

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

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### 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 ( $M_{\text{age}} = 42$  years) described their most important family meal of the day and food intake for an index child ( $M_{\text{age}} = 9$  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 ( $r$ s between  $-.14$  and  $.25$ ), 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;  $p$ s  $< .001$ ). 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.

*Keywords:* child, parent, family meal, mealtime routines, nutrition, eating

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## 1 Introduction

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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*.

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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.

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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 and colleagues (2018) identified six mealtime routines that are linked

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

## 32 **1.1. Research Gaps**

### 33 **1.1.1 Validation of the Mealtime Routines**

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

### 40 **1.1.2 Relationship Between Family Mealtime Routines**

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

49           Studies that went beyond a single routine all turned to the relationship of media use and  
50 mealtime atmosphere. In summary, media consumption in general and mealtime atmosphere have  
51 been found to be negatively correlated. More specifically, TV consumption at family meals was  
52 negatively associated with mealtime atmosphere (Trofholz et al., 2017); restaurant meals with  
53 family and friends were less enjoyable and associated with a lower sense of well-being when  
54 smartphones lay on the table (Dwyer et al., 2018), and general media use was related to lower  
55 quality of family communication (Fulkerson et al., 2014). In contrast, link between mealtime  
56 atmosphere and the meal's duration has received scant attention: One diary study showed that the  
57 duration of a face-to-face social interaction predicted participants' happiness (Vlahovic et al.,  
58 2012), and there are indications that this finding generalizes to the duration of social interaction  
59 at family meals and positive atmosphere (Feunekes et al., 1995).

### 60 **1.1.3 Family Mealtime Routines and Children's Diet Quality**

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

### 73 **1.1.4 Experimental Manipulation of Mealtime Atmosphere**

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

### 85 **1.2 Hypotheses and Research Questions**

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

97 models and empirical studies on the relation between different mealtime routines, our  
98 examination of the other links between the seven different family mealtime routines was  
99 inevitably exploratory.

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

## 106 **2 Methods**

### 107 **2.1 Transparency and Openness**

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

### 113 **2.2 Design and Procedure**

114 Adult participants were recruited via telephone from forsa.omninet panel, an internet panel  
115 that is representative of the German population aged 14 and over. To be eligible, participants  
116 needed to have at least one child between 3 and 17 years old. Only one parent per family  
117 participated in the study. This parent was instructed to answer the questionnaire in relation to  
118 themselves and to one child of the family. If there was more than one child in the family, the  
119 parent was asked to answer with respect to the child with the most recent birthday (the 'index  
120 child'). After giving informed consent, participants answered an entry questionnaire and then

121 were randomly assigned to one of three experimental groups (see details below). Over the next 7  
122 consecutive days all participants answered identical questions about their mealtime routines every  
123 day between 6 pm and midnight. Participants could receive a maximum reward of €10 for taking  
124 part in the study: €1.50 for answering the first questionnaire and another €1 for each additional  
125 questionnaire answered, and if they answered all seven questionnaires, a bonus of €2.50.

## 126 **2.3 Measures**

### 127 **2.3.1 Entry Questionnaire**

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

### 135 **2.3.2 Daily Questionnaires**

136 **Meal Characteristics.** Family meals are here defined as meals in which at least one parent  
137 eats breakfast, lunch, dinner, or any other meal together with at least one child (i.e., the index  
138 child). We thus took the substantial number of single-parent or working-parent households into  
139 account (Middleton et al., 2020). This definition is in line with theoretical frameworks focusing  
140 on what families *do* (e.g., how they eat) rather than how they *look* (e.g., their socioeconomic  
141 status). First, parents described the characteristics of the meal as follows: most important family  
142 meal of the day (answer options: breakfast, lunch, dinner, other meals, and no meal), meal  
143 participants (e.g., mother, father, others), location (e.g., at home, restaurant, other); and whether  
144 their child had eaten the same or a different dish from the adults (5-point scale of 1 = *ate*

145 *something completely different* to 5 = *ate the same dish as the adults*). If they reported not having  
146 had a family meal, they received no further questions that day.

147 **Mealtime Routines.** Participants reported on different routines of their most important  
148 family meal of the day (based on the meta-analysis by Dallacker et al., 2019). Media  
149 consumption during the meal was assessed by asking participants if the TV was on during the  
150 meal (5-point Likert scale of 1 = *yes, all the time* to 5 = *no, at no time*; adapted from Horodynski  
151 et al., 2010). Equivalent questions were asked for smartphone use. Atmosphere during the meal  
152 was measured with four items (Cronbach's  $\alpha = .82$ ), asking about perceived mealtime  
153 atmosphere, parent's satisfaction with the meal, enjoyment of the meal, and child's mood during  
154 the meal on a 5-point Likert scale (1 = *very negative* to 5 = *very positive* or 1 = *not at all* to 5 =  
155 *much enjoyed/very satisfied*). Parental modeling was assessed in two ways: (1) Participants were  
156 asked if they had deliberately eaten fruit or vegetables during the meal to be a role model for their  
157 child (5-point Likert scale from 1 = *not at all* to 5 = *very much*, adapted from Musher-Eizenman  
158 & Holub, 2007); (2) they reported their own fruit and vegetable intake during the meal (from "0"  
159 to "4.5 or more portions" in steps of 0.5 portions; adapted from Harris & Ramsey, 2015).  
160 Involvement was measured by asking how the index child had helped or was involved in  
161 preparing the meal (5-point Likert scale from 1 = *did not help/was not involved at all* to 5 =  
162 *helped a lot/was very involved*; adapted from Chu et al., 2013); this question was only asked if  
163 the most important meal was eaten at home or a friend's/relative's house. Duration of a meal was  
164 self-measured and then reported in minutes (open answer). Quality of a meal was assessed by  
165 asking if the food was homemade (yes/no; adapted from Sweetman et al., 2011).

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

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

### 174 **2.3.3 Final Questionnaire**

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

## 178 **2.4 Experimental Manipulation**

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

## 187 **2.5 Participants**

188           A total of 351 parents took part in the study; 41 parents who completed fewer than two  
189 questionnaires over the study week were excluded. The final sample comprised 310 participants.  
190 Parents ranged in age from 18 to 76 ( $M=41.6$ ,  $SD=7.0$ ) and children from 3 to 17 years ( $M=8.9$ ,  
191  $SD=4.18$ ). Gender distribution was similar for children and parents such that about half were  
192 girls/mothers. Of all parents, 58% reported not having a university degree. The BMI for parents

193 and children ranged widely: children's z-BMI from -5.46 to 3.44 and parents' BMI from 17.26 to  
194 48.44 (for detailed sample characteristics see Table 1).

## 195 **2.6 Statistical Analyses**

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

## 212 **3 Results**

### 213 **3.1 Descriptive Statistics**

214 Parents rated their child's eating behavior during the study week as "rather typical" ( $M =$   
215 4.98,  $SD = .80$  on a 6-point scale). On average, families described dinner as the most important  
216 family meal. The family meals usually took place at home (see Table 2 for details).

### 217 **3.2 Frequency of Mealtime Routines**

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

233 Next, we calculated how the different routines varied within one family over 7 days versus  
234 between families using multilevel intercept-only models (see Figure 2). All routines except  
235 parental modeling varied more within families than between families (within-family variance:  
236 42.8%–95.5%; between-families variance: 4.5%–57.2%). To account for this large share of  
237 within-family variance, we use multilevel modeling in the following analyses.

### 238 **3.3 Relation Between Mealtime Routines**

239 Table 3 shows the mean correlation between routines, averaged over all study days, as  
240 well as the respective minimum and maximum correlations (i.e., the highest and the lowest

241 correlation on any of the study days). The highest mean correlation was observed between  
242 mealtime duration and atmosphere ( $r = .25$ ), followed by mealtime atmosphere and child's  
243 involvement in meal preparation ( $r = .15$ ). In general, the associations between different meal  
244 routines are rather small and even though they show a notable variability between the individual  
245 study days, the variability in correlations for weekdays versus weekends was very small (see  
246 supplementary material for individual correlation tables; to exclude bias due to experimental  
247 manipulation, graphs and tables for frequency and relations are also provided separately for the  
248 three groups in the Supplementary Materials. All results with the passive control group only are  
249 comparable in effect size and direction.).

### 250 **3.4 Prediction of Children's Fruit and Vegetable Intake**

251 To test whether family mealtime routines predict children's fruit and vegetable intake, a  
252 random intercept model was specified. Fruit and vegetable intake (i.e., the sum of eaten portions  
253 of fruits and vegetables during the meal) was used as the dependent variable. Predictors were  
254 atmosphere, involvement, duration, modeling (deliberate modeling as well as the sum of parent's  
255 fruit and vegetable intake), homemade, TV and smartphone. Further, we controlled for the sum of  
256 offered portions of fruits and vegetables, weekday versus weekend, and intervention group  
257 membership. The results show a significant predictive effect of the implicit measure of parental  
258 modeling—parental fruit and vegetable intake ( $p < .001$ ,  $R^2 = .52$ )—and positive mealtime  
259 atmosphere ( $p < .001$ ,  $R^2 = .10$ ) on fruit and vegetable intake of children (see Table 4). The  
260 coefficients remain largely unchanged in size, direction, and statistical significance when further  
261 controlling for children's age, gender, and BMI  $z$  score, or parent's educational level, household  
262 income, and being the nutritional gatekeeper.

### 263 **3.5 Manipulation of Mealtime Atmosphere**

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

#### 275 **4 Discussion**

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

282 All mealtime routines were reported to be practiced, even though frequency differed  
283 substantially. Specifically, we found that in contrast to media reports, the consumption of TV and  
284 smartphone use played a very small role at the family meal table, with reported use below 10%.  
285 Similarly, mealtime atmosphere was rather positive to very positive in over 90% of the meals per  
286 family. In addition, 87% meals were reported to be homemade. In contrast, children's  
287 involvement in meal preparation and parental modeling occurred, on average, considerably less

288 frequently in about 50% of meals. Longer duration of a meal occurred in only about 25% of  
289 reported meals. Importantly, the average family used more than 4 mealtime routines per meal,  
290 which underlines the importance of studying different mealtime routines at the same time.  
291 Overall, the routines are rather the rule rather than the exception. Importantly, these patterns of  
292 use emerged consistently across the three experimental groups.

293         Conducting the study across 7 consecutive days allowed us to examine the day-to-day  
294 differences in the practice of the different mealtime routines. Except for parental modeling, all  
295 routines showed much larger variability within than between families. This means that many  
296 differences in family meals will likely not be detected between families but rather within families  
297 over the course of a typical week. This underlines the value designs with consecutive data  
298 collection in this research.

299         Another goal was to understand whether the family mealtime routines identified to date  
300 represent distinct or overlapping behaviors. The small correlations between the seven routines  
301 suggest that their distinct nature. In contrast to Hypothesis 2a and previous research (Trofholz et  
302 al., 2017), we found only minimal correlations between mealtime atmosphere and media  
303 consumption. The correlation between atmosphere and TV consumption across all survey days  
304 was very small but in the expected negative direction; the correlations with smartphone  
305 consumption were near zero. One likely explanation for these findings could be the little variance  
306 regarding norms and behaviors pertaining to media use at the meal table in our sample: In over  
307 90% of the reported meals, TVs and smartphones were turned off. There are likely to be notable  
308 cultural differences. Even though family culture in Germany seem to mostly ban the use of media  
309 during meals, having the TV turned on during meals is very common in other European countries  
310 such as Greece and Portugal (Roos et al., 2014). Further, self-report of media use and atmosphere

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

313         Supporting Hypothesis 2b, we found the largest correlations between family mealtime  
314 routines for atmosphere and duration, corroborating past preliminary research (Feunekes et al.,  
315 1995; Vlahovic et al., 2012). Surprisingly and contrary to Hypothesis 2c, we found a very small  
316 relation between children's involvement in meal preparation and the meal being prepared at  
317 home. One may expect that the involvement of children in the preparation of dinner would be  
318 higher if the meal was homemade. A possible explanation could again be the small variance in  
319 meal preparation: Nearly all meals were prepared at home.

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

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

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

357 **Limitations, Strengths, and Future Research**

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

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

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

378 Our diary study focused on the mealtime routines obtained as predictors for nutritional  
379 health that Dallacker et al. (2019) obtained. We extended TV use during mealtimes by adding  
380 smartphone use. In future research it would be interesting to extend the list of routines.  
381 Candidates include the availability and frequency of fruit and vegetable portions at the family

382 meal. While this variable was treated as a control variable in the current study, understanding  
383 what predicts the number of portions offered as well as also including other indicators of healthy  
384 nutrition could further advance this field of research.

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

### 390 **Conclusion**

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

401

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535

536 **Table 1**537 *Sample Characteristics*

Variable	Parent		Child	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Answered daily questionnaires	5.76	1.34		
Age (in years)	41.61	7.00	8.93	4.18
BMI (kg/m <sup>2</sup> )				
Female	25.28	4.98	-0.40 <sup>a</sup>	
Male	26.51	3.57	-0.49 <sup>a</sup>	
	<i>n</i>	%	<i>n</i>	%
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 2,000 euros	29	9.35		
2,000-2,999 euros	57	18.39		
3000 euros and more	187	60.32		

538 *Note.*  $N = 310$ . Participants who did not provide information are not included in the table;

539 therefore,  $100 - \text{shown percentage values} = \text{percentage of missing responses}$ .

540 <sup>a</sup> Body mass index (BMI)  $z$  scores, which indicate standard deviation from the mean of the

541 population (age-adjusted and calculated based on The Child and Adolescent Health Survey

542 reference data for 2003 to 2006; Neuhauser et al., 2013); 75% of children in this sample were

543 healthy weight, 11% overweight, and 14% underweight.

544 **Table 2**545 *Mealtime Characteristics and Routines (Mean Value per Family, Averaged Across All Families)*

		<i>M</i>	<i>SD</i>	<i>%</i>
Meal type	Breakfast			13.31
	Lunch			24.39
	Dinner			56.79
	Other			0.70
	None			4.81
Others present at the meal	Mother			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 <sup>a</sup>	4.05	0.41	
	Involvement <sup>a</sup>	1.93	0.71	
	Modeling			
	Deliberately <sup>a</sup>	2.49	1.03	
	Fruit and vegetable intake <sup>b</sup>	1.10	0.76	
	TV use <sup>a</sup>	0.31	0.72	
Smartphone use (from 1-5)	0.11	0.24		
Child's nutritional health	Fruit and vegetable intake <sup>b</sup>	0.95	0.66	

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

549 <sup>a</sup> Rated on a scale of 1 to 5.550 <sup>b</sup> Number of fruit and vegetable portions.

551 **Table 3**

552 *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 [-.14, .05]	.03 [-.04, .08]						
4. Involvement	-.06 [-.18, .05]	.03 [-.02, .06]	.15 <sup>+</sup> [.00, .21]					
5. Duration	-.05 [-.10, .00]	.07 [-.04, .22]	.25* [.19, .33]	.10 [.04, .21]				
6. Quality	-.03 [-.12, .05]	-.08 [-.18, .03]	.02 [-.09, .16]	.09 [-.07, .17]	-.14 <sup>+</sup> [-.27, -.06]			
7. Deliberate parental modeling	-.05 [-.08, .07]	-.06 [-.14, .00]	.03 [-.04, .12]	.13 [-.07, .23]	-.03 [-.21, .10]	.05 [-.06, .19]		
8. Veg and fruit parent	-.04 [-.13, .04]	-.06 [-.13, .01]	.18 [.10, .25]	.09 [.02, .18]	.17 [.05, .32]	.14 [-.01, .24]	.13 [.00, .27]	
9. Veg and fruit child	-.04 [-.10, .01]	-.04 [-.18, .08]	.20 <sup>+</sup> [.10, .25]	.12 [.03, .26]	.16 <sup>+</sup> [.07, .28]	.13 [-.03, .23]	.06 [-.14, .20]	.79* [.72, .85]

553 *Note.* Values in square brackets represent minimum and maximum correlations during the 7-day study period. Veg and fruit = Vegetable

554 and fruit intake during the meal.

555 \* $p < .05$  on all 7 study days. <sup>+</sup> $p < .05$  on 4 or more study days.

556 **Table 4**557 *Prediction of Child's Fruit and Vegetable Intake Through Mealtime Routines*

Effect	Estimate	SE	95% CI		p
			LL	UL	
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			

558 *Note.* Total  $N = 305$ . All continuous variables were scaled by dividing the centered columns by their

559 standard deviation to allow comparison of coefficients. Group is dummy-coded with the passive control

560 group as the baseline condition. Veg and fruit = Number of consumed portions of fruits and vegetables

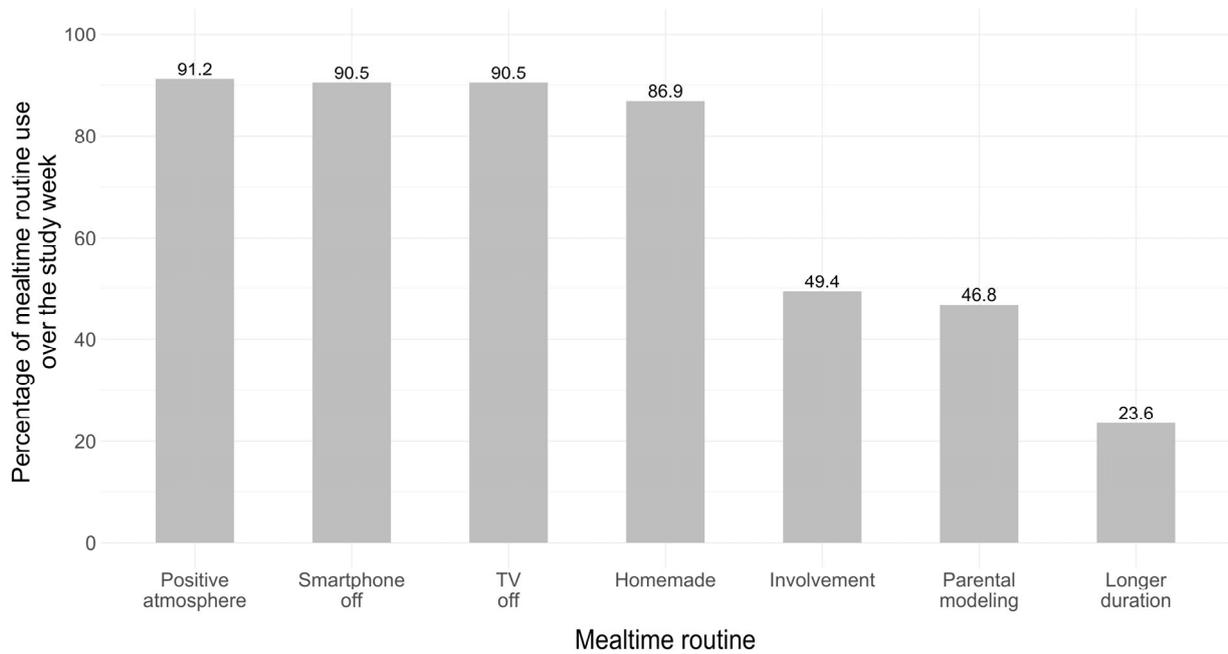
561 during the meal; offered= number of different types of fruit and vegetables offered; CI = confidence

562 interval; *LL* = lower limit; *UL* = upper limit. Conditional  $R^2 = .552$

563

564 **Figure 1**

565 *Percentage of Use of Seven Family Mealtime Routines Averaged Across all Families*



566

567 *Note.* The percentage of use was calculated as frequency of routine use divided by number of

568 total answers for an item (e.g., 7 = item was answered on all 7 days of the study). Smartphone off

569 and TV off = All meals for which “never” (i.e., never on) was the chosen answer category;

570 homemade = all meals where the answer to the item was “yes” (i.e., homemade); positive

571 atmosphere = all meals with an item score >3; longer duration = all meals that took at least 10%

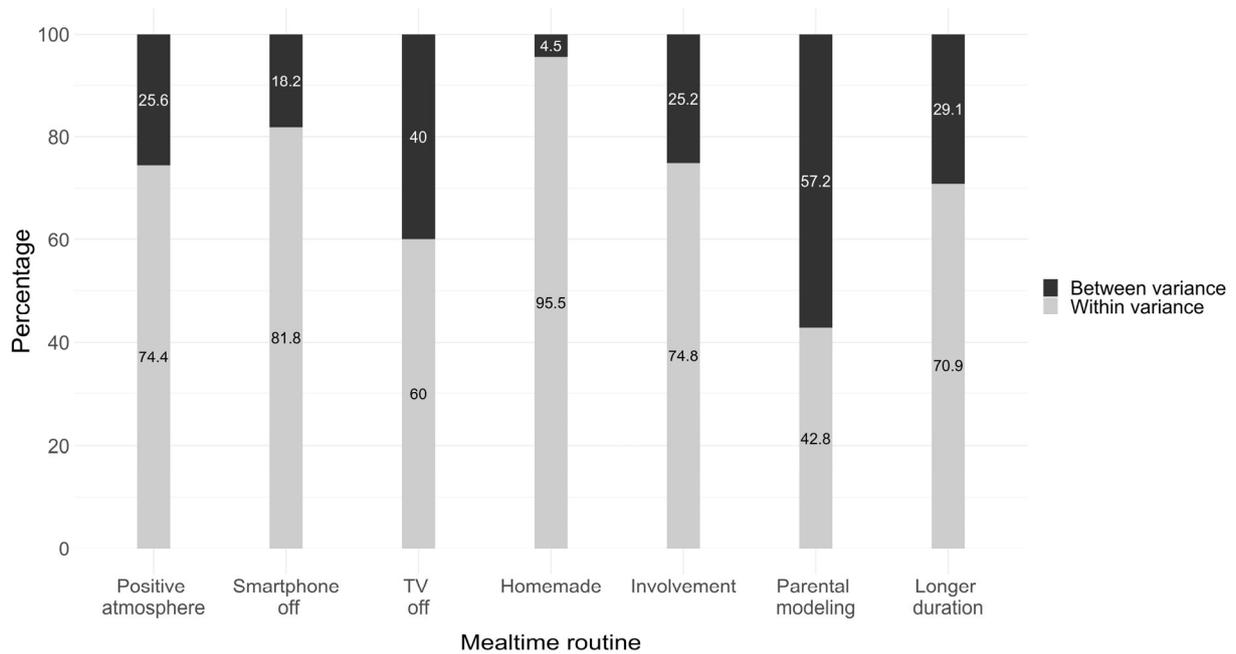
572 longer than the mode (33 min in this sample); involvement = all meals for which the answer was

573 at least “a little involved”; parental modeling = all meals for which the item assessing if fruits and

574 vegetables were eaten deliberately was answered with at least “somewhat true.”

575

576 **Figure 2**



577

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

579 *Note.* Smartphone off and TV off = All meals for which “never” (i.e., never on) was the chosen

580 answer category; homemade = all meals where the answer to the item was “yes” (i.e.,

581 homemade); positive atmosphere = all meals with an item score >3; longer duration = all meals

582 that took at least 10% longer than the mode (33 min in this sample); involvement = all meals for

583 which the answer was at least “a little involved”; parental modeling = all meals for which the

584 item assessing if fruits and vegetables were eaten deliberately was answered with at least

585 “somewhat true.”