L E I N F O

Keywords:
Cultural transmission
Social learning
Family meals
Vegetarian
Dyad

A B S T R A C T

Objective: Can children's preferences make family meals healthier and more sustainable? Extending cultural evolution theory, we explored the children's role in a possible bottom-up transmission of meat preferences to their parents in the context of family meals.
Methods: Fifty-seven parent–child dyads from Germany (age: $M_{children}$ = 15.9 years, $M_{parents}$ = 50.5 years; 67% daughters, 93% mothers; 14% of children and 0% of parents followed a vegetarian/vegan diet; 82% of children were still in school; 42% of parents had a bachelor's degree or higher) decided on a family meal through discussion, which was videotaped. Before and after discussing, dyad members separately stated their preferred meat proportion for the family meal.
Results: In contrast to our hypotheses, on average children neither preferred less meat nor had a stronger influence on meat proportions in family meals than their parents. Daughters—despite a considerably lower preference for meat—did not reduce meat at family meals more than sons. Rather than demographic characteristics (i.e., age, gender), it was specific behaviors of children or dyads that predicted stronger influence on and eventually lower proportion of meat at family meals. These specific behaviors were following a vegetarian/vegan diet, general conflicts about meat-related aspects of family meals, and—in tendency—mentioning sustainability arguments in discussions. **Conclusions**: Children can be part of the change toward healthier and more sustainable family foodways—which could improve the family's health—if they themselves eat accordingly and actively advocate for it.

1. Introduction

Families are an essential context and predictor of protective health behaviors in general (e.g., Fosco et al., 2023) and a central environment for eating behaviors in particular (e.g., Dallacker et al., 2018, 2019, 2023; Knobl et al., 2022). The literature on health behaviors in family contexts usually assumes that parents influence their children. Children as active agents have often been overlooked in models and theories conceptualizing families as health-promoting settings (Michaelson et al., 2021 for a review, but see e.g., Moore et al., 2017, for a framework which acknowledges children as active participants). This neglect of focus on children seems to reflect a more general theoretical gap in the literature on how children—or more broadly, the filial generation—shape society. Cultural evolution theory—a theory on how preferences or behaviors change over time within groups or societies—distinguishes between vertical (parents to children), horizontal (peers to peers), and oblique (nonparental members of the parental generation to the filial generation; Cavalli-Sforza et al., 1982) transmission of information rarely considers that a transmission of information, preferences, or behavior from children to their parents might

☆ We have no conflicts of interest to disclose. This study was supported by a grant from the German Research Foundation (DFG) to Jutta Mata, project no. 519145270, and a grant from the Japanese Society for the Promotion of Science (JSPS) to Masanori Takezawa, project no. 220233601. We thank Melina Biegler, Elena Buck, Nina Haberland, Eva Hirt, Lea Kahlert, Anna Lichtenthaeler, Lara Ries, and Julia Weinberg for help with data collection and coding; and Dominik Deffner, Ira Herwig, Yuta Kido, Chinatsu Sano, and Kohei Tamura for valuable suggestions. We are grateful to Anita Todd for editing this manuscript.
* Corresponding author. Health Psychology, School of Social Sciences, University of Mannheim, Germany.
E-mail address: jutta.mata@uni-mannheim.de (J. Mata).

https://doi.org/10.1016/j.appet.2025.107916
Received 10 September 2024; Received in revised form 18 February 2025; Accepted 19 February 2025
Available online 21 February 2025
0195-6663/© 2025 Published by Elsevier Ltd.

occur.

Yet, the lifetimes of different generations often overlap by several decades, and psychological theories predict—and empirical research shows—lifelong learning until late in adulthood (e.g., Lindenberger & Lövdén, 2019). Therefore, cultural transmission from the filial to the parental generation seems plausible. A recent example is the "Fridays for Future" movement, started by the younger generation in 2018 to combat climate change, prompting parents to form "Parents for Future" in 2019 to show support (https://parentsforfuture.de/en/). Similarly, children influence family dynamics, as families—typically consisting of two generations—serve as daily contexts for cultural transmission through social learning and intergroup processes. One central area of cultural transmission in the family is eating (e.g., Fischler, 2011; Germov & Williams, 2008). Although eating is an important topic in health psychology, its social context and the transmission of culture (i.e., preferences, behaviors) in eating have received comparably little attention (but see Chen & Antonelli, 2020 for a conceptual framework; Higgs & Ruddock, 2020, pp. 277–291, for the importance of social norms; Rozin, 1996, for the importance of the socio-cultural context for eating).

Research on family meals generally suggests that parents have an important role as nutritional gate keeper and in providing their children's nutrition environment. For instance, parental modeling has been identified as a key predictor of children's healthy nutrition during family meals (Dallacker et al., 2019). Also, parents claim to be more strongly involved in family meal planning, grocery shopping, and meal preparation than their children (Knobl & Mata, 2024). Yet, adolescence is a period that is also marked by increasing autonomy in eating decisions (Ziegler et al., 2021). Adolescents actively contribute to family meals by introducing new products, often influenced by external sources such as school or peers (Williams et al., 2019), and by encouraging the family to incorporate meat substitutes into meals (Pater et al., 2022).

The goal of the current study was to explore when children influence family meals, using the example of meat consumption. Germany seems a particularly interesting context for such a study, as the filial and parental generations tend to have notably distinct preferences: In a representative survey in Germany (Heinrich-Böll-Stiftung, 2021), more than 20% of adolescents between 14 and 19 years reported not eating meat; this is about 3 times as high as in older age groups (Bundesministerium für Ernährung und Landwirtschaft, 2023). This age difference is relevant to family meals, as children—based on their different preferences— may influence their parents, promoting healthier, more sustainable diets through bottom-up transmission. Opportunities are numerous: Of children between 12 and 17 years of age in Germany, 80% have dinner with their family daily or almost daily (Frank, Brettschneider, Lage Babosa, & Mensink, 2019). Probably not all children influence their parents' preferences for meat at family meals equally (if at all). Based on previous research, we expected to find the following moderators:

Gender. Population-based studies show that girls and young women are more likely to prioritize environmental protection and refrain from eating meat compared to boys and young men (Jürkenbeck et al., 2021; Modlinska et al., 2020). While research on family meals is scarce, studies on shared meals suggest women and men adjust their diets when living together (women eat more meat; men more vegetables; Hartmann et al., 2014). Explorative analyses indicate women may anticipate more tension when adopting a plant-based diet (Gregson & Piazza, 2023), and interviews show women face more hostility from male family members than men do for vegetarianism (Merriman, 2010). However, among teenagers, young men report less support for vegetarian diets and are perceived as less masculine compared to teenage women (Modlinska et al., 2020), suggesting plant-based diets may be more acceptable for daughters in family settings.

Dietary style. Refraining from eating meat is likely to more strongly predict smaller proportions of meat at the family table because finding a meal that all family members can eat together often entails agreeing on the smallest common denominator, which is likely food the family member with the most dietary restrictions will eat (cf., Veen et al., 2023).

Concerns about the environment/sustainability. Some studies suggest that adolescents and young adults are more concerned about certain environmental issues and sustainability than their parents (Belz et al., 2022; Johnson & Schwadel, 2018) and often cite political reasons for abstaining from animal products, increasing their willingness to argue for less meat at family meals (Jürkenbeck et al., 2021; Knobl & Mata, 2024; Slotnick et al., 2023). Other research finds the opposite, that is, parents demonstrate even greater environmental concern and motivation for pro-environmental behaviors than their children (Casaló & Escario, 2016; Grønhøj & Thøgersen, 2017). Notably, parent-child motivation levels are interrelated (Grønhøj & Thøgersen, 2017). Similarities in sustainable consumption between parents and children tend to increase with close relationships (Gong et al., 2022) and effective communication but decrease when children exhibit stronger peer conformity (Essiz & Mandrik, 2022). These findings suggest that the presence of sustainability-related attitudes and motivations within the parent-child dyad may contribute to more sustainable dietary choices.

Conflicts about food/meals. Different attitudes toward environmental protection and meat consumption can lead to conflicts at family meals when either parents or children advocate for reducing meat; such challenging and reshaping of social norms for shared meals has been especially found in close relationships (Salmivaara et al., 2022). Such conflicts may precede shifts toward meat reduction in family foodways (O'Neill et al., 2019). While theoretical models often overlook children's active role (Michaelson et al., 2021), interviews show that reduced meat consumption within a family often stems from a desire for family cohesion and respecting children's preferences, driving transitions toward healthier, more sustainable foodways (Hesselberg et al., 2024). Family systems theory (Baptist & Hamon, 2022) and social transition frameworks (Judge et al., 2024) suggest that such conflicts can signal progress toward new norms, like meat-reduced diets.

1.1. Research questions (RQs) and hypotheses

RQ1: Who Influences Meat Proportions at Family Meals Most?

Considering adolescents' increasing eating-related independence from their parents and their greater inclination towards meat-free diets, we propose *Hypothesis 1 (H1):* Children (a) will prefer lower proportions of meat at family meals and (b) will have a stronger influence than their parents on the joint meal decision with respect to meat.

Given girls' higher frequency and stronger preference for meat-free diets as well as higher perceived support for vegetarian diets, we propose *H2* on gender: (a) Dyads with daughters will agree on smaller proportions of meat than dyads with sons, and (b) daughters will more strongly influence family meals toward a smaller proportion of meat than sons.

RQ2: What Behaviors Influence the Joint Decision?

When children refrain from eating meat, family meals often settle on the lowest common denominator. Therefore, we suggest *H3* on diet style: (a) Dyads with children with a stricter diet style regarding meat (i.e., vegetarian or vegan) will agree on a smaller proportion of meat, and (b) children with a stricter diet style will influence the proportion of meat in the family meal more strongly than those with a less strict diet style.

Those with greater sustainability concerns are more likely to advocate for less meat at family meals, so we propose *H4*: Dyads who mention sustainability-related motives will agree on a smaller proportion of meat in their family meal than dyads who do not discuss sustainability.

Given differing meat preferences between children and parents and potential friction from new behaviors, we hypothesize that conflict may signal a shift toward meat-reduced diets *(H5)*: Dyads who report conflicts about meat-related nutrition will agree on a smaller proportion of meat in their family meal.

RQ3 (Exploratory): How Do Predecision Preferences for Meat and Making a Joint Decision Influence Postdecision Preferences for Meat?

Previous research has not explored how individual preferences before a joint decision and the joint household decision itself can shape (future) individual preferences. Given the limited research, we explore this aspect rather than proposing hypotheses.

2. Materials and methods

2.1. Participants

Participants were 57 parent–child dyads (Table 1 for details). About two-thirds of children identified as girls. Most parents were female, with only four fathers participating. Parents had more years of education than the average adult in Germany (i.e., 22.1% of 40- to 49-year-olds in Germany have a bachelor's degree or higher, 18.1% among 50- to 59-year-olds; Destatis, 2021). Exclusion criteria for participation were: child younger than 12 years, child does not live with their parents, the family reports "never" having family meals, parent or child has conditions or severely restrictive food preferences that would exclude three or more of the six food categories examined (e.g., celiac disease; intolerance for fructose or lactose, several allergies; very restrictive diet styles), not giving informed consent to participate in the study, or more than 50% missing data. Children needed to be 12 or older to complete questionnaires independently.

2.2. Procedure

The study was conducted via a video call. Parents first answered a screening questionnaire to determine eligibility (see exclusion criteria above). Parent–child dyads who fulfilled all inclusion criteria were invited to a video call in which they participated via separate mobile devices. They were advised to spatially separate such that all verbal and nonverbal communication occurred via the video call. First, parent and child separately stated their individual meal preferences in an online questionnaire; both times they were explicitly instructed to imagine that they alone were to decide what will be eaten at the next family meal. Next, they were invited to discuss what they wanted to eat for their next family meal and had a maximum of 10 min to reach a joint decision. After the joint decision, they separately rated their satisfaction with the joint decision and stated their individual preferences for the next family meal (see Fig. 1). The video call was taped and continuously monitored by an experimenter who was also on the call (with camera off and muted during joint discussion). Dyads received a €30 voucher as compensation for study participation. This study was approved by the local ethics board (ID: EK 39/2022) (see Fig. 2).

Table 1
Sample characteristics.

Variable	Child ($n = 57$)	Parent ($n = 57$)
Age (*M*, *SD*, range, in years)	15.93 (2.91) 12–25 years	50.46 (5.22) 40–62 years
Gender (female)	67%	93%
Diet style		
Omnivore	86%	100%
Vegetarian	12%	
Vegan	2%	
Education		
None	0%	2%
Secondary	2%	26%
Higher level/university entrance diploma	12%	25%
University/College	4%	42%
Other	0%	5%
Currently in school[a]	82%	0%
Family meal frequency/week		
(Nearly) every day	79%	79%
3-5 times/week	14%	14%
1-2 times/week	4%	7%
Less than 1 or 2 times/week	4%	0%
Number of six food categories restricted[b]		
0 food categories	74%	93%
1 food category	23%	7%
2 food categories	4%	0%

Note. Percentages that do not add up to 100% within a category are due to rounding. There was no upper limit to the age of the children, as long as they still lived in the same household as their parents. Race was not assessed as this is a question that is usually not asked in Germany, for historical reasons. It is reasonable to assume that most participants would identify as Caucasian.
[a] Only children were asked this question.
[b] Parents and children indicated for which of the following six food categories (carbohydrates, plant-based proteins, meat, milk products, fruits and vegetables, other) they have restrictions/do not eat because of allergies or preferences.

2.3. Measures

2.3.1. Demographics
Parents and children both reported their age, gender, and level of education (Table 1).

2.3.2. Conflicts about food or joint meals
On a 5-point Likert scale from "*never*" to "*more than 4 times* per *week*," parents and children separately indicated how often they have conflicts concerning food or joint meals. They were also asked to describe the topic of these conflicts (open-answer format). These open answers were coded by two independent raters as to whether the conflict described was about meat or a vegetarian diet (see coding manual C1 in the Supplemental Materials). After the joint decision, parents and children were also asked in an open-question format whether they had had any conflicts during the discussion. These answers were also rated by two independent raters as "general conflict occurred", "meat-related conflict occurred", or "no conflict occurred" (see coding manual C1 in the Supplemental Materials). Yet, given that only one parent and two children reported a meat-related conflict during the discussion, we did not include this measure in the analysis.

2.3.3. Proportions of food groups preferred in meals
Participants individually described the family meal they preferred before and after the joint discussion as well as the joint meal. First, they gave their dish a name (e.g., "lasagna") and then further specified it according to the desired proportion of six food categories (in 5% steps adding up to 100%): "Carbohydrates (e.g., pasta, potatoes, etc.)", "plant-based proteins (e.g., lentils, peas, soy, etc.)", "vegetables and fruits (e.g., salad, fried or steamed vegetables, fruit salad, fresh fruit, etc.)", "dairy products (e.g., cheese, yogurt, butter, etc.)", "meat and fish (e.g., salmon, chicken, schnitzel, minced meat, sausages, etc.)", and "other." This way, it was possible to distinguish between, for example, a vegan, a vegetarian, and a meat-based lasagna. The first five categories were based on the planetary health diet from the EAT–*Lancet* Commission on Healthy Diets From Sustainable Food Systems (Willett et al., 2019). Around 20% of parents and 30% of children also included "other" food groups in their preferred meals—these food groups were extremely heterogeneous (e.g., eggs, sweets, oil) and account for only a small proportion of the total of food categories in the meal (3%–4% for parents and 5%–8% for children). As the survey software does not automatically add all categories up to 100%, it was possible to enter more than 100% in total. Therefore, all percentages were normed to 100% before running the analyses. Next, to further differentiate participants' food preferences and as a consistency check, participants were asked which of the following animal products would be part of their family meal: meat, fish, dairy, eggs, or honey.

2.3.4. Satisfaction with the decision
At the end of the joint decision task, parent and child separately rated on a 5-point-Likert Scale (from "do not agree" to "agree"), whether they were satisfied with their joint decision.

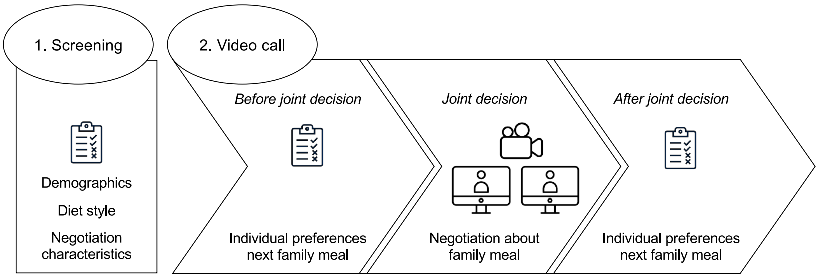


Fig. 1. Study procedure.
Note. Clipboard icon made by Kiranshastry; camera icon made by Slidicon; screen icon made by BizzBox; all from www.flaticon.com.

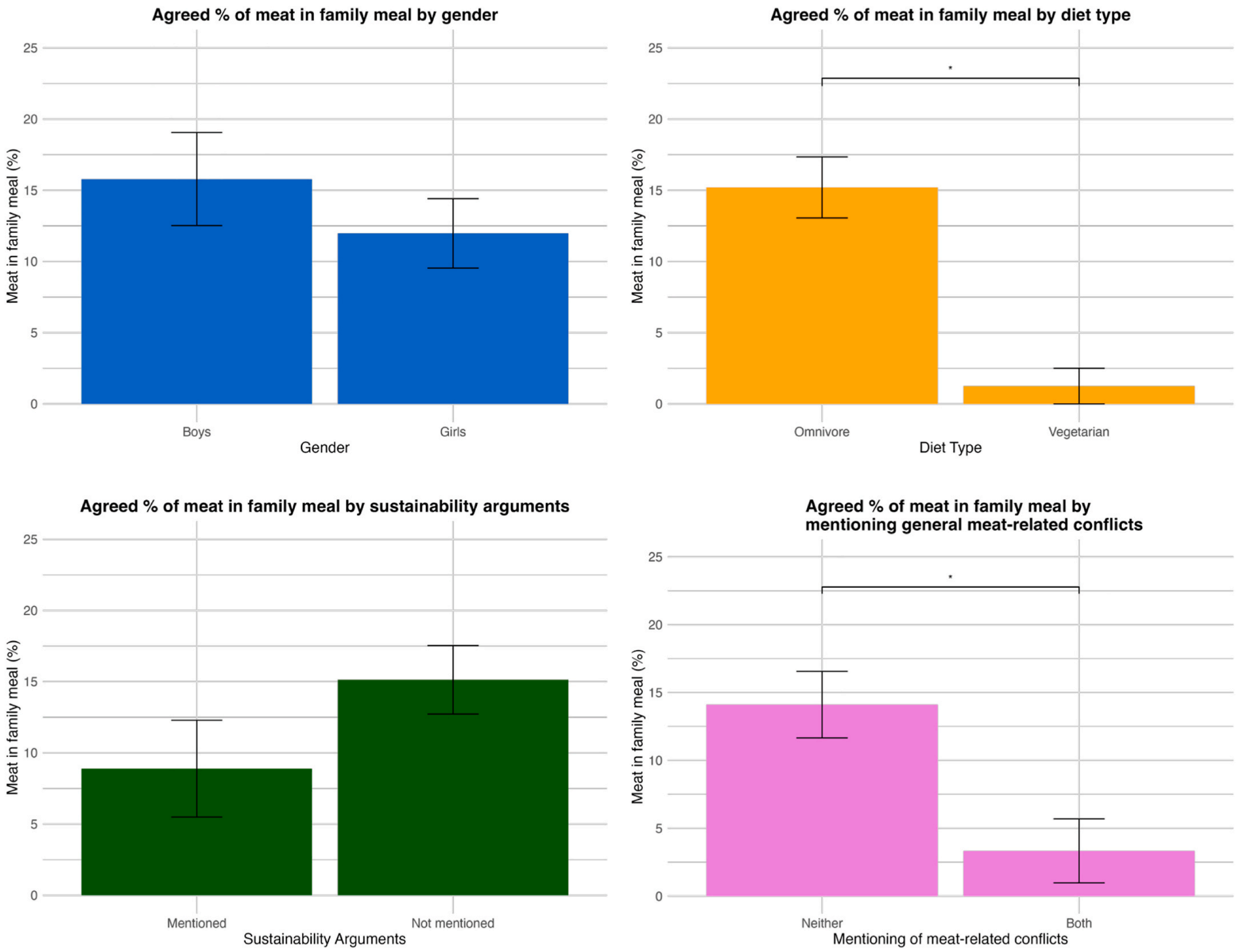


Fig. 2. *Results for Percentage of Meat in Joint Meal by Different Dyad Characteristics and Behaviors.*
Note. Meat in family meal (%) on the y-axis refers to the proportion of meat agreed on during the joint discussion. For the graph on diet type: diet type refers to the diet type of the child; for the graph on meat-related conflicts: neither = neither parent or child mentioned a meat-related conflict, both = parent and child mentioned a meat-related conflict.

2.3.5. *Diet style*

Participants described their individual diet style using the proportions of the same six food categories used to describe their preferred meals (in 5% steps adding up to 100%; see above). Again, participants also stated which of the five animal products (meat, fish, dairy, eggs, or honey) are part of their diet. Participants were classified as omnivores if they indicated eating meat, independent of whether they did not like fish, dairy products, eggs, or honey. Participants who stated they did not eat meat or fish were classified as “vegetarian; ” participants who did not eat meat, fish, dairy, eggs, and honey were classified as “vegan.”

2.3.6. *Sustainability-related arguments in joint meal discussion*

Sustainability-related motives were operationalized as arguments about reducing meat in the discussed family meal. To do so, the discussions were transcribed, and each statement was evaluated by two independent raters regarding the occurrence of such arguments (yes/no) and the direction (more meat/less meat). Examples of arguments about reducing meat include “Can we make this dish with [plant-based] chicken substitute [instead of chicken suggested by the other person]?" and “Do we want to cook something vegan? You liked this last time, too.” The interrater reliability is in the acceptable range at 0.61 for occurrence and direction. All disagreements were discussed together with a third person after coding until an agreement was reached (see coding manual C2 in the Supplemental Materials).

2.4. Statistical analyses

Differences between groups before the discussion (e.g., in preferences for the proportion of meat for a family meal) were calculated using *t* tests. RQ1 on who influences family meal decisions regarding meat was examined using the absolute difference between individual and joint preference for meat proportion. For RQ2, person characteristics and behaviors that influence food decisions were examined using *t* tests. To exploratively examine how postdecision preference is influenced (RQ3), we used regression models. All calculations were run with R version 4.3.2 and RStudio version 2023.12.0.369, using the packages *tidyverse* (v2.0.0; Wickham et al., 2019), *readxl* (v1.4.3; Wickham & Bryan, 2023), *rstatix* (v0.7.2; Kassambara, 2023), *psych* (v2.3.9; Revelle, 2023), *DT* (v0.32; Xie et al., 2024), and *gtsummary* (Sjoberg et al., 2021). All data relevant to the current analyses and all analysis scripts are available in open-science repositories, except for the videos, which are not available because of data protection issues. The transcripts of the videos [in German] are available at OSF (https://osf.io/ntegm/?view_only=5fc4b733fdab4e66b1f038c2986f3eb2).

3. Results

RQ1: Who Influences Meat Proportions at Family Meals Most?

3.1. Age group (children vs. parents)

Parents and children did not differ with respect to the proportion of meat they preferred in the family meal before the joint discussion: Children wanted on average 15.6% (SD = 15.7%) meat in their family meal, parents 14.1% (SD = 12.7%), $t(56) = 0.738$, p = .768. Thus, H1a—children prefer lower proportions of meat at family meals—is not supported. To test H1b, children will have a stronger influence than their parents on the joint meal decision with respect to meat, we calculated their mean difference: We found that the difference between parents' predecision preferences for the proportion of meat and the joint decision was equal to their children's difference between predecision preferences and joint decision, $t(56) = -0.262$, p = .397 (mean difference = −0.005). Therefore, H1b is not supported.

3.2. Gender

We compared gender differences in children but not their parents because only four of the 57 parents identified as fathers and therefore, were too small a group to analyze. Before the joint discussion, supporting H2a, girls preferred less meat in the family meal than boys (M_{girls} = 12.0%, SD = 12.5%; M_{boys} = 22.7%, SD = 19.3%), $t(25.7)$ = 2.208, p = .036, but mothers of daughters and mothers of sons showed comparable preferences for the proportion of meat ($M_{mothers\_of\_daughters}$ = 11.9%, SD = 9.7%; $M_{mothers\_of\_sons}$ = 14.3%, SD = 15.4%), $t(26.3)$ = 0.621, p = .540). Although descriptively dyads with daughters agreed on a smaller proportion of meat in their joint meal than those with sons (M = 12.0%, SD = 15.1% vs. M = 15.8%, SD = 14.3%), this difference is not statistically significant, $t(37.9) = 0.935$, p = .178. We further tested H2b, that daughters will have a stronger influence on including a smaller proportion of meat in the family meal than sons, by first calculating the difference between mothers' predecision preference and the joint decision regarding the proportion of meat. A larger distance value means that the decision moves farther away from the mother's individual preference (negative values = more meat than mother's preference, positive values = less meat than mother's preference). We then compared this distance between daughters and sons using a *t*-test. Daughters did not significantly influence the family meal toward including a smaller proportion of meat more than sons, but note that, descriptively, daughters reduced meat and sons increased it ($M_{distance\_daughters}$ = 2.1%, SD = 15.0%; M = −1.5%, SD = 14.2%), $t(38.0)$ = −0.876, p = .193.

RQ2: What Behaviors Influence the Joint Decision?

3.3. Dietary style

To test H3a, that dyads with children with a stricter diet style will agree on a smaller proportion of meat in the joint meal, we compared meat proportions after the joint discussion between dyads in which children's diet style was classified as “vegan” or “vegetarian” (because only one child was classified as vegan, we collapsed vegan and vegetarian into one category, denoted “veg”) and dyads with children whose diet style was classified as “omnivore.” H3a was supported (M_{veg} = 1.3%, SD = 4.0%; $M_{omnivore}$ = 15.2%, SD = 15.0%), $t(48.1) = 5.625$, $p <$ .001. H3b, that children with a stricter diet style will influence the proportion of meat in the family meal more strongly than children with a less strict diet, was analyzed parallel to H2. That is, we tested whether the absolute difference between the parent's predecision preference for the proportion of meat and the proportion of meat in the family meal was larger for dyads with children with a stricter diet style. H3b was supported: Children had more influence on the joint meal decision than their parents if their eating was classified as “vegan/vegetarian” compared to “omnivore” ($M_{omnivore}$ = −0.006, SD = 0.15; M_{veg} = 0.100, SD = 0.10), $t(12.3) = -2.523$, p = .013.

3.4. Sustainability motives

Sustainability motives were operationalized as meat-related arguments. Of all 57 dyads, 18 discussed arguments for reducing meat, with 36 sustainability-related arguments in total (range: 1–4 per dyad). Children and parents each mentioned 18 arguments. Because of the small number of dyads who had meat-related arguments, we split the dyads into two groups: those who did not mention meat reduction at all versus those who did. H4 stated that dyads who discuss sustainability motives will agree on a smaller proportion of meat than dyads who do not. We found that the proportion of meat in the joint meal was descriptively smaller in dyads who mentioned reducing meat in their discussion (M = 8.9%, SD = 14.4) than in those who did not, although this result was only statistically significant on a $p < .1$-level (M = 15.1%, SD = 14.9%), $t(34.4) = -1.499$, p = .072.

3.5. Conflicts about food and meals

Of all dyads, 30% of parents and 29% of children reported conflicts related to eating meat/vegetarian meals. Interestingly, the agreement rate between parents and children on whether they had meat-related conflicts at home was surprisingly low: Meat-related conflict was reported in 18 of the 57 dyads: In nine of those dyads, both parent and child reported meat-related conflict. Given these small participant numbers, these findings should be interpreted with caution: Of the nine dyads in which both dyad members reported meat-related conflicts at home, only two decided to include meat in their joint meal (M = 3.3%, SD = 7.1%); of the nine dyads in which either parent or child reported meat-related conflicts, seven agreed on meat in the joint meal (M = 19.4%, SD = 14.5%) and decided on comparably high proportions of meat, whereas in those 39 dyads in which no one mentioned meat-related conflicts, 22 included meat in their joint meal (M = 14.1%, *SD* = 15.3%) and in lower proportions. To test H5—dyads reporting conflicts will agree on smaller proportions of meat—we compared dyads in which both members reported conflicts regarding meat or vegetarian nutrition with dyads in which neither member reported such conflicts and found that dyads reporting conflict agreed on a smaller proportion of meat, $t(27.79) = 3.169$, $p = .004$, supporting our hypothesis.

RQ3: How Do Predecision Preferences for Meat and the Joint Decision Influence Postdecision Preferences for Meat?

To explore the relations between predecision preferences and joint decisions regarding meat and preferences after the decision (i.e., future preferenes), we ran regressions with parents' postdecision meat preference as outcome, and parents' and children's predecision preference and the joint decision as predictors (Model 1). Only parents' predecision preference and the decision predicted parents' postdecision preferences. To test whether children's predecision preferences indirectly influenced parents' postdecision preferences via the joint decision, we omitted the joint decision as a predictor (Model 2). Children's predecision preferences still did not predict parents' postdecision preferences, suggesting no observable influence on parents' postdecision preference. A similar pattern was found for parents' predecision preferences: they also did not predict children's postdecision preferences (Table 2). Despite maintaining individual preferences, both parents and children were highly satisfied with the joint decision (children: M = 4.84, SD = 0.59; parents: M = 4.75, SD = 0.63).

4. Discussion

Using a psychological research approach, we tested whether and when children influence their parents regarding the proportion of meat planned for a joint family meal. In this study, about 14% of the children but none of the parents never ate meat. Parents and children had comparable individual preferences and equally influenced the proportion of meat in their joint meal. We examined gender, dietary style, arguments regarding meat consumption in the decision process, and general meat-related conflicts in family meals: Although boys preferred a higher proportion of meat than girls, girls did not have a stronger influence on reducing the proportion of meat in the family meal. Although mother–son dyads preferred an about 25% larger proportion of meat in joint meals than mother–daughter dyads, this difference was not statistically significant. Rather than individual characteristics such as age and gender, it was specific behaviors that reduced the amount of meat in family meal planning: Children with a stricter diet style regarding meat (i.e., vegetarian or vegan) more strongly influenced joint meal decisions toward smaller proportions of meat than omnivorous children. Dyads who mentioned sustainability arguments (i.e., related to meat reduction) in their discussions showed a tendency to prefer smaller proportions of meat in their joint meal, but this was not statistically significant. About 30% of participants reported conflicts over meat or vegetarian diets in family meals, and these dyads preferred smaller meat proportions. Children's and parents' predecision preferences did not influence each other after the joint decision.

Contrary to H1a, children did not, on average, prefer less meat at family meals than their parents. In this study, 14% of children identified as vegetarian, compared to none of the parents. However, some young adults consumed more meat than their parents, balancing the group averages. This aligns with surveys (Heinrich-Böll-Stiftung, 2021; Knobl & Mata, 2024) showing higher vegetarianism rates among adolescents and young adults, not necessarily different average meat consumption from the parental generation. While children and parents differed at the extremes of meat consumption (some children avoiding meat entirely, others consuming more), children did not influence meat proportions at family meals more strongly than parents. This suggests that "generation" or "age" might be too broad to explain meat consumption proportions, supporting research on parents' central role in shaping family meals (Knobl & Mata, 2024). These findings contrast with studies showing that children's environmental knowledge (Kong & Jia, 2023), concerns (Singh et al., 2020), and literacy (Liu et al., 2022) change parents' behavior. A key difference may be that prior studies focused on general attitudes and behaviors, whereas this study involved a specific decision. This is further reflected in the conflict findings: while most families reported general meal-related conflicts, often over meat, almost no conflicts arose during the specific decision task. This suggests that such conflicts occur across various situations over time but may not be visible in every instance. Additionally, observer presence during the study may have encouraged more desirable outcomes, such as avoiding conflict (McCarney et al., 2007).

Consistent with surveys showing girls and women prefer less meat than boys and men (e.g., Modlinska et al., 2020), we found daughters preferred about half the meat for family meals compared to sons. However, this difference was not reflected in joint family decisions, where meat amounts were similar regardless of the child's gender, nor did daughters have a stronger influence on meat proportions, contrary to H2. Further research is needed on gender differences in incorporating vegetarian preferences into family meals. A review describing that vegetarianism should be more acceptable in teenage women (Modlinksa et al., 2020) would have suggested a greater influence of daughters' vegetarian preferences on reducing meat in family meals. Other studies suggest young women often face greater hostility, particularly from male relatives, for their dietary choices. As our study primarily involved mothers, this dynamic could not be fully examined.

Although demographic factors like age and gender were unrelated to meat-reduced family meals, specific behaviors were: Supporting H3,

Table 2
Regression analyses on whether predecision preferences for meat and the joint decision influence postdecision preferences for meat, separately for parents and children (exploratory analyses).

Predictor	Parents						Children					
	Model 1			Model 2			Model 1			Model 2		
	Estimate	95% CI	*p*	Estimate	95% CI	*p*	Estimate	95% CI	*p*	Estimate	95% CI	*p*
(Intercept)	**.05**	[0.00, 0.10]	**.039**	**.06**	[0.01, 0.11]	**.014**	−0.00	[-0.05, 0.04]	0.899	0.02	[-0.04, 0.07]	0.576
Pre-pref meat P	**.38**	[0.11, 0.66]	**.007**	**.50**	[0.21, 0.78]	**.001**	−0.17	[-0.44, 0.11]	0.229	−0.01	[-0.31, 0.29]	0.963
Pre-pref meat C	−0.12	[-0.35, 0.10]	0.282	−0.01	[-0.24, 0.22]	0.919	**.62**	[0.40, 0.85]	**<.001**	**.78**	[0.54, 1.02]	**<.001**
Decision meat proportion	**.35**	[0.11, 0.58]	**.005**	—	—	—	**.49**	[0.26, 0.73]	**<.001**		–	
Observations	57						57					
R^2/adjusted R^2	0.330/0.292						0.619/0.597					

Note. Model 1 includes predecision preferences for meat of both parents and children, as well as the proportion of meat agreed upon in the joint decision; Model 2 only includes predecision preferences of parents and children. Statistically significant predictors are in bold. 95% CI = 95% Confidence interval; Pre-pref = predecision preference; P = parent; C = child.

dyads with children following stricter diets (vegan or vegetarian) agreed on smaller meat portions, and these children had a stronger influence on joint decisions. This notable effect—despite the small number of children with stricter diets—highlights their potential to shift family foodways toward healthier, more sustainable norms. Family systems theory suggests that changes in one part of the system influence the whole (Baptist & Hamon, 2022). This dynamic mirrors broader social change, where small shifts, driven by front-runners like moral innovators reducing meat consumption, can lead to tipping points that transform systems (Judge et al., 2024). However, vegetarians often self-silence to avoid stigma, slowing progress. Support from allies—like experimenters in studies or parents in families—can empower advocacy for meat-free diets (Bolderdijk & Cornelissen, 2022, for a lab experiment). On a larger scale, moral innovators can network with grassroots movements, fostering connections that evolve into societal shifts capable of reshaping norms and behaviors over time (Nardini et al., 2021).

Further, we found that the more often sustainability arguments were mentioned in the joint discussion, the lower the proportion of meat agreed on in the joint meal (in line with H4), although this result did not reach statistical significance. Interestingly, sustainability was less of a discussion topic than expected given the importance adolescents and their parents assign to sustainability in surveys: Only a third of the dyads mentioned it at all. This finding might again be explained by the current joint meal decision being one point in time in a history of family meals. When describing the nature of their usual conflicts about food at family meals, three in 10 participants stated they were related to eating meat.

In line with H5, we found that dyads in which both members reported more general meat-related conflicts agreed on smaller proportions of meat than dyads who did not report any conflicts. This finding needs to be interpreted with caution, because it relies on just a few cases: In only nine of the 57 dyads did both dyad members report having meat-related conflicts. It remains unclear why in several dyads only one dyad member reported a meat-related conflict. Such asymmetry in conflict perception may increase dietary tension and openness to change, as observed by Gregson and Piazza (2023) in cohabiting couples.

Our single-point measurement likely overlooks the cyclical nature of conflict. When one family member changes their diet, it can shift household food routines, intensifying or easing conflict (O'Neill et al., 2019). Conflict may rise if others resist but decrease if adjustments promote collaboration, as seen in a recent interview study on meat-reduced family foodways (Hesselberg et al., 2024). Over time, initial tensions may give way to acceptance as families adapt (Judge et al., 2024). Relationship quality also matters, as less harmonious families may experience greater challenges during joint meals (Low et al., 2019), particularly when reducing meat. These complex dynamics over time may explain variations in conflict reports across dyads.

Our exploratory analyses suggest that one dyad member's predecision preferences do not influence the other member's postdecision preferences, aligning with our other findings. Predecision preferences did not significantly alter the joint decision or the other member's preferences afterward. Since we studied naturally existing dyads, it is likely this was not their first joint food decision. Preference changes in family meals likely happen gradually over time, rather than in one short laboratory situation.

4.1. Strengths, limitations, and generalizability

4.1.1. Strengths

This study examined a joint family meal decision using a dyadic, process-oriented mixed-methods design. This design has a high ecological validity because participants were natural dyads (parent and child) discussing everyday food decisions—yet the setting was standardized and controlled, owing to the video-call setting with an experimenter. We used mixed methods: That is, we used quantitative methods to predict joint decisions based on previously measured individual preferences, and qualitative methods to categorize arguments used in these discussions. The participants were an ideal target for studying potential bottom-up vertical cultural transmission, because numerous parent–child dyads have different preferences concerning meat consumption yet need to find solutions for their joint meals.

4.1.2. Limitations

The observed meal decision was a single snapshot of ongoing family meal negotiations in a controlled setting. While we could only examine one decision and its short-term effects (e.g., on postdecision preferences), it is notable that we did observe some consequences of ongoing family meal decisions. Yet, longitudinal studies capturing multiple family meal decisions in natural settings could reveal stronger effects, particularly regarding sustainability arguments and conflicts. Such designs would better capture the cyclical nature of these processes, where individual changes can trigger system-wide shifts through feedback loops, conflict, and exchange of arguments.

In this study, we classified children as vegetarian based on their diet descriptions rather than self-identified labels like "vegetarian." We chose this approach because pilot testing showed unreliable self-categorization, with some "vegetarians" reporting meat consumption and confusion around terms like „flexitarian.“ While this approach improves analytical reliability, it is important to note that children we labeled as "vegetarian" may not endorse this social identity, which could reduce the visibility of their choices and related social or family conflicts (Nezlek & Forestell, 2020).

Especially the consequences of meat-related discussions in dyads with different preferences would be interesting to observe over a longer time frame. This was an exploratory study examining an innovative question using a new design; therefore, effect sizes were difficult to determine beforehand. Although the sample contained different age groups and diet styles, it was less heterogeneous regarding education, with 42% of parents having a college education, which is about twice as high as in the general population in Germany (Destatis, 2021). It can be assumed that most participants would identify as Caucasian. Importantly, the focus on within-dyad dynamics of the meat-related food decisions might mitigate some of the limitations of the sample composition.

4.1.3. Generalizability

The main effects—such as meat-free diets, sustainability arguments in discussions, and meat-related conflicts—likely generalize to families with adolescents or young adults in Germany and similar Western countries. However, our sample consisted mostly of mothers, who were often better educated than the general population, which may influence generalizability since meat attitudes vary by gender, education, and region (Modlinska et al., 2020; Mata et al., 2023). Most German teenagers regularly share family meals (Frank et al., 2019), and such habits persist across socioeconomic levels (Dallacker et al., 2019), suggesting broad applicability of the findings. Generalizability may also change over time as meat preferences evolve; for example, pro-environmental behaviors in adolescents may diminish with shifting societal priorities such as Covid-19 (Krettenauer et al., 2024), or parents may increasingly adopt norms supporting reduced meat consumption.

4.1.4. Implications

The findings show the potential of children as drivers of social innovation toward healthier and more sustainable nutrition. This has several implications for theories and research, of which we want to highlight the following: The findings support the assumptions of a long-term bottom-up vertical transmission of preferences and behaviors from children to adults, extending current assumptions of cultural evolution theory and suggesting that children (adolescents) might be a promising target group for healthy nutrition interventions that benefit the entire family system. The current study also underlines the potential of children as active agents in a family system (see also Hesselberg et al., 2024), and more generally, the importance of (close) social others for behavior change, which is often ignored in current theoretical frameworks (Rhodes & Beauchamp, 2024).

That behaviors (i.e., diet style, sustainability discussions, and conflicts) rather than demographics are linked to smaller meat portions and stronger influence on family decisions is promising for intervention strategies. Families, a key social unit in Germany with 8.2 million households and 14.3 million children (Destatis, 2023), often share meals, with 80% eating family dinners (Frank et al., 2019). Integrating these findings into a social change framework (Judge et al., 2024) suggests strategies for early change: families can support children in discussing their meat-reduced diets and connecting with like-minded peers, reducing social costs and encouraging norm shifts. Practitioners can educate parents about adolescent preferences, and policymakers could promote meat-reduced diets by improving food label visibility and supporting early adopters. A key practical insight from this research is that mothers, often identifying as nutritional gatekeepers, were the primary parental participants, reflecting broader trends of greater maternal involvement in food provision (Rahill et al., 2020). Given fathers' generally higher preference for meat (e.g., Mata et al., 2023), targeting them in future initiatives is crucial. For instance, a low-threshold online intervention was found to increase fathers' motivation and self-efficacy to engage in cooking and trying new foods (Moura et al., 2023).

In Germany, daily beef consumption is three times and pork more than ten times the recommended levels of the planetary health diet (Bundesanstalt für Landwirtschaft und Ernährung, 2024). The average adult consumes meat 6–7 days a week (Mata et al., 2023). Shifting to meat-reduced diets could significantly benefit both human and environmental health, as diets high in meat, particularly processed meat, are more harmful than unsafe sex, alcohol, tobacco, and drugs combined (Global Panel on Agriculture and Food Systems for Nutrition, 2016). Such a shift could reduce greenhouse gas emissions by 54–87% and prevent 20% of premature deaths (Springmann et al., 2018). Dietary changes are one of the most effective ways to address the climate crisis (Willett et al., 2019), making it crucial to better understand how to drive this change.

4.2. Conclusion

This study explored the dynamics of healthier, more sustainable family meals using a daily decision task. Children's age and gender were not linked to meat consumption in family meals. Instead, behaviors like following a meat-free diet, discussing sustainability, or experiencing meat-related conflicts were associated with lower meat proportions at joint meals, partially supporting bottom-up transmission of preferences. Considering social contexts—and children or parent-child dyads specifically—can enhance our understanding of family foodways and might be one of the levers to promote healthier, more environmentally sustainable diets across generations.

CRediT authorship contribution statement

Jutta Mata: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Vanessa Knobl:** Formal analysis, Writing – review & editing, Methodology, Data curation, Conceptualization. **Masanori Takezawa:** Writing – review & editing, Formal analysis, Conceptualization.

Public significance statement

Can children's preferences make family meals healthier and more sustainable by reducing meat? Current research largely ignores children's active role in family health. In child-parent dyads discussing their next family meal, we find that specific behaviors—not individual traits (age, gender)—reduced meat: children eating a meat-free diet, dyads discussing sustainability and engaging in meat-related conflicts. This study underlines the social innovation potential of children for family foodways.

Ethical statement

We hereby all confirm that for the manuscript, "Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption", by Jutta Mata, Vanessa Knobl, and Masanori Takezawa, all procedures were performed in compliance with the relevant laws and institutional guidelines. This study has been approved by the appropriate institutional committee, that is the local ethics board at the University of Mannheim, ID: EK 39/2022, on July 8, 2022.

The privacy rights of human subjects have been observed and informed consent was obtained by all participants.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used chatGPT to receive suggestions for rephrasing and shortening parts of the text. After using this tool, the authors reviewed and edited the content carefully and take full responsibility for the content of the publication.

Declaration of competing interest

We hereby all confirm that for the manuscript, "Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption", by Jutta Mata, Vanessa Knobl, and Masanori Takezawa, we have nothing to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2025.107916.

Data availability

All data relevant to the current analyses and all analysis scripts are available OSF (https://osf.io/ntegm/?view_only = 5fc4b733fdab4e66b1f038c2986f3eb2).

References

Baptist, J., & Hamon, R. R. (2022). Family systems theory. In *Sourcebook of family theories and methodologies: A dynamic approach* (pp. 209–226). Cham: Springer International Publishing.

Belz, J., Follmer, R., Hölscher, J., Stiess, I., Sunderer, G., & Birzle-Harder, B. (2022). Umweltbewusstsein in Deutschland 2020: Ergebnisse einer repräsentativen Bevölkerungsumfrage. *Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz (BMUV)*. https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/ubs_2020_0.pdf.

Bolderdijk, J. W., & Cornelissen, G. (2022). "How do you know someone's vegan?" They won't always tell you. An empirical test of the do-gooder's dilemma. *Appetite, 168*, Article 105719. https://doi.org/10.1016/j.appet.2021.105719

Bundesanstalt für Landwirtschaft und Ernährung. (2024). *Versorgung mit Fleisch in Deutschland im Kalenderjahr 2023 [Meat supply in Germany in calendar year 2023]*. https://www.ble.de/DE/BZL/Daten-Berichte/Fleisch/fleisch_node.html;jsessionid=8D72E1DB28AA35CBE1D694A694402FA5.1_cid335.

Bundesministerium für Ernährung und Landwirtschaft. (2023). Deutschland, wie es isst. Der BMEL-Ernährungsreport 2023 [Germany, how it eats. The BMEL nutrition report 2023]. https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/ernaehrungsreport-2023.pdf?_blob=publicationFile&v=4.

Casaló, L. V., & Escario, J.-J. (2016). Intergenerational association of environmental concern: Evidence of parents' and children's concern. *Journal of Environmental Psychology, 48*, 65–74. https://doi.org/10.1016/j.jenvp.2016.09.001

Cavalli-Sforza, L. L., Feldman, M. W., Chen, K. H., & Dornbusch, S. M. (1982). Theory and observation in cultural transmission. *Science, 218*(4568), 19–27. https://doi.org/10.1126/science.7123211

Chen, P. J., & Antonelli, M. (2020). Conceptual models of food choice: Influential factors related to foods, individual differences, and society. *Foods, 9*(12), 1898. https://doi.org/10.3390/foods9121898

Dallacker, M., Hertwig, R., & Mata, J. (2018). The frequency of family meals and nutritional health in children: A meta-analysis. *Obesity Reviews, 19*, 638–653. https://doi.org/10.1111/obr.12659

Dallacker, M., Hertwig, R., & Mata, J. (2019). Quality matters: A meta-analysis on components of healthy family meals. *Health Psychology, 38*(12), 1137–1149. https://doi.org/10.1037/hea0000801

Dallacker, M., Knobl, V., Hertwig, R., & Mata, J. (2023). Effect of longer family meals on children's fruit and vegetable intake: A randomized clinical trial. *JAMA Network Open, 6*(4). https://doi.org/10.1001/jamanetworkopen.2023.6331. Article e236331.

Destatis. (2021). *Bildung* [education]. https://www.destatis.de/DE/Service/Statistik-Campus/Datenreport/Downloads/datenreport-2021-kap-3.html.

Destatis. (2023). *Haushalte und Familien* [Households and Families]. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Haushalte-Familien/Tabellen/2-5-familien.html.

Essiz, O., & Mandrik, C. (2022). Intergenerational influence on sustainable consumer attitudes and behaviors: Roles of family communication and peer influence in environmental consumer socialization. *Psychology and Marketing, 39*(1), 5–26. https://doi.org/10.1002/mar.21540

Fischler, C. (2011). Commensality, society, and culture. *Social Science Information, 50* (3–4), 528–549. https://doi.org/10.1177/0539018411413963

Fosco, G. M., Lee, H., Feinberg, M. E., Fang, S., & Sloan, C. J. (2023). COVID-19 family dynamics and health protective behavior adherence: A 16-wave longitudinal study. *Health Psychology, 42*(10), 756–765. https://doi.org/10.1037/hea0001313

Frank, M., Brettschneider, A.-K., Lage Barbosa, C., Haftenberger, M., Lehmann, F., Perlitz, H., et al. (2019). Prevalence and temporal trends of shared family meals in Germany. Results from EsKiMo II. *Ernährungs-Umschau, 66*(4), 60–67. https://doi.org/10.4455/eu.2019.013

Germov, J., & Williams, L. (2008). Exploring the social appetite: A sociology of food and nutrition. In J. Germov, & L. Williams (Eds.), *A sociology of food and nutrition: The social appetite* (3rd ed., pp. 3–23). Oxford University Press.

Global Panel on Agriculture and Food Systems for Nutrition. (2016). *Food systems and diets: Facing the challenges of the 21st century*. https://cgspace.cgiar.org/server/api/core/bitstreams/04282ea4-4028-4a8b-abc1-2f4d0de566fb/content.

Gong, Y., Li, J., Xie, J., et al. (2022). Will "green" parents have "green" children? The relationship between parents' and early adolescents' green consumption values. *Journal of Business Ethics, 179*, 369–385. https://doi.org/10.1007/s10551-021-04835-y

Gregson, R., & Piazza, J. (2023). Relational climate and openness to plant-forward diets among cohabitating couples. *Appetite, 187*, Article 106617.

Grønhøj, A., & Thøgersen, J. (2017). Why young people do things for the environment: The role of parenting for adolescents' motivation to engage in pro-environmental behaviour. *Journal of Environmental Psychology, 54*, 11–19. https://doi.org/10.1016/j.jenvp.2017.09.005

Hartmann, C., Dohle, S., & Siegrist, M. (2014). Time for change? Food choices in the transition to cohabitation and parenthood. *Public Health Nutrition, 17*(12), 2730–2739. https://doi.org/10.1017/S1368980013003297

Heinrich-Böll-Stiftung. (2021). *Fleischatlas 2021.* [Meat Atlas 2021]. https://www.boell.de/sites/default/files/2021-01/Fleischatlas2021_0.pdf?dimension1=ds_fleischatlas_2021.

Hesselberg, J., Pedersen, S., & Grønhøj, A. (2024). Meat reduction meets family reality: Negotiating sustainable diets in households with adolescents. *Appetite, 195*, Article 107213. https://doi.org/10.1016/j.appet.2024.107213

Higgs, S., & Ruddock, H. (2020). Social influences on eating. *Handbook of eating and drinking: Interdisciplinary perspectives*.

Jürkenbeck, K., Spiller, A., & Schulze, M. (2021). Climate change awareness of the young generation and its impact on their diet. *Cleaner and Responsible Consumption, 3*. https://doi.org/10.1016/j.clrc.2021.100041. Article 100041.

Johnson, E. W., & Schwadel, P. (2018). It is not a cohort thing: Interrogating the relationship between age, cohort, and support for the environment. *Environment and Behavior, 51*(7), 879–901. https://doi.org/10.1177/0013916518780483

Judge, M., Bouman, T., Steg, L., & Bolderdijk, J. W. (2024). Accelerating social tipping points in sustainable behaviors: Insights from a dynamic model of moralized social change. *One Earth, 7*(5), 759–770. https://doi.org/10.1016/j.oneear.2024.04.004

Kassambara, A. (2023). rstatix: Pipe-friendly framework for basic statistical tests. https://rpkgs.datanovia.com/rstatix/.

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2022). Happy and healthy: How family mealtime routines relate to child nutritional health. *Appetite, 171*. https://doi.org/10.1016/j.appet.2022.105939. Article 105939.

Knobl, V., & Mata, J. (2024). Intersecting perspectives: Advocating for sustainable family meals across generations. *Appetite, 201*, Article 107618. https://doi.org/10.1016/j.appet.2024.107618

Kong, X., & Jia, F. (2023). Intergenerational transmission of environmental knowledge and pro-environmental behavior: A dyadic relationship. *Journal of Environmental Psychology, 89*, Article 102058. https://doi.org/10.1016/j.jenvp.2023.102058

Krettenauer, T., Lefebvre, J. P., & Goddeeris, H. (2024). Pro-environmental behaviour, connectedness with nature, and the endorsement of pro-environmental norms in youth: Longitudinal relations. *Journal of Environmental Psychology, 94*, Article 102256. https://doi.org/10.1016/j.jenvp.2024.102256

Lindenberger, U., & Lövdén, M. (2019). Brain plasticity in human lifespan development: The exploration-selection-refinement Model. *Annual Review of Developmental Psychology, 1*, 197–222. https://doi.org/10.1146/annurev-devpsych-121318-085229

Liu, J., Chen, Q., & Dang, J. (2022). New intergenerational evidence on reverse socialization of environmental literacy. *Sustainability Science, 17*(6), 2543–2555. https://doi.org/10.1007/s11625-022-01194-z

Low, R. S. T., Overall, N. C., Cross, E. J., & Henderson, A. M. E. (2019). Emotion regulation, conflict resolution, and spillover on subsequent family functioning. *Emotion, 19*(7), 1162–1182. https://doi.org/10.1037/emo0000519

Mata, J., Kadel, P., Frank, R., & Schüz, B. (2023). Education- and income-related differences in processed meat consumption across Europe: The role of food-related attitudes. *Appetite, 182*. https://doi.org/10.1016/j.appet.2022.106417. Article 106417.

McCarney, R., Warner, J., Iliffe, S., van Haselen, R., Griffin, M., & Fisher, P. (2007). The Hawthorne effect: A randomised, controlled trial. *BMC Medical Research Methodology, 7*. https://doi.org/10.1186/1471-2288-7-30. Article 3.

Merriman, B. (2010). Gender differences in family and peer reaction to the adoption of a vegetarian diet. *Feminism & Psychology, 20*(3), 420–427. https://doi.org/10.1177/0959353510368283

Michaelson, V., Pilato, K. A., & Davison, C. M. (2021). Family as a health promotion setting: A scoping review of conceptual models of the health-promoting family. *PLoS One, 16*(4), Article e0249707. https://doi.org/10.1371/journal.pone.0249707

Modlinska, K., Adamczyk, D., Maison, D., & Pisula, W. (2020). Gender differences in attitudes to vegans/vegetarians and their food preferences, and their implications for promoting sustainable dietary patterns—a systematic review. *Sustainability, 12*(16). https://doi.org/10.3390/su12166292. Article 6292.

Moore, E. S., Wilkie, W. L., & Desrochers, D. M. (2017). All in the family? Parental roles in the epidemic of childhood obesity. *Journal of Consumer Research, 43*(5), 824–859. https://doi.org/10.1093/jcr/ucw059

Moura, A. F., Grønhøj, A., & Aschemann-Witzel, J. (2023). Spicing up food interactions: Development of a healthy food education activity targeting fathers and their young children. *Journal of Human Nutrition and Dietetics, 36*(5), 1795–1810. https://doi.org/10.1111/jhn.13179

Nardini, G., Rank-Christman, T., Bublitz, M. G., Cross, S. N., & Peracchio, L. A. (2021). Together we rise: How social movements succeed. *Journal of Consumer Psychology, 31* (1), 112–145. https://doi.org/10.1002/jcpy.1201

Nezlek, J. B., & Forestell, C. A. (2020). Vegetarianism as a social identity. *Current Opinion in Food Science, 33*, 45–51.

O'Neill, K. J., Clear, A. K., Friday, A., & Hazas, M. (2019). Fractures' in food practices: exploring transitions towards sustainable food. *Agriculture and Human Values, 36*, 225–239. https://doi.org/10.1007/s10460-019-09913-6

Pater, L., Kollen, C., Damen, F. W., Zandstra, E. H., Fogliano, V., & Steenbekkers, B. L. (2022). The perception of 8-to 10-year-old Dutch children towards plant-based meat analogues. *Appetite, 178*, Article 106264.

Rahill, S., Kennedy, A., & Kearney, J. (2020). A review of the influence of fathers on children's eating behaviours and dietary intake. *Appetite, 147*, Article 104540. https://doi.org/10.1016/j.appet.2019.104540

Revelle, W. (2023). psych: Procedures for psychological, psychometric, and personality research. https://personality-project.org/r/psych-manual.pdf.

Rhodes, R. E., & Beauchamp, M. R. (2024). Development of the social dimensions of health behaviour framework. *Health Psychology Review*. https://doi.org/10.1080/17437199.2024.2339329

Rozin, P. (1996). The socio-cultural context of eating and food choice. In *Food choice, acceptance and consumption* (pp. 83–104). Boston, MA: Springer US.

Salmivaara, L., Niva, M., Silfver, M., & Vainio, A. (2022). How vegans and vegetarians negotiate eating-related social norm conflicts in their social networks. *Appetite, 175*, Article 106081. https://doi.org/10.1016/j.appet.2022.106081

Singh, P., Sahadev, S., Oates, C. J., & Alevizou, P. (2020). Pro-environmental behavior in families: A reverse socialization perspective. *Journal of Business Research, 115*, 110–121. https://doi.org/10.1016/j.jbusres.2020.04.047

Sjoberg, D. D., Whiting, K., Curry, M., Lavery, J. A., & Larmarange, J. (2021). Reproducible summary tables with the gtsummary package. *The R Journal, 13*(1), 570–580. https://doi.org/10.32614/RJ-2021-053

Slotnick, M. J., Falbe, J., Cohen, J. F. W., Gearhardt, A. N., Wolfson, J. A., & Leung, C. W. (2023). Environmental and climate impact perceptions in university students: Sustainability motivations and perceptions correspond with lower red meat intake. *Journal of the Academy of Nutrition and Dietetics, 123*(5), 740–750. https://doi.org/10.1016/j.jand.2022.09.015

Springmann, M., Wiebe, K., Mason-D'Croz, D., Sulser, T. B., Rayner, M., & Scarborough, P. (2018). Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: A global modelling analysis with country-level detail. *The Lancet Planetary Health, 2*(10), e451–e461. https://doi.org/10.1016/S2542-5196(18)30206-7

Veen, E., Dagevos, H., Michielsen, Y., de Vrieze, A., & Riedel, S. (2023). Eating apart together: How vegetarian and meat eating students manage commensality in a flexitarian age. *Consumption and Society, 2*(1), 42–59. https://doi.org/10.1332/YQFO9787

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L., François, R., et al. (2019). Welcome to the tidyverse. *Journal of Open Source Software, 4*(43). https://doi.org/10.21105/joss.01686. Article 1686.

Wickham, H., & Bryan, J. (2023). readxl: Read Excel files. https://readxl.tidyverse.org.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., et al. (2019). Food in the Anthropocene: The EAT-*Lancet* Commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Williams, L., Magee, A., Kilby, C., Maxey, K., & Skelton, J. A. (2019). A pilot summer day camp cooking curriculum to influence family meals. *Pilot and Feasibility Studies, 5*, 1–9.

Xie, Y., Cheng, J., & Tan, X. (2024). DT: A wrapper of the JavaScript library 'DataTables. https://github.com/rstudio/DT.

Ziegler, A. M., Kasprzak, C. M., Mansouri, T. H., Gregory, A. M., Barich, R. A., Hatzinger, L. A., et al. (2021). An ecological perspective of food choice and eating autonomy among adolescents. *Frontiers in Psychology, 12*, Article 654139. https://doi.org/10.3389/fpsyg.2021.654139

Supplements

C1: Coding Manual: Topics of Conflict reported

General Conflicts:

- We code 4 different categories:
    1. If the description of the topic of typical conflict related to nutrition or family meals is related to meat or fish (i.e., conflict is about meat, vegan, or vegetarian diet – a conflict about eating vegetables is not counted in this category), we count it as “related to meat”=2.
    2. If is is not related to either meat or fish as described above, we count it as “Related to other topics”=1.
    3. If participants report never having conflicts about meals or food, we count the NA into the category “there are no conflicts” =0
    4. If no description of the conflict is given, we count it as “no description” = NA.
  - If several topics of conflict are mentioned, and one of the topic concerns meat, the conflict is coded as meat-related. If none of the topic is related to meat, the topic is coded as “other”.
  - Each conflict is counted for one category only.

Conflicts after Discussion

- We code 4 different categories:
    1. If the description of the topic of typical conflict related to nutrition or family meals is related to meat or fish (i.e., conflict is about meat, vegan, or vegetarian diet – a conflict about eating vegetables is not counted in this category), we count it as “related to meat”=2.
    2. If is is not related to either meat or fish as described above, we count it as “not meat-related”=1.
    3. If participants state that they do not have conflicts about meals or food, we count it into the category “there are no conflicts”=0; descriptions such as “we easily found a compromise” or “we agreed easily on a joint dish” are also counted in this category.
    4. If no description of the conflict is given, we count it as “no description” = NA.
  - If several topics of conflict are mentioned, and one of the topic concerns meat, the conflict is coded as meat-related. If none of the topic is related to meat, the topic is coded as “other”.
  - Each conflict is counted for one category only.

Supplements

C2: Rules for Coding Sustainability Motives

1. The entire conversation including the discussion about the meal decision and the entering the decision in the questionnaire is coded.
2. One speech contribution is considered a unit to be coded, which is finished when the person speaking changes.
3. If an argument is found in one speech contribution, it is coded as 1 in the first step, otherwise as 0.
4. In the second step, the direction of the argument is indicated (1=favoring less meat, 2= favoring more meat).
5. The examples given are intended as a guide; statements do not necessarily have the same wording.

Special cases:
1. If a person does not speak for themselves but for someone else (e.g. other people in the family, see examples), the statement is also coded as “1”.
2. If at the end of the discussion participants talk neutrally about the percentage of meat in the meal, the statement is coded as 0
3. Fish also counts as meat.

Meat-related arguments	**Does the discussion reveal an explicit motive for wanting to eat less/more meat?** **Examples:** - ... xy is vegetarian/vegan/without meat/with less meat - ... we can make xy vegetarian/vegan/without meat/with less meat - ... vegetarian schnitzel, vegetarian sausage (similar) - ... we make tomato sauce instead of Bolognese, dad eats vegetarian” - ... we want to eat less meat

Rules added during discussion of the coding:
- We do not code neutral reactions (yes, okay).
- We code buzzword “vegetarian” mentions (if already mentioned before)
- Default of the dish is with meat/animal products - Is there a change that is suggested? Then code 1.
- All contributions in which parts are incomprehensible are coded as NA

General Discussion

The aim of this dissertation was to gain a deeper understanding of the family meal process and its impact on family nutritional health. This involved examining both *how* family meals could be structured for more beneficial outcomes and the roles that parents and children play in fostering healthy eating decisions. In the following, I will briefly summarize the main findings from the five individual studies, integrate them into previous research, and highlight their theoretical and practical implications. Then, I discuss strengths as well as limitations of this research program while evaluating implications for future research and practice.

Summary of Findings

Manuscript 1 showed how extending the duration of family meals affects the fruit and vegetable intake of children during the meal. To examine this, 50 parent-child dyads were invited to the laboratory for dinner on two occasions. In one session, participants ate for the duration they had previously reported as their typical family meal duration. In the other session, the meal duration was extended by 50%. The results showed that children consumed significantly more fruits and vegetables during the longer meal condition, but not significantly more bread or cold cuts. However, despite a slower eating rate and increased satiety, there was no significant reduction in dessert consumption.

In Manuscript 2, the study investigated whether families report the routines identified by Dallacker et al. (2019; i.e., longer mealtime duration, a positive mealtime atmosphere, higher food quality, parental role modeling, turning off the television during meals, and involving children in meal preparation), how these routines are interrelated, and whether their predictive effects on children's nutritional health remain stable when considered in one statistical model. To address these questions, 310 parents reported on their family meals of the day over seven consecutive days. The results show that parents consistently reported the identified family mealtime routines. Specifically, a positive atmosphere and the non-use of TV and smartphones were reported to be components of most family meals. The seven routines exhibited only weak intercorrelations, indicating that they likely represent distinct and mostly independent constructs. Finally, when all routines were included in one statistical model, only the predictive effects of parental behavioral modeling and positive atmosphere on children's fruit and vegetable intake remained significant.

In Manuscript 3, we examined the extent to which parents' knowledge of food product nutrients (i.e., sugar, salt, and fat) is associated with the long-term nutritional health of their family. A total of 508 parents, who reported being mainly responsible for food planning, were visited at home by an interviewer, completed a questionnaire, and performed an estimation task for nine different products. Additionally, both parent and one child were weighed and measured. The results show that parents significantly misestimated the sugar, salt, and fat content of products. General numeracy and nutrient awareness were found to predict the accuracy of their estimates, albeit differently across nutrients: numeracy was a predictor for accurately estimating salt content, while nutrient awareness was predictive for sugar and fat estimation accuracy. Unexpectedly, no significant associations were found between underestimations of nutrient content and health conditions or BMI. However, exploratory analyses revealed that greater misestimation was associated with lower BMI.

In Manuscript 4, we broadly examined how generations differ in their dietary preferences and their influence on family meals. To address this, we surveyed 500 adolescents and 500 adults from their parental generation about their food-choice motives, their own and their family's dietary styles, and how they advocate for healthy and sustainable food decisions during family meals. Our findings reveal that adolescents are three times more likely to abstain from eating meat compared to their parent generation. While they are not more likely than adults to advocate for eating less meat at family meals, they are more likely to do so for reducing other animal products and introducing new plant-based options. Furthermore, when sustainability motives are important to them and reflected in their personal dietary habits, adolescents are more likely to advocate for more sustainable family meals.

In Manuscript 5, we investigated how parents and children agree on the amount of meat in the next shared family meal, focusing on which generation has stronger influence, and which demographic and behavioral variables determine the amount of meat they decide on. We invited 57 parent-child dyads to a videocall after answering a detailed screening questionnaire. During the call, parents and children first reported their personal preferences for the composition of the next family meal using a personal questionnaire. Afterward, they were asked to negotiate the final meal. The results indicate that, on average, parents and children have equal influence over how much meat is decided on for the next family meal. However, when children themselves do not eat meat, and when both dyad members report previous conflicts about meat consumption, the dyads agree on significantly less meat..

Integration of Findings and Theoretical Implications

In the following section, I will discuss the key findings of the five manuscripts that comprise this dissertation in relation to the broader body of research. This discussion will highlight the theoretical and empirical contributions of the dissertation to the understanding of the role of (1) routines and (2) individual family members in shaping family nutritional health.

Family Mealtime Routines

The routines identified in the meta-analysis by Dallacker et al.(2019) play a significant role in the daily lives of families and are likely to represent distinct constructs. The importance of duration, which was found to be the routine most strongly correlated with family health outcomes, is further substantiated by Manuscript 1. We demonstrated a causal relationship between meal duration and children's fruit and vegetable consumption, whereas previous research was only correlational. Interestingly, this dissertation provides mixed findings for mealtime duration: In Manuscript 2, mealtime duration was no longer a significant predictor; however, we observed that, on at least four out of seven days, meal duration remained significantly correlated with children's fruit and vegetable intake. The comparably high correlation between duration and atmosphere might suggest that the effect of duration on fruit and vegetable intake may be mediated through the positive mealtime atmosphere.

The significance of positive atmosphere and parental modeling as key predictors for children’s fruit and vegetable intake in addition to duration is confirmed in our findings. However, for modeling, it is the actual behavior of parents, rather than their intention to model healthy behaviors, that holds predictive value. This is in line with previous studies investigating parental modeling in an eating context (Harris & Ramsey, 2015).

The atmosphere during family meals and the duration spent together at the table are not merely individual behaviors exhibited by parents or children but rather represent collective family behaviors. This extends the Revised Family Ecological Model (Davison et al., 2013) by incorporating an additional dimension and, importantly, demonstrates the influence of these familial behaviors on the short-term nutritional health of both parents and children.

Thus, Manuscripts 1 and 2 of this dissertation emphasize that it is not only the frequency of shared meals that matters, but also the way in which these meals are structured plays a crucial role for children's nutritional health.

Role of Parents

As discussed in the previous section, parents are role models for healthy eating decisions – additionally, they serve as nutritional gatekeepers, which makes them responsible for purchasing foods and meal planning. How does their nutritional knowledge predict purchasing and providing healthy products and, therefore, family nutritional health outcomes? The Revised Family Ecological Framework (Davison et al., 2013) and empirical evidence suggest that nutritional knowledge influences health outcomes (e.g., Gase et al., 2014). Previous research has shown that misestimation (König et al., 2019), and specifically underestimation (Dallacker et al., 2018a) of nutrient content is associated with higher BMI in both parents and children. Interestingly, we did not replicate this relationship in Manuscript 3. While we did find that parents tend to underestimate sugar content, supporting the findings of Dallacker et al. (2018a), and also generated new evidence on how parents estimate salt and fat content, we could not demonstrate a significant correlation with underestimation and health outcomes—neither for children nor for parents. In a recent study, König et al. (2024) found no longer a statistically relevant relationship between sugar misestimation and BMI. Although we identified a relationship between misestimation and BMI in Manuscript 3, this relationship was in the opposite direction than expected, namely greater misestimation being related to a lower BMI, contrasting with previous studies (Dallacker et al., 2018a; König et al., 2019). These findings suggest that knowledge alone may not be sufficient to reliably predict long-term nutritional health outcomes such as BMI and non-communicable diseases, which may manifest only later in life. In addition to knowledge about healthy and unhealthy foods, aspects during meal planning, including costs, convenience and preferences of other family members (Middleton et al., 2022), particularly those of children, should be considered.

Role of Children

As descriptively shown in Manuscript 4, adolescents report having the most influence in the planning step of the family meal process, suggesting balancing and integrating diverse interests as an important aspect of mealtime planning.

Previous research indicates that children tend to prefer less healthy food options (Kümpel Nørgaard et al., 2007; McKeown & Nelson, 2018). Our findings suggest that reducing meat intake might be an outcome where children can positively influence the healthiness of family meals. In Manuscript 4, while adolescents did not report significantly more advocating for reducing meat consumption during family meals than adults, they did report higher advocating for trying new plant-based products, including meat substitutes—a finding supported by existing literature (Pater et al., 2022). While not all ingredients of high-processed meat substitutes might be health-favorable (Coffey et al., 2023), this suggests a potential pathway for reducing meat consumption within families by replacing meat, leading to a diet richer in whole plant foods (Gastaldello et al., 2022). It is particularly noteworthy that adolescents actively advocate for dietary changes aligned with their own behavior. This contradicts concepts like *self-silencing (*not mentioning own preferences to avoid social costs*;* Bolderdijk and Cornelisson, 2022), known in the context of vegetarianism/veganism for more public social contexts.

Evidence from Manuscript 5 further supports that parent-child dyads, who reported prior conflicts over meat consumption and where children follow a vegetarian or vegan diet, tend to agree on family meals with less meat content, leading to the conclusion that adolescents could have a tangible influence on family meat consumption, highlighting one important requirement: Advocating for eating less meat at the family table is not merely an outcome of belonging to a specific generation. It requires motivation and behavior that actively align with these values. However, since adolescents are increasingly adopting meat-free diets (Bundesministerium für Ernährung und Landwirtschaft, 2019, 2021, 2023), they appear to effectively translate their motivation into behavior, making them potential drivers for healthy and sustainable family meals. From a theoretical perspective, these findings challenge the traditional view that parents are the sole influencers of their children's nutritional health and dietary habits (Cavalli-Sforza et al., 1982; Michaelson et al., 2021). Instead, they underscore that children, as active agents, can shape the dietary patterns of their parents and the entire family.

Practical Implications

The findings of this research program hold several practical implications: First, the results underscore the critical role of family routines already identified in the previous meta-analysis by Dallacker et al., (2019) for fostering nutritional health in children, although not all routines demonstrated equivalent importance in the studies included in this dissertation. For families, it is particularly valuable to understand which routines consistently yield the most significant benefits for children’s nutritional health. This insight this dissertation gives can guide the prioritization of effective interventions and help distinguish between routines that are essential and those that may be less critical in the already challenging day-to-day family life (Manuscripts 1 and 2). A focus on longer family meals represents an important initial step. For example, extending the duration of family meals by approximately 10 minutes has been shown to lead to the consumption of one additional portion of fruits and vegetables by children, marking a meaningful contribution toward meeting WHO dietary recommendations, which are currently missed by most children (Robert Koch-Institut, 2018). Furthermore, the idea about how to offer fruits and vegetables (e.g., cut in small pieces) discussed in Manuscript 1 can help parents when preparing fruits and vegetables for their children. Additionally, parents' roles as nutritional gatekeepers and behavioral role models are of central importance. The influence of modeling healthy eating behaviors is well-documented in the literature (Dallacker et al., 2019; Patrick & Nicklas, 2005; Sweetman et al., 2011; Vollmer & Baietto, 2017) and our findings further establish its significance as a robust predictor of children's nutritional health. This effect is particularly pronounced when considered in conjunction with the quality of the mealtime atmosphere. Both factors emerge as critical determinants of nutritional outcomes, even when accounting for the influence of other routines (Manuscript 2). So, by improving their own diet, parents can also improve the diet of their children.

The finding that nutritional knowledge alone is insufficient to sustain family health offers a sense of reassurance for parents, alleviating some of the pressure that children's health relies solely on their understanding of nutrient content. However, the observed difficulty parents face in accurately estimating nutrient levels in food (Manuscript 3) also underscores the need for targeted policy interventions. A central question arises: how can it be made easier for parents to evaluate the healthfulness of food products? Our findings indicate that parents who frequently consult nutritional labels better estimate sugar and fat content. Despite this, nutrition labels were reported to be used only rarely or occasionally. Initial attempts to introduce traffic light labeling in Germany were unsuccessful (Deutscher Bundestag, 2008), leading to the implementation of the Nutri-Score system in 2019 (Hercberg et al., 2022). While the Nutri-Score represents one step in the right direction, the usage is still voluntary for food companies in Germany and needs ongoing adjustments to improve the clarity and accessibility of nutritional information and support informed decision-making at the point of purchase (Van Der Bend et al., 2022).

Lastly, adolescents emerge as active influencers during family meals, a role that should be emphasized in interventions (e.g., in schools) aimed at promoting more sustainable and healthy eating habits. Nation-wide surveys show that adolescents in Germany are increasingly adopting meat-free diets (Bundesministerium für Ernährung und Landwirtschaft, 2023), and our findings indicate that they bring those behaviors and related motives to the family table (Manuscript 4 and 5). As shown, their niches partly align with not traditionally healthy foods, such as promoting plant-based meat substitutes, but their potential positive influence on family nutritional health should not be underestimated (Gastaldello et al., 2022). It becomes particularly relevant in the context of *One Health*, which emphasizes the interconnectedness of human, animal, and planetary health (Food and Agriculture Organization of the UN, 2024). By considering the broader implications of dietary behaviors for all those aspects of One Health, interventions can harness the potential of younger generations as drivers of change toward healthier and more sustainable food practices.

Strengths, Limitations, and Future Research

Strengths

This dissertation is characterized by three main strengths: First, it unites methodological and transdisciplinary diversity with practical relevance. For each research question, the most appropriate methodological approach was selected, ranging from diary studies and laboratory experiments to large-scale surveys. Additionally, the research integrates theories from consumer science (Gentina & Muratore, 2012), nutritional science (Vidgen & Gallegos, 2014), and cultural transmission (Cavalli-Sforza et al., 1982), providing a transdisciplinary approach to understanding family nutritional health.

The practical relevance of the findings stands out, offering actionable recommendations that are easy to implement in family contexts. Many insights do not require complex, resource-intensive interventions from professionals but instead, empower families to make meaningful changes autonomously.

Second, this dissertation emphasizes the family meal as a social environment and highlights children as active agents. It extends the Revised Family Ecological Model (Davison et al., 2013) by incorporating behaviors on a family level and the influence of adolescents on healthy family eating decisions. This expansion addresses a critical gap previously overlooked in health research models (Michaelson et al., 2021) and cultural transmission theory (Cavalli-Sforza et al., 1982), leading to a better understanding how the family mealtime process is related to family health. By investigating at which points children might exert influence, this research identifies niches for their active participation by examining specific behaviors, such as their role in shaping family meat intake.

Third, this dissertation embodies a strong commitment to open science principles through practices like preregistration and open access. While preregistration was not a sensible option for Manuscript 2 (data was already accessible at the start of the dissertation) and Manuscript 5 (explorative nature of the study), the studies in Manuscripts 1,3 and 4 were preregistered. Data R scripts, and supplementary materials for all five manuscripts are publicly available on the Open Science Framework (OSF). These practices enhance the transparency and reproducibility of the research, thus amplifying its scientific impact.

Limitations and Future Research

While this dissertation provides additional evidence supporting the importance of various mealtime routines and extends the Revised Family Ecological Model by Davison et al., (2013), it does so only for some of the identified factors and leaves open multiple research questions to be addressed by future research: For instance, while mealtime atmosphere emerges as an important mealtime routine together with mealtime duration and parental modeling, there is still insufficient understanding of the construct itself – what exactly is mealtime atmosphere? While considered dimensions, such as communication during meals (Fulkerson et al., 2006) or affect (White et al., 2015), have been captured in questionnaires, a definition of mealtime atmosphere remains elusive. Additionally, our findings on mealtime atmosphere rely solely on parental reports. It is yet unclear whether children perceive mealtime atmosphere differently, initial evidence suggests they do (e.g., Fulkerson et al., 2006). Future research should aim to get a better understanding of mealtime atmosphere as well as the other routines to establish a reliable foundation for testing causality and to identify which aspects of, for instance, mealtime atmosphere are most effectively addressed through interventions. Moreover, not all paths and constructs represented in the theoretical model, got addressed in this dissertation. Several aspects remain unexplored, including critical influence factors such as inequality and stress. These represent key areas for future investigation, as the field still lacks substantial insights into how inequality shapes eating decisions (Claassen et al., 2019; Schüz, 2024). Expanding future research to include more diverse samples would not only address these gaps but also strengthen the field of family meal research more broadly.

Another limitation of the present research lies in the limited ability to capture, in an ecologically valid manner, the negotiation processes between parents and children during meal planning, the conflicts that arise in these interactions, and the family mealtime routines used when eating together. Although we employed diary studies and observational methods to approach this issue, they have proven insufficient in fully capturing the complexity of these processes. For instance, in Manuscript 5, the reported conflicts surrounding meat consumption before the study, which were then related to deciding on less meat consumption for the next family meal, could not be observed during the study negotiation. Further, ceiling effects concerning mealtime atmosphere or TV non-use when asking for it in the lab or a questionnaire. To address these limitations, future research needs to adopt new methodologies capable of minimally invasively capturing the interactions occurring at the family dinner table in real-world settings. Technologies such as sensors, which could track the start and end times of meals, assess the emotional valence of interactions, and, when combined with self-report measures, facilitate long-term field-based assessments, could prove valuable in advancing this area of research (Harari & Gosling, 2023).

Lastly, the consistency and comparability of the results across the studies included in this dissertation are limited, particularly concerning the children's age range and the use of different outcomes as proxies for nutritional health. The variation in the children's age groups reflects the different research questions and methodological approaches adopted in each study. For instance, in Manuscript 2, the age range spans from 3 to 17 years, as this study was designed to capture parental responses, thus allowing for a broad inclusion of children's age groups. In Manuscripts 4 and 5, the age range was restricted to 12 years and older, ensuring that adolescents were capable of completing the surveys independently. This age selection was particularly relevant given the focus on generational influences, as adolescence is typically a period when eating decisions become increasingly autonomous (Ziegler et al., 2021). The differing outcome variables (vegetable/fruit consumption, BMI, health conditions, meat intake) across the studies further complicate the direct comparison of findings. Manuscripts 1 and 2 specifically examine fruit and vegetable consumption, a frequently utilized metric for assessing short-term nutritional health outcomes (Caspi et al., 2012). By employing diary studies and observing actual family dinners, these manuscripts justify an analysis of daily-level outcomes. In contrast, Manuscript 3 adopts a cross-sectional survey design, with parental knowledge as a stable variable and key predictor, addressing more long-term health outcomes such as BMI and overall health conditions.

Manuscripts 4 and 5, on the other hand, focus on meat intake, identifying it as a specific niche through which adolescent influence on family meals might be health promotive. Thus, the dissertation does not provide a fully integrated investigation of a singular paradigm, outcome, or age group but instead fragmented insights into each distinct research question and outcome. However, the inclusion of diverse age groups, paradigms, and outcomes could be viewed as a strength, offering a comprehensive exploration of various facets of family nutritional health. The shifting focus of research questions and paradigms across the studies as well as variations in predictors and outcomes so result in a wide-ranging overview, but not a unified, generalized conclusion.

General Conclusion

This dissertation enhances our understanding of the potential of family meals in fostering family nutritional health. By employing a multi-methodological approach and integrating transdisciplinary theories, I highlight the important role of mealtime routines and the influence of family members on various nutritional health outcomes for parents, children, and the family as a whole, particularly in the contexts of eating, purchasing, preparation, and planning of family meals.

Key contributions of this work to the field of health psychology include strengthening and extending the existing body of research on the importance of mealtime routines and identifying key routines such as mealtime atmosphere, duration, and parental modeling. These routines were shown to play crucial roles in shaping family eating behaviors and predicting children's nutritional health. Furthermore, this dissertation underscores the significance of family meals as a social context, highlighting family-level variables and the influence of children as active agents in meal planning. It emphasizes how psychological variables, including motives and behaviors, can be more influential than demographic factors, such as generation affiliation, in shaping healthy eating decisions.

The nutritional health of children is a crucial area for research and intervention, particularly in the context of obesity prevention. This dissertation's practical insights and findings offer an excellent foundation for actionable recommendations that can be directly implemented in real-world settings: Family meals serve as an accessible environment for children to learn about healthy eating, develop desirable eating habits, but also advocate for own needs, making them an invaluable tool in fostering long-term nutritional health of the whole family.

References

Ayadi, K., & Bree, J. (2010). An ethnography of the transfer of food learning within the family. *Young Consumers*, *11*(1), 67–76. https://doi.org/10.1108/17473611011026028

Berge, J. M., Hazzard, V. M., Larson, N., Hahn, S. L., Emery, R. L., & Neumark-Sztainer, D. (2021). Are there protective associations between family/shared meal routines during COVID-19 and dietary health and emotional well-being in diverse young adults? *Preventive Medicine Reports*, *24*, 101575. https://doi.org/10.1016/j.pmedr.2021.101575

Bleich, S. N., Herring, B. J., Flagg, D. D., & Gary-Webb, T. L. (2012). Reduction in Purchases of Sugar-Sweetened Beverages Among Low-Income Black Adolescents After Exposure to Caloric Information. *American Journal of Public Health*, *102*(2), 329–335. https://doi.org/10.2105/AJPH.2011.300350

Bolderdijk, J. W., & Cornelissen, G. (2022). “How do you know someone’s vegan?” They won’t always tell you. An empirical test of the do-gooder’s dilemma. *Appetite*, *168*, 105719. https://doi.org/10.1016/j.appet.2021.105719

Brettschneider, A.-K., Lage Barbosa, C., Haftenberger, M., Lehmann, F., & Mensink, G. B. (2021). Adherence to food-based dietary guidelines among adolescents in Germany according to socio-economic status and region: Results from Eating Study as a KiGGS Module (EsKiMo) II. *Public Health Nutrition*, *24*(6), 1216–1228. https://doi.org/10.1017/S136898002100001X

Bundesministerium für Ernährung und Landwirtschaft. (2019). *Deutschland, wie es isst—Der BMEL-Ernährungsreport 2019*. https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/Ernaehrungsreport2019.pdf?__blob=publicationFile

Bundesministerium für Ernährung und Landwirtschaft. (2021). *Deutschland, wie es isst - Der*

BMEL-Ernährungsreport 2021. https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/ernaehrungsreport-2021.pdf?__blob=publicationFile&v=6

Bundesministerium für Ernährung und Landwirtschaft. (2023). *Deutschland, wie es isst – Der BMEL-Ernährungsreport 2023*. https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/ernaehrungsreport-2023.pdf?__blob=publicationFile&v=4

Caspi, C. E., Sorensen, G., Subramanian, S. V., & Kawachi, I. (2012). The local food environment and diet: A systematic review. *Health & Place*, *18*(5), 1172–1187. https://doi.org/10.1016/j.healthplace.2012.05.006

Cavalli-Sforza, L. L., Feldman, M. W., Chen, K. H., & Dornbusch, S. M. (1982). Theory and Observation in Cultural Transmission. *Science*, *218*(4567), 19–27. https://doi.org/10.1126/science.7123211

Chen, Y.-S., Lehto, X., Behnke, C., & Tang, C.-H. (2016). Investigating Children's Role in Family Dining-Out Choices: Evidence From a Casual Dining Restaurant. *Journal of Hospitality Marketing & Management*, *25*(6), 706–725. https://doi.org/10.1080/19368623.2016.1077368

Claassen, M. A., Corneille, O., & Klein, O. (2019). Psychological Consequences of Inequality for Food Intake. In J. Jetten & K. Peters (Eds.), *The Social Psychology of Inequality* (pp. 155–172). Springer International Publishing. https://doi.org/10.1007/978-3-030-28856-3_10

Coffey, A. A., Lillywhite, R., & Oyebode, O. (2023). Meat versus meat alternatives: Which is better for the environment and health? A nutritional and environmental analysis of animal-based products compared with their plant-based alternatives. *Journal of Human Nutrition and Dietetics*, *36*(6), 2147–2156. https://doi.org/10.1111/jhn.13219

Dallacker, M., Hertwig, R., & Mata, J. (2018a). Parents' considerable underestimation of sugar and their child's risk of overweight. *International Journal of Obesity*, *42*(5), 1097–1100. https://doi.org/10.1038/s41366-018-0021-5

Dallacker, M., Hertwig, R., & Mata, J. (2018b). The frequency of family meals and nutritional health in children: A meta-analysis: Family meals and children's health. *Obesity Reviews*, *19*(5), 638–653. https://doi.org/10.1111/obr.12659

Dallacker, M., Hertwig, R., & Mata, J. (2019). Quality matters: A meta-analysis on components of healthy family meals. *Health Psychology*, *38*(12), 1137–1149. https://doi.org/10.1037/hea0000801

Davison, K. K., Jurkowski, J. M., & Lawson, H. A. (2013). Reframing family-centred obesity prevention using the Family Ecological Model. *Public Health Nutrition*, *16*(10), 1861–1869. https://doi.org/10.1017/S1368980012004533

De Bourdeaudhuij, I., & Van Oost, P. (1998). Family Members' Influence on Decision Making about Food: Differences in Perception and Relationship with Healthy Eating. *American Journal of Health Promotion*, *13*(2), 73–81. https://doi.org/10.4278/0890-1171-13.2.73

Deutscher Bundestag. (2008, March 10). Verbraucher stärken – Lebensmittelinformationsverordnung im Fokus. *Das Parlament*. Retrieved from https://webarchiv.bundestag.de/archive/2010/0203/dasparlament/2008/11/WirtschaftFinanzen/19839051.html

Dunbar, R. I. M. (2017). Breaking Bread: The Functions of Social Eating. *Adaptive Human Behavior and Physiology*, *3*(3), 198–211. https://doi.org/10.1007/s40750-017-0061-4

Fiese, B. H., Jones, B. L., & Jarick, J. M. (2015). Family mealtime dynamics and food consumption: An experimental approach to understanding distractions. *Couple and Family Psychology: Research and Practice*, *4*(4), 199–211.

https://doi.org/10.1037/cfp0000047

Filippini, T., Malavolti, M., Whelton, P. K., & Vinceti, M. (2022). Sodium Intake and Risk of Hypertension: A Systematic Review and Dose–Response Meta-analysis of Observational Cohort Studies. *Current Hypertension Reports*, *24*(5), 133–144. https://doi.org/10.1007/s11906-022-01182-9

Food and Agriculture Organization of the UN. (2024). *One Health*. https://www.fao.org/one-health/overview/one-health-overview/en

Frank, M., Brettschneider, A.-K., Lage Barbosa, C., & Mensink, G. B. (2019). Prevalence and temporal trends of shared family meals in Germany. Results from EsKiMo II. *Ernahrungs Umschau*, *66(4)*, 60–67. https://doi.org/10.4455/eu.2019.013

Fulkerson, J. A., Neumark-Sztainer, D., & Story, M. (2006). Adolescent and Parent Views of Family Meals. *Journal of the American Dietetic Association*, *106*(4), 526–532. https://doi.org/10.1016/j.jada.2006.01.006

Gase, L. N., Robles, B., Barragan, N. C., & Kuo, T. (2014). Relationship Between Nutritional Knowledge and the Amount of Sugar-Sweetened Beverages Consumed in Los Angeles County. *Health Education & Behavior*, *41*(4), 431–439. https://doi.org/10.1177/1090198114529128

Gastaldello, A., Giampieri, F., De Giuseppe, R., Grosso, G., Baroni, L., & Battino, M. (2022). The rise of processed meat alternatives: A narrative review of the manufacturing, composition, nutritional profile and health effects of newer sources of protein, and their place in healthier diets. *Trends in Food Science & Technology*, *127*, 263–271. https://doi.org/10.1016/j.tifs.2022.07.005

Gentina, E., & Muratore, I. (2012). Environmentalism at home: The process of ecological resocialization by teenagers: Ecological resocialization by teenagers. *Journal of Consumer Behaviour*, *11*(2), 162–169. https://doi.org/10.1002/cb.373

Gu, X., Drouin-Chartier, J.-P., Sacks, F. M., Hu, F. B., Rosner, B., & Willett, W. C. (2023). Red meat intake and risk of type 2 diabetes in a prospective cohort study of United States females and males. *The American Journal of Clinical Nutrition*, *118*(6), 1153–1163. https://doi.org/10.1016/j.ajcnut.2023.08.021

Hammons, A. J., & Fiese, B. H. (2011). Is Frequency of Shared Family Meals Related to the Nutritional Health of Children and Adolescents? *PEDIATRICS*, *127*(6), e1565–e1574. https://doi.org/10.1542/peds.2010-1440

Harari, G. M., & Gosling, S. D. (2023). Understanding behaviours in context using mobile sensing. *Nature Reviews Psychology*, *2*(12), 767-779.

Harris, T. S., & Ramsey, M. (2015). Paternal modeling, household availability, and paternal intake as predictors of fruit, vegetable, and sweetened beverage consumption among African American children. *BMC Health Service Research*, *15*(575), 7. https://doi.org/10.1186/s12913-015-1178-4

Hercberg, S., Touvier, M., & Salas-Salvado, J. (2022). The Nutri-Score nutrition label: A public health tool based on rigorous scientific evidence aiming to improve the nutritional status of the population. *International Journal for Vitamin and Nutrition Research*, *92*(3–4), 147–157. https://doi.org/10.1024/0300-9831/a000722

Hooper, L., Martin, N., Jimoh, O. F., Kirk, C., Foster, E., & Abdelhamid, A. S. (2020). Reduction in saturated fat intake for cardiovascular disease. *Cochrane Database of Systematic Reviews*, *2020*(8). https://doi.org/10.1002/14651858.CD011737.pub3

König, L. M., Schupp, H. T., & Renner, B. (2024). A matter of the metric? Sugar content overestimation is less pronounced in sugar cubes versus grams. *Nutrition Research*, *131*, 111–120. https://doi.org/10.1016/j.nutres.2024.09.007

König, L. M., Ziesemer, K., & Renner, B. (2019). Quantifying Actual and Perceived Inaccuracy When Estimating the Sugar, Energy Content and Portion Size of Foods.

Nutrients, *11*(10), 2425. https://doi.org/10.3390/nu11102425

Kucharczuk, A. J., Oliver, T. L., & Dowdell, E. B. (2022). Social media's influence on adolescents′ food choices: A mixed studies systematic literature review. *Appetite*, *168*, 105765. https://doi.org/10.1016/j.appet.2021.105765

Kümpel Nørgaard, M., Bruns, K., Haudrup Christensen, P., & Romero Mikkelsen, M. (2007). Children's influence on and participation in the family decision process during food buying. *Young Consumers*, *8*(3), 197–216.

https://doi.org/10.1108/17473610710780945

Libuda, L., Alexy, U., & Kersting, M. (2014). Time trends in dietary fat intake in a sample of German children and adolescents between 2000 and 2010: Not quantity, but quality is the issue. *British Journal of Nutrition*, *111*(1), 141–150. https://doi.org/10.1017/S0007114513002031

Liu, J., Chen, Q., & Dang, J. (2022). New intergenerational evidence on reverse socialization of environmental literacy. *Sustainability Science*, *17*(6), 2543–2555. https://doi.org/10.1007/s11625-022-01194-z

Mahmood, L., Flores-Barrantes, P., Moreno, L. A., Manios, Y., & Gonzalez-Gil, E. M. (2021). The Influence of Parental Dietary Behaviors and Practices on Children's Eating Habits. *Nutrients*, *13*(4), 1138. https://doi.org/10.3390/nu13041138

Martin-Biggers, J., Spaccarotella, K., Berhaupt-Glickstein, A., Hongu, N., Worobey, J., & Byrd-Bredbenner, C. (2014). Come and Get It! A Discussion of Family Mealtime Literature and Factors Affecting Obesity Risk1–3. *Advances in Nutrition*, *5*(3), 235–247. https://doi.org/10.3945/an.113.005116

McKeown, A., & Nelson, R. (2018). Independent decision making of adolescents regarding food choice. *International Journal of Consumer Studies*, *42*(5), 469–477. https://doi.org/10.1111/ijcs.12446

Michaelson, V., Pilato, K. A., & Davison, C. M. (2021). Family as a health promotion setting: A scoping review of conceptual models of the health-promoting family. *PLOS ONE*, *16*(4), e0249707. https://doi.org/10.1371/journal.pone.0249707

Middleton, G., Golley, R. K., Patterson, K. A., & Coveney, J. (2022). The Family Meal Framework: A grounded theory study conceptualising the work that underpins the family meal. *Appetite*, *175*, 106071. https://doi.org/10.1016/j.appet.2022.106071

Moores, C. J., Kelly, S. A. M., & Moynihan, P. J. (2022). Systematic Review of the Effect on Caries of Sugars Intake: Ten-Year Update. *Journal of Dental Research*, *101*(9), 1034–1045. https://doi.org/10.1177/00220345221082918

Pater, L., Kollen, C., Damen, F. W. M., Zandstra, E. H., Fogliano, V., & Steenbekkers, B. L. P. A. (2022). The perception of 8- to 10-year-old Dutch children towards plant-based meat analogues. *Appetite*, *178*, 106264. https://doi.org/10.1016/j.appet.2022.106264

Patrick, H., & Nicklas, T. A. (2005). A Review of Family and Social Determinants of Children's Eating Patterns and Diet Quality. *Journal of the American College of Nutrition*, *24*(2), 83–92. https://doi.org/10.1080/07315724.2005.10719448

Perrar, I., Alexy, U., & Nöthlings, U. (2024). Intake of free sugar among children and adolescents in Germany declines – current results of the DONALD study. *European Journal of Nutrition*, *63*(7), 2827–2833. https://doi.org/10.1007/s00394-024-03456-1

Perrea, T., Brunsø, K., Altintzoglou, T., Einarsdóttir, G., & Luten, J. (2012). Decomposing the (seafood versus meat) evening meal decision-making sequence: Insights from a diary study in Norway, Iceland and Denmark. *British Food Journal*, *114*(11), 1533–1557. https://doi.org/10.1108/00070701211273018

Persson Osowski, C., & Mattsson Sydner, Y. (2019). The family meal as an ideal: Children's perceptions of foodwork and commensality in everyday life and feasts. *International Journal of Consumer Studies*, *43*(2), 178–186.

https://doi.org/10.1111/ijcs.12495

Quick, V., Golem, D., Alleman, G. P., Martin-Biggers, J., Worobey, J., & Byrd-Bredbenner, C. (2018). Moms and Dads Differ in Their Family Food Gatekeeper Behaviors. *Topics in Clinical Nutrition*, *33*(1), 3–15. https://doi.org/10.1097/TIN.0000000000000127

Ramseyer Winter, V., Jones, A., & O'Neill, E. (2019). Eating Breakfast and Family Meals in Adolescence: The Role of Body Image. *Social Work in Public Health*, *34*(3), 230–238. https://doi.org/10.1080/19371918.2019.1575314

Remer, T., Hua, Y., Esche, J., & Thamm, M. (2022). The DONALD study as a longitudinal sensor of nutritional developments: Iodine and salt intake over more than 30 years in German children. *European Journal of Nutrition*, *61*(4), 2143–2151. https://doi.org/10.1007/s00394-022-02801-6

Robert Koch-Institut. (2018). *Sports and dietary behaviour among children and adolescents in Germany. Results of the cross-sectional KiGGS Wave 2 study and trends*. https://doi.org/10.17886/RKI-GBE-2018-070

Robson, S. M., McCullough, M. B., Rex, S., Munafò, M. R., & Taylor, G. (2020). Family Meal Frequency, Diet, and Family Functioning: A Systematic Review With Meta-analyses. *Journal of Nutrition Education and Behavior*, *52*(5), 553–564. https://doi.org/10.1016/j.jneb.2019.12.012

Santos, L. P., Gigante, D. P., Delpino, F. M., Maciel, A. P., & Bielemann, R. M. (2022). Sugar sweetened beverages intake and risk of obesity and cardiometabolic diseases in longitudinal studies: A systematic review and meta-analysis with 1.5 million individuals. *Clinical Nutrition ESPEN*, *51*, 128–142. https://doi.org/10.1016/j.clnesp.2022.08.021

Sawyer, S. M., Azzopardi, P. S., Wickremarathne, D., & Patton, G. C. (2018). The age of adolescence. *The Lancet Child & Adolescent Health*, *2*(3), 223–228.

https://doi.org/10.1016/S2352-4642(18)30022-1

Schüz, B. (2024). Socioeconomic Status and Theories of Health Behavior. In P. Liamputtong (Ed.), *Handbook of Concepts in Health, Health Behavior and Environmental Health* (pp. 1–18). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-0821-5_29-1

Snuggs, S., & Harvey, K. (2023). Family Mealtimes: A Systematic Umbrella Review of Characteristics, Correlates, Outcomes and Interventions. *Nutrients*, *15*(13), 2841. https://doi.org/10.3390/nu15132841

Søndergaard, H. A., & Edelenbos, M. (2007). What parents prefer and children like – Investigating choice of vegetable-based food for children. *Food Quality and Preference*, *18*(7), 949–962. https://doi.org/10.1016/j.foodqual.2007.03.009

Sweetman, C., McGowan, L., Croker, H., & Cooke, L. (2011). Characteristics of Family Mealtimes Affecting Children's Vegetable Consumption and Liking. *Journal of the American Dietetic Association*, *111*(2), 269–273. https://doi.org/10.1016/j.jada.2010.10.050

Umer, A., Kelley, G. A., Cottrell, L. E., Giacobbi, P., Innes, K. E., & Lilly, C. L. (2017). Childhood obesity and adult cardiovascular disease risk factors: A systematic review with meta-analysis. *BMC Public Health*, *17*(1), 683. https://doi.org/10.1186/s12889-017-4691-z

Van Der Bend, D. L. M., Van Eijsden, M., Van Roost, M. H. I., De Graaf, K., & Roodenburg, A. J. C. (2022). The Nutri-Score algorithm: Evaluation of its validation process. *Frontiers in Nutrition*, *9*, 974003. https://doi.org/10.3389/fnut.2022.974003

Vidgen, H. A., & Gallegos, D. (2014). Defining food literacy and its components. *Appetite*, *76*, 50–59. https://doi.org/10.1016/j.appet.2014.01.010

Vollmer, R. L., & Baietto, J. (2017). Practices and preferences: Exploring the relationships between food-related parenting practices and child food preferences for high fat and/or sugar foods, fruits, and vegetables. *Appetite*, *113*, 134–140. https://doi.org/10.1016/j.appet.2017.02.019

Watne, T., Lobo, A., & Brennan, L. (2011). Children as agents of secondary socialisation for their parents. *Young Consumers*, *12*(4), 285–294. https://doi.org/10.1108/17473611111185841

White, H. J., Haycraft, E., Wallis, D. J., Arcelus, J., Leung, N., & Meyer, C. (2015). Development of the Mealtime Emotions Measure for adolescents (MEM-A): Gender differences in emotional responses to family mealtimes and eating psychopathology. *Appetite*, *85*, 76–83. https://doi.org/10.1016/j.appet.2014.11.011

Williams, L., Magee, A., Kilby, C., Maxey, K., & Skelton, J. A. (2019). A pilot summer day camp cooking curriculum to influence family meals. *Pilot and Feasibility Studies*, *5*(1), 147. https://doi.org/10.1186/s40814-019-0528-0

Woo, J. G., Zhang, N., Fenchel, M., Jacobs, D. R., Hu, T., Urbina, E. M., Burns, T. L., Raitakari, O., Steinberger, J., Bazzano, L., Prineas, R. J., Jaquish, C., Juonala, M., Ryder, J. R., Daniels, S. R., Sinaiko, A., Dwyer, T., & Venn, A. (2020). Prediction of adult class II/III obesity from childhood BMI: The i3C consortium. *International Journal of Obesity*, *44*(5), 1164–1172. https://doi.org/10.1038/s41366-019-0461-6

Woolley, K., & Fishbach, A. (2017). A recipe for friendship: Similar food consumption promotes trust and cooperation. *Journal of Consumer Psychology*, *27*(1), 1–10. https://doi.org/10.1016/j.jcps.2016.06.003

Ziegler, A. M., Kasprzak, C. M., Mansouri, T. H., Gregory, A. M., Barich, R. A., Hatzinger, L. A., Leone, L. A., & Temple, J. L. (2021). An Ecological Perspective of Food Choice and Eating Autonomy Among Adolescents. *Frontiers in Psychology*, *12*, 654139. https://doi.org/10.3389/fpsyg.2021.654139

Zühlsdorf, A., Jürkenbeck, K., Schulze, M., & Spiller, A. (2021). *Politicized Eater: Jugendreport zur Zukunft nachhaltiger Ernährung*. Retrieved from: https://www.uni-goettingen.de/de/document/download/ecc93c87045b061c7e7f61ff5f5f206f.pdf/Jugendreport%20zur%20Zukunft%20nachhaltiger%20Ernährung.pdf

Statement of Co-Authors – Manuscript 1

We confirm that Vanessa Knobl, doctoral candidate at the School of Sciences at the University of Mannheim, made a substantial contribution to the following manuscript included in this dissertation:

Dallacker, M., Knobl, V., Hertwig, R., & Mata, J. (2023). Effect of longer family meals on children's fruit and vegetable intake: A randomized clinical trial. *JAMA network open, 6(4), e236331-e236331*. https://doi.org/10.1001/jamanetworkopen.2023.6331

We sign this statement to the effect that Vanessa Knobl contributed to conceptualizing and was responsible for the statistical analyses as well as data interpretation and revising the manuscript. Mattea Dallacker was responsible for conceptualizing and designing the study, data analysis and interpretation as well as drafting the manuscript. Jutta Mata contributed by conceptualizing, drafting and revising the manuscript as well as providing supervision. Ralph Hertwig provided resources, supervision, and ideas for conceptualizing and revising the manuscript.

Mattea Dallacker   Ralph Hertwig   Jutta Mata

Statement of Co-Authors – Manuscript 2

We confirm that the following manuscript included in this dissertation was primarily conceived and written by Vanessa Knobl, doctoral candidate at the School of Sciences at the University of Mannheim:

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2022). Happy and healthy: How family mealtime routines relate to child nutritional health. *Appetite*, 171, 105939. https://doi.org/10.1016/j.appet.2022.105939

We sign this statement to the effect that Vanessa Knobl is credited as the primary source of the ideas and the main author of the manuscript as she conceptualized the hypotheses, implemented the statistical analyses, and wrote the original draft of the manuscript. Mattea Dallacker and Ralph Hertwig contributed to conceptualization of the study and revising the manuscript. Jutta Mata contributed to conceptualization, by providing supervision and resources, as well as co-writing and revising the manuscript.

Mattea Dallacker   Ralph Hertwig   Jutta Mata

Statement of Co-Authors – Manuscript 3

We confirm that the following manuscript included in this dissertation was primarily conceived and written by Vanessa Knobl, doctoral candidate at the School of Sciences at the University of Mannheim:

Knobl, V., Dallacker, M., Hertwig, R., & Mata, J. (2024). *Hard to guess: Do parents' estimates of sugar, salt, and fat relate to family health?* [Manuscript submitted for publication].

We sign this statement to the effect that Vanessa Knobl is credited as the primary source of the ideas and the main author of the manuscript as she conceptualized the hypotheses, implemented the statistical analyses, and wrote the original draft of the manuscript. Mattea Dallacker designed the measures, organized and supervised data collection and contributed to revising the manuscript. Ralph Hertwig and Jutta Mata contributed to conceptualization, by providing supervision and resources, as well as revising the manuscript.

Mattea Dallacker Ralph Hertwig Jutta Mata

Statement of Co-Authors – Manuscript 4

I confirm that the following manuscript included in this dissertation was primarily conceived and written by Vanessa Knobl, doctoral candidate at the School of Sciences at the University of Mannheim:

Knobl, V., & Mata, J. (2024). Intersecting perspectives: Advocating for sustainable family meals across generations. *Appetite*, 201, 107618. https://doi.org/10.1016/j.appet.2024.107618

I sign this statement to the effect that Vanessa Knobl is credited as the primary source of the ideas and the main author of the manuscript as she derived the theoretical and methodological background, was responsible for the investigation, implemented the statistical analyses, and wrote the original draft of the manuscript. I contributed by conceptualizing, providing resources and supervision, as well as co-writing and revising the manuscript.

Jutta Mata

Statement of Co-Authors – Manuscript 5

We confirm that Vanessa Knobl, doctoral candidate at the School of Sciences at the University of Mannheim, made an important contribution to the following manuscript included in this dissertation:

Mata, J., **Knobl, V.**, & Takezawa, M. (2025). Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption. *Appetite*, Article 107916. https://doi.org/10.1016/j.appet.2025.107916

We sign this statement to the effect that Vanessa Knobl contributed to conceptualizing and was responsible the investigation, for statistical analysis as well as data interpretation and revising the manuscript. Masanori Takezawa played a lead role in conceptualization, data analysis as well as revising and editing the manuscript. Jutta Mata played a lead role in funding acquisition and supervision, conceptualization, investigation, methodology, writing–original draft, and writing–review and editing.

Jutta Mata Masanori Takezawa

Acknowledgements

The past 4.5 years have probably been the period in my life when I've grown the most—at least that's how it feels right now. Before starting my dissertation, I could never have imagined experiencing so much and developing so significantly in such a short time, and I'm incredibly grateful for it. Many people have shaped these past 4.5 years into what they were, and the best part is that this isn't a goodbye—many of you will continue to be part of my journey in the next chapter.

There are two people I'd like to thank in the beginning, as this just makes sense chronologically: First, **Mai Thi Nguyen-Kim**, who showed me so vividly that being a scientist is not just a career but a way of life—and also the coolest job out there. You are an incredible role model. Second, **Anso**, you were, in many ways, my first real mentor. Thank you for sharing your network with me and making this path possible. I had ideas what I wanted to do, and you always had exactly the right suggestions and knew the right people for how to make them happen.

Of course, my deepest gratitude goes to you, **Jutta**. Thank you for always believing in me, even when it took me a little longer to do so myself. Thank you for motivating me with so much care and sensitivity to step out of my comfort zone and gradually expand my limits—without ever disregarding them. You've taught me to find the excitement in every research question and every result, and that no matter the challenge, there is always a solution. ☺

I also want to thank my co-authors — **Ralph, Mattea**, and **Masanori**. It has been an honor to work with you. Your valuable feedback has undoubtedly made me a better researcher.

I started this dissertation in the middle of the first covid 19 lockdown in 2020 and I am sure I would not have made it without my lovely team:

Tine, thank you for making me feel like I belonged from the very first second. Your inspiring enthusiasm—not only, but especially for researching the important topics—your warmth, authenticity, and of course, your sense of humor, truly form the heart of our team. I'm so excited to join you soon in our next adventure, the postdoc life.

Ira, I absolutely love working with you. You are incredibly smart and caring, and no one gives feedback that's as detailed yet so kind and constructive as you do. Even though our work habits differ in some ways, you're my favorite office buddy. Every gadget and every plant you've brought in makes the office feel like home.

Caro, Elena, and **Dario**, we haven't known each other for very long, but it feels like we're all in exactly the right place together. Thank you for your support over the past few months—I can't wait to work on new ideas together with you.

Michael and **Philipp**, even though you've moved on to new ventures, you absolutely deserve a mention here as part of this beloved team. I've learned so much from both of you—thank you for every discussion, every exchange about scientific, methodological, and all the other topics we've explored together.

Of course, beyond the team, there were and are so many other people in L13 who make it the best workplace ever. **Petra, Daniela, Nina, Lea**, **Fabiola, Letti, Caro, Julia, Daria, Desi, Sergio, Nils, Viola**, and everyone else—thank you for being part of it all.

Dear **Malte, Caro, Hannah, Julia, Constanze**, and **Katha**—thank you for sticking with me throughout my academic journey. I value your friendship more than I can say.

A heartfelt thanks to **my parents**—for supporting me with everything you had and giving me the freedom to grow into who I am today. I know that, just like me, you've grown along the way.

A brief but meaningful thanks goes to those who didn't believe in me. Your disbelief fueled my drive for success, and I wouldn't be here today if there hadn't been you.

Turi, my sweet angel, thank you for pulling me away from my desk over the last two years to spend time outdoors, share cuddles, and enjoy playful moments. I truly appreciate the positive impact you've had on my mental health.

And lastly, **Jannis**—both of us know this achievement is just as much yours as it is mine. Conservatively, it's often the women who have their men's backs, but everyone knows that traditional clichés aren't really your thing. Thank you for your unconditional support—whether instrumental, emotional, or in every other imaginable way. Your love and care make me feel like I can accomplish anything I set my mind to. With you, I am fearless.

Statement of Originality

1. I hereby declare that the presented doctoral dissertation with the title *The Family Meal Potential: Routines and Family Members Fostering Nutritional Health* is my own work.
2. I did not seek unauthorized assistance of a third party and I have employed no other sources or means except the ones listed. I clearly marked any quotations derived from the works of others.
3. AI-assisted technologies were used only in the writing process to improve the readability and language of the dissertation and included manuscripts.
4. I did not yet present this doctoral dissertation or parts of it at any other higher education institution in Germany or abroad.
5. I hereby confirm the accuracy of the declaration above.
6. I am aware of the significance of this declaration and the legal consequences in case of untrue or incomplete statements.

I affirm in lieu of oath that the statements above are to the best of my knowledge true and complete.

Mannheim, Dezember 19, 2024 Vanessa Knobl