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Cross-sectional and longitudinal associations between family meals frequency and children's overweight/obesity in families at high risk of type 2 diabetes: The Feel4Diabetes-study

Lubna Mahmood[1] | Esther M. Gonzalez-Gil[1,2] | Konstantinos Makrilakis[3] | Stavros Liatis[4] | Peter Schwarz[4,5,6] | Sandra Herrmann[4,5,6] | Ruben Willems[7] | Greet Cardon[8] | Julie Latomme[8] | Imre Rurik[9] | Sándorné Radó[9] | Violeta Iotova[10] | Natalya Usheva[10] | Tsvetalina Tankova[11] | Eva Karaglani[12] | Yannis Manios[12,13] | Luis A. Moreno[1,14,15] | on behalf of the Feel4Diabetes-Study Group

[1]Growth, Exercise, Nutrition and Development (GENUD) Research Group, University of Zaragoza, Zaragoza, Spain

[2]Centro de Investigación Biomédica en Red de Fisiopatología de la Obesidad y Nutrición (CIBERObn), Instituto de Salud Carlos III, Madrid, Spain

[3]National and Kapodistrian University of Athens Medical School, Athens, Greece

[4]Paul Langerhans Institute Dresden of the Helmholtz Center Munich at University Hospital and Faculty of Medicine, TU Dresden, Dresden, Germany

[5]Department for Prevention and Care of Diabetes, Medical Faculty Carl Gustav Carus at the Technical University of Dresden, Dresden, Germany

[6]German Center for Diabetes Research (DZD e.V.), Neuherberg, Germany

[7]Department of Public Health and Primary Care, Ghent University, Ghent, Belgium

[8]Department of Movement and Sports Sciences, Ghent University, Ghent, Belgium

[9]Faculty of Health Sciences, University of Debrecen, Debrecen, Hungary

[10]Department of Social Medicine and Health Care Organization, Medical University of Varna, Varna, Bulgaria

[11]Department of Diabetology, Clinical Center of Endocrinology, Medical University of Sofia, Sofia, Bulgaria

[12]Department of Nutrition and Dietetics, School of Health Science & Education, Harokopio University, Athens, Greece

[13]Institute of Agri-food and Life Sciences, Hellenic Mediterranean University Research Centre, Heraklion, Greece

[14]Instituto Agroalimentario de Aragón (IA2), Zaragoza, Spain

[15]Instituto de Investigación Sanitaria de Aragón (IIS Aragón), Zaragoza, Spain

Correspondence
Esther M. Gonzalez-Gil, Growth, Exercise, Nutrition and Development (GENUD) Research Group University of Zaragoza Zaragoza, Spain.
Email: esthergg@unizar.es

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Summary

Background: The frequency of family meals has been suggested as a protective factor against obesity among children.

Objective: This study aimed to investigate the cross-sectional and longitudinal associations between family meals frequency and children's overweight/obesity in families at high risk of type 2 diabetes (T2D) across six European countries.

Methods: 989 parent–child dyads (52% girls and 72% mothers) were included. Participants completed validated measures to assess the frequency of family meals and anthropometrics. Multivariable regression models were applied to examine the

longitudinal associations between family meals frequency and overweight/obesity in children. Logistic regression was performed to predict the odds of having overweight/obesity depending on changes in family meals frequency over a two-year follow-up period. Analyses were stratified for children's sex.

Results: High frequency of family breakfasts and/or dinners was inversely associated with children's BMI in boys and girls at T2. Results showed decreased odds of overweight/obesity at follow-up among both boys (OR = 0.65; 95% CI 0.41, 0.96) and girls (OR = 0.53; 95% CI 0.31, 0.87) who consumed minimum of three times family breakfasts and/or family dinners a week at baseline. An increase in family breakfasts and/or dinners frequency was associated with lower odds of overweight/obesity in both boys and girls at follow-up.

Conclusion: A high frequency of family breakfasts and/or dinners but not lunch during childhood is associated with lower odds of overweight/obesity development in children from families at high risk of T2D. The promotion of family meals could help in preventing the development of overweight/obesity among children.

KEYWORDS

body composition, body mass index, children, family meals frequency, obesity, type 2 diabetes

1 | INTRODUCTION

Childhood obesity is a serious health condition, which has major health consequences and contributes to the onset of type 2 diabetes (T2D) in childhood and adulthood.[1] In addition, obesity among children tends to persist into later life and may increase the risk of obesity during adulthood.[2,3] Parents are carrying a major responsibility for shaping their children's eating habits and dietary environment,[4] having a direct impact on children's food preferences, food consumption and weight status.[3]

One aspect of family life is eating meals together, which has shown social and behavioural benefits for young children.[5] For instance, family meals provide consistency, routine, and opportunity for a better communication between children and their parents,[5] helping children to learn more about nutrition and building adequate eating habits.[5] Family meals frequency is positively associated with children's diet quality (DQ)[3] such as a higher fruit and vegetables (FV),[5] whole grains and calcium consumption.[6] Similarly, several longitudinal studies have shown that children having 3–5 times family meals per week had also higher intakes of FV, calcium and fibre-rich foods.[7,8]

In addition, previous research suggests that family meals are one of the most important potential factors in protecting against childhood obesity through targeting their dietary behaviours.[9,10] A meta-analysis found a 12% reduction in overweight among children who used to have family meals three or more times per week.[11] Likewise, some longitudinal and cross-sectional studies found that having frequent family meals was associated with reduced risk of obesity.[12,13] Similarly, a cross-sectional study of family dinners frequency among American children showed that family dinners frequency measures were inversely associated with children's body composition measures.[14] Recent studies also found that children with normal body weight share family meals more frequently in comparison with children with obesity.[11,13,15,16] Moreover, one longitudinal study of school children in Finland determined that high frequency of family meals predicted a lower body mass index (BMI) 2 years later.[16] Although the association between family meals in general and obesity in children has been sufficiently demonstrated, there is less known about which meal impacts children's food consumption and weight status most. Such information is however crucial to develop targeted nutrition interventions.[11,12]

It has been shown that children of parents with insulin resistance (IR) are more likely to develop obesity and IR compared to children of non-IR parents.[17] Recently, it has been found that European children from families at high risk of developing T2D have low frequency of family meals.[18] Besides, results of a large multicentred European study showed that children born to IR parents and at risk of T2D were more likely to have unhealthy dietary patterns.[19] Thus, assessing families at high risk of T2D who potentially have already unhealthy lifestyle behaviours could help to identify modifiable factors in the family meals' structure that can protect against overweight/obesity and to get a better insight into this specific population.

To date, despite the growing interest in this topic, most of the studies looking at the association between family meals and children's body weight presented findings considering only healthy subjects, or only one of the genders, social class, and race/ethnicity. To our knowledge, studies assessing the relationship between family meals frequency and their impact over time on children's BMI in European populations at high-risk to develop T2D are missing. Therefore, the present study aims to investigate the cross-sectional and longitudinal associations, over a two-year follow-up, between the frequency of family meals and children's overweight/obesity in families at high risk of developing T2D across six European countries.

2 | METHODS

2.1 | Study design

The European Feel4Diabetes study developed a community-based intervention, aimed to promote healthy lifestyle and tackle obesity and obesity-related metabolic risk factors for the prevention of T2D among families from vulnerable groups. The study was implemented between 2016 and 2018, with data collection at baseline in 2016 (T0) and at 1 (T1) and 2 years (T2) follow-up. The six European countries involved in the study were categorized as countries under austerity measures following the economic crisis (Greece and Spain), low-income countries (Bulgaria and Hungary), and high-income countries (Belgium and Finland). For the recruitment of families, primary schools were used as the entry-point to the community in each selected province. Children of 1st, 2nd and 3rd grade and their parent(s) were invited to participate in the study, with 11 396 families enrolling at baseline. More details on the general procedures, recruitment strategy and the study protocol can be found elsewhere.[20]

Families were seen as "High-risk families" when at least one parent was identified by the Finnish Diabetes Risk Score (FINDRISC) as being at risk of developing T2D.[19] The FINDRISC score is obtained based on eight questions related to age, waist circumference (WC), BMI, consumption of FV, physical activity, history of high blood glucose, family history of diabetes, and the use of antihypertensive medication.[21]

Families assigned to the intervention group were invited to participate in a 2-year intervention plan to promote a healthier lifestyle. During the first year, behavioural change approaches were used in the counselling sessions to promote motivation and self-efficacy, improve self-regulation, and develop objectives to adopt a healthier and more active lifestyle. A more complete summary of the counselling sessions' content may be obtained elsewhere.[20] The intervention during the second year intended to sustain the improvements made during the first year of intervention, therefore it was less intensive than the first. Parents got motivating advice via text messages delivered to their cell phones during the second year.

All countries involved in the study provided good clinical practices and followed the conventions of the council of Europe on human rights and biomedicine as well as the ethical guidelines of the Declaration of Helsinki. Ethical approval was obtained in each country involved in the study: Spain (CP03/2016), Greece (46/3-4-2015), Finland (174/1801/2015), Belgium (B670201524237), Bulgaria (52/10-3-201r), and Hungary (20095/2016/EKU). All parents were informed about the purpose of the study, and signed a written informed consent for their participation, which gave them the chance to withdraw from the study at any point. The Feel4Diabetes-study is registered within the clinical trials registry (NCT02393872).

2.2 | Study sample

For this study, parent–child dyads including a parent at risk of T2D were included. All dyads with full anthropometric measurements and completely filled out questionnaires for both the parent and the child at baseline and T2, were included in the study. Since some families participated with more than one child, we randomly selected one child per family in order not to duplicate parental information. Parents were randomly selected in those families with both parents at risk of T2D according to FINDRISC. Due to the longitudinal nature of the study and the fact that the availability of data from the same parent–child dyad at both time points was mandatory for inclusion, from the 2748 high-risk families that were identified and measured at baseline, 989 parent–child dyads had complete data at both time points for inclusion in this study.

2.3 | Dietary assessment

Two self-reported questionnaires (i.e., the food frequency and eating behaviour questionnaire and the energy balance-related behaviour questionnaire) were filled out by one of the parents, who completed the questionnaires both for him/herself and their child. The frequency of family meals was measured individually for each meal occasion (i.e., breakfast, lunch, and dinner), and it was assessed through the question: "How often does your child have the following meals with the family?", which could be answered by choosing one of the following options: never, less than 1 time/week, 1–2 times/week, 3–4 times/week, 5–6 times/week, and daily.

2.4 | Anthropometric measurements

Anthropometric measurements were conducted according to standardized protocols.[22] In children, weight was measured by Seca 813 digital flat scale and recorded to the nearest 0.1 kg, and standing height was measured by Seca 217 stadiometer for mobile height measurement and recorded to the nearest 0.1 cm. Height and weight were measured while children were barefoot and head in the Frankfurt plane with light clothing. The BMI of parents and children was calculated by dividing body weight (kg) to height squared (m^2). Parental BMI was calculated based on their self-reported weight and height, while, children's BMI was calculated based on their objective weight and height which were measured at schools by trained researchers. Two readings were obtained for each measurement and the mean was used for the analysis. Children's changes in BMI (ΔBMI = BMI T2 – BMI T0) were calculated, and BMI z-scores were calculated for children according to Cole et al.[23] to obtain an optimal measure for their weight in accordance with their sex and age, the International Obesity Task Force (IOTF) cut-off points[23] were used to categorize children as having "normal weight", "overweight", or "obesity".

2.5 | Parental demographic characteristics

Information on demographic characteristics of the parents included in the present study was considered. The marital status of parents was

obtained by questionnaire, and the responses included five choices: "single", "married or cohabiting", "separated or divorced", "widowed", and "other". Regarding the employment status, parents were asked to identify their main occupation over the last 6 months, and 7 answer possibilities were included: "stay at home parent", "work full-time", "work part-time", "unemployed", "full-time education", "retired", "something else". The education level of parents was also obtained and responses could range from "less than 7 years" to "more than 16 years" of education, with a six-point scale response option.

2.6 | Diet quality

The DQ of parents and their children was assessed by the Healthy Diet Score (HDS). The HDS is a validated indicator developed for adults and was tested before over families at high-risk of T2D.[24] For this study, we adapted the scores for adults with the information available from the children. In this context, the component of oil and fats included only the cooking oil and fats, and the components of nuts and seeds were not included.[19] The dietary goals set in Feel4Diabetes intervention related to food behaviour and food choices were used as the basis for the HDS. The main components of the HDS include family meals, breakfast, whole-grain cereals, low-fat dairy products, red meat, vegetables, fruits and berries, nuts and seeds, oils and fats, sweet snacks, salty snacks, and sugary drinks.

For parents, a maximum score of 6 was given to the consumption of low-fat dairy products, nuts and seeds, salty snacks, and sweet snacks. A maximum score of 8 was given to the frequency of family meals as well as the consumption of oils and fats. The rest of the components got a maximum score of 10. For children, a maximum score of 4 was given to the cooking oils and fats component. A maximum score of 6 was given to sweet snacks, salty snacks and low-fat dairy. The frequency of family meals was given a maximum score of 8. The rest of the components got a maximum score of 10. The total score, calculated as the sum of the component scores, was ranging from 0 to 100 for parents, and from 0 to 86 for children, in which higher scores indicating better DQ. More information about HDS has been described in detail elsewhere.[19,24]

2.7 | Statistical analysis

Descriptive data on participants' characteristics are presented as percentages or means for categorical or continuous variables, respectively. The normal distribution of variables was checked by Kolmogorov–Smirnov test. Since sex interactions were observed in the associations between dietary habits and weight status among children, analyses were stratified by sex. Student's *t*-tests were used to compare means of continuous variables by sex, and Pearson's chi-square test was used in the case of categorical variables.

Multivariable regression models were used to examine the cross-sectional associations between family meals frequency and children BMI at baseline and T2, while adjusting for country, group (intervention-control), age and DQ of children, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI). Multivariable regression model was also used to study the longitudinal associations between the changes in the frequency of family meals from T0 to T2 and the changes over time in children's BMI. The model was adjusted for country, group (intervention-control), age and DQ of children, and parental characteristics (age, marital status, educational level, employment, sex, DQ, BMI) as well as family meals frequency and BMI of children at baseline.

Multilevel logistic regression was performed to predict the odds for children having overweight or obesity at T2 depending on family meals frequency at baseline, considering group (control vs. intervention) and country as levels to account for the study design, and adjusting for children's age, DQ, and BMI at baseline, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI change between baseline and T2). Out of the responses given in the Food frequency questionnaire (FFQ): (never, less than 1 time/week, 1–2 times/week, 3–4 times/week, 5–6 times/week, and daily), three categories of family meals frequency were created out of them and used as independent variables: "Never", "one to two times per week", and "three to seven times per week". BMI categories (normal weight, overweight, and obesity) were considered as dependent variables.

Finally, multilevel logistic regression models were also used to examine the prospective association between the following: (1) changes in family meals frequency over 2 years and children's BMI at T2, in which five categories of family meals frequency were created: (never, remained low, decreased, increased, remained high), and "never" was considered as a reference. While the BMI were categorized as follows: (normal weight, overweight/obesity). The group (control vs. intervention) and country were considered as levels, and the model was adjusted for children's age, DQ, and BMI at baseline, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI). (2) Changes in family meals frequency and changes in BMI from T0 to T2, in which the five categories of family meals frequency remained the same (never, remained low, decreased, increased, remained high). BMI change was categorized from better to worse as: normal weight at T0 and T2, overweight/obesity at T0 but normal weight at T2, normal weight at T0 but overweight/obesity at T2, overweight/obesity at T0 and T2. The model was adjusted for children's age and DQ, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI).

Statistical analyses were carried out using IBM-SPSS (Version 26.0. Armonk, NY: IBM Corp), except for the logistic regression model, which was conducted using Stata/SE 13 (Stata Corp LP, College Station, TX), with a $p < 0.05$ representing statistical significance for all tests.

3 | RESULTS

3.1 | Characteristics of study participants

Demographic and anthropometric characteristics of children and parents at T0 are presented in Table 1. Overweight/obesity was measured in 32% of the boys and 36% of the girls (sex difference: $p = 0.163$).

TABLE 1 Characteristics of the study participants at baseline (T0)

Characteristics	Parents	Children		
		Boys ($n = 480$)	Girls ($n = 509$)	p-value
Age (in years)	38.98 (5.24)	7.3(0.99)	7.4 (1.02)	0.968
Sex (female%)	72%	-	52%	-
Education level (% high education*)	73%	-	-	-
Employment status (% employed)	62%	-	-	-
Marital status (% married)	79%	-	-	-
Body weight (kg)	77.1 (17.1)	30.5 (7.9)	29.4 (7.8)	**0.020**
Height (cm)	165.9 (8.4)	131.2 (8.0)	130.3 (7.5)	**0.022**
BMI (kg/m^2)	27.8 (5.52)	17.65 (2.9)	17.59 (8.2)	0.287
BMI categories (%)				
Normal	37.5%	68.3%	63.1%	0.163
Overweight	35%	21%	25.1%	
Obesity	27.5%	10.6	11.6%	
BMI z-score	-	0.64 (1.1)	0.72 (1.1)	0.753
Family breakfast frequency	-			
Never or less than 3 times/week	59.1%	42.5%	34%	**0.036**
3–7 times/week	40.9%	57.5%	66%	
Family lunch frequency				
Never or less than 3 times/week	38.7%	50.5%	52.3%	0.261
3–7 times/week	61.3%	49.5%	47.7%	
Family dinner frequency				
Never or less than 3 times/week	19.2%	6.4%	6.9%	**0.018**
3–7 times/week	80.8%	93.6%	93.1%	
Healthy Diet Score (HDS)				
≤50	27.5%	38.4.7%	35.7%	**0.044**
>50	72.5%	61.6%	64.3%	

Note: $N = 989$ parents and children. This table provides mean (SD) for the continuous variables and frequency (%) for the categorical variables. Boldface indicates statistical significance between sexes at $p < 0.05$. *13–14 years of education or more. *Higher HDS indicates better diet quality. BMI, body mass index. BMI z-scores were calculated according to Cole et al.

3.2 | Cross-sectional associations between family meals frequency and BMI of children at baseline and follow-up

Family dinners frequency at baseline was inversely associated with children's BMI in boys ($\beta = -0.182$, $p = 0.021$) and girls ($\beta = -0.124$, $p < 0.001$), while no such associations were found for family breakfasts and/or lunches frequency (Table 2). The same holds true at T2, with the exception that a significant inverse association was also found between family breakfasts frequency and children's BMI for both boys and girls.

3.3 | Longitudinal associations between changes in family meals frequency and changes in children's BMI over time

When family meals frequency and BMI of children at baseline were included as covariables, it has been found that the increase in family breakfasts frequency was negatively associated with changes in BMI in girls ($\beta = -0.078$, $p = 0.035$) only (Table 3). No association was found with change in family lunches frequency and BMI change over time. Regarding family dinners frequency, the increase in family dinners frequency was inversely associated with changes in BMI of boys ($\beta = -0.102$, $p = 0.019$) and girls ($\beta = -0.198$, $p < 0.001$).

3.4 | Odds ratios of overweight/obesity status at T2 among children by baseline family meals frequency

The odds of having overweight/obesity are decreased for boys (OR = 0.76; 95% CI 0.52, 1.04) and girls (OR = 0.72, 95% CI 0.58, 0.93) who consumed family breakfasts three to seven times a week at baseline, compared to those who never had breakfasts with family (Table 4). In general, family lunches frequency was not associated with the odds of overweight/obesity among boys and girls. On the other hand, having three or more family-shared dinners per week at baseline

TABLE 2 Cross-sectional associations between family meals frequency and BMI of children at baseline (T0) and at 2nd follow-up (T2)

	Boys		Girls	
	β	*p*-value	*β*	*p*-value
Family meals frequency (T0)	**BMI of children (T0)**			
Breakfast	−0.073	0.063	−0.039	0.122
Lunch	0.024	0.202	−0.008	0.235
Dinner	**−0.182**	**0.021**	**−0.124**	**<0.001**
Family meals frequency (T2)	**BMI of children (T2)**			
Breakfast	**−0.217**	**0.033**	**−0.155**	**0.026**
Lunch	−0.094	0.301	−0.064	0.323
Dinner	**−0.191**	**0.004**	**−0.142**	**0.009**

Note: $N = 989$ parents and children. Boldface indicates statistical significance at $p < 0.05$. Regression analyses were adjusted for country, group (intervention-control), age and DQ of children, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI). In each shared meal occasion, the frequency was categorized as (never, 1–2 meals/week, and ≥3 meals/week). *β*, standardized coefficient. BMI, body mass index.

TABLE 3 Associations between changes in family meals frequency (T0–T2) and changes in BMI of children (T0–T2)

	Δ BMI of children			
	Boys		Girls	
	β	*p*-value	*β*	*p*-value
Δ Family meals frequency				
Breakfast	−0.051	0.066	**−0.078**	**0.035**
Lunch	−0.041	0.189	−0.085	0.214
Dinner	**−0.102**	**0.019**	**−0.198**	**<0.001**

Note: $N = 989$ parents and children. Boldface indicates statistical significance at $p < 0.05$. Regression analyses: adjusted for country, group (intervention-control), age of children and DQ, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI), with additional adjustments for family meals frequency and BMI of children at baseline. β, standardized coefficient; BMI, Body Mass Index.

was significantly associated with reduced odds of having overweight/obesity (OR = 0.65; 95% CI 0.41, 0.96) 2-years later in boys compared with those who never shared family dinners during childhood. In addition, girls who had family-shared dinners three to seven times a week at baseline had 34.6% decreased odds of having overweight and obesity 2-years later compared with girls who never had family-shared dinners at baseline.

3.5 | Associations between changes in family meals frequency (T0 to T2) and BMI categories at T2

Results from multilevel logistic regressions indicated that the increase in family meals frequency over time was associated with decreased odds of overweight/obesity among boys and girls at T2 (Table 5). Increased family breakfasts frequency over time was associated with lower odds of overweight/obesity in boys (OR = 0.78; 95% CI: 0.52–1.11) and girls (OR = 0.78; 95% CI: 0.55–1.01). However, no association was indicated between changes in family lunches frequency and the odds of overweight/obesity over time. Boys and girls that improved family-shared dinners over time showed lower odds of overweight/obesity at T2 (35% vs. 37.8%, respectively).

3.6 | Associations between changes in family meals frequency (T0 to T2) and BMI categories (at T0 and T2)

As shown in Table 6, an increase in the family meals frequency over time was associated with decreased odds of being in a higher outcome category of BMI over time. Specifically, boys and girls whose family breakfasts frequency increased were more likely to have lower BMI values (boys: OR = 0.68; 95% CI: 0.49–0.91; girls: OR = 0.69; 95% CI: 0.34–0.92) than those with a decreased frequency of family breakfasts. A similar association was found between a change in family dinner frequency and the odds of overweight/obesity in boys (OR = 0.57; 95% CI: 0.39–0.83) and girls (OR = 0.69; 95% CI: 0.42–0.91). On the other hand, no associations were observed between changes in the frequency of family lunches and BMI categories of children.

4 | DISCUSSION

The present study found that a high frequency of family meals consumption, especially breakfasts and/or dinners, but not lunch, is inversely associated with BMI in children cross-sectionally, at baseline and at follow-up. Also, having family-shared breakfasts and/or dinners three or more times per week at baseline was significantly associated with reduced odds of overweight/obesity at year 2 of follow-up. Moreover, the increase in the frequency of family breakfasts and/or dinners during a period of 2 years was associated with lower odds of overweight/obesity over time in boys and girls from families at high risk of developing T2D.

Results from this study suggest that girls tend to consume more meals with the family than boys. It is noteworthy that no previous research has assessed family meals frequency by children's sex, thus, a direct comparison could not be made. One explanation might be gender differences in dietary and social behaviours. Girls may for instance have more involvement in cooking with mothers and other food-related tasks including meals preparation and setting the dining table.[25] Moreover, according to Keller et al, girls enjoy more meals gathering with family and friends compared to boys, and these differences could be noticed in early childhood.[26] In this context, a cross-sectional study on UK children reported that boys were found to eat less with family, as they tend to eat more meals out, and they consumed more takeaway meals compared to girls.[27]

TABLE 4 Odds ratios of overweight/obesity status at (T2) among children by baseline family meals frequency (longitudinal)

	Overweight/obesity status (T2)			
	Boys		Girls	
Baseline family meals frequency	OR	(95% CI)	OR	(95% CI)
Breakfast				
Never	Ref.		Ref.	
One to two times per week	1.12	(0.79, 1.23)	1.06	(0.81, 1.22)
Three to seven times per week	0.76*	(0.52, 1.04)	0.72*	(0.58, 0.93)
Lunch				
Never	Ref.		Ref.	
One to two times per week	1.07	(0.73, 1.27)	1.13	(0.67, 1.78)
Three to seven times per week	1.11	(0.86, 1.57)	1.07	(0.48, 1.67)
Dinner				
Never	Ref.		Ref.	
One to two times per week	0.78*	(0.46, 0.98)	0.68*	(0.45, 0.96)
Three to seven times per week	0.65*	(0.41, 0.96)	0.53**	(0.31, 0.87)

Note: $N = 989$ parents and children. In the regression analysis, group (control vs. intervention) and country were considered as levels to account for the study design and adjusted for children's (BMI at baseline, age, and DQ), and parental characteristics (age, marital status, education level, employment, sex, DQ, and changes in BMI). OR, odds ratio; CI, confidence interval. Ref, reference category; BMI, body mass index. Statistical significance indicated at (*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$). The category (never) was considered as a reference.

TABLE 5 Associations between changes in family meals frequency over time (T0–T2) and BMI of children at (T2)

	BMI of children at T2			
	Boys		Girls	
Δ Family meals frequency	OR	(95% CI)	OR	(95% CI)
Breakfast				
Never	Ref.		Ref.	
Remained low	1.03	(0.77, 1.29)	1.01	(0.88, 1.18)
Decreased	1.02	(0.75, 1.30)	1.04	(0.73; 1.27)
Increased	0.78*	(0.52, 1.11)	0.78**	(0.55, 1.01)
Remained high	0.91	(0.69, 1.22)	0.92	(0.61, 1.08)
Lunch				
Never	Ref.		Ref.	
Remained low	1.04	(0.79; 1.18)	1.01	(0.77, 1.19)
Decreased	1.03	(0.66, 1.31)	1.03	(0.71, 1.28)
Increased	0.88	(0.69; 1.18)	0.88	(0.63, 1.22)
Remained high	0.88	(0.55, 1.24)	0.77	(0.59, 1.17)
Dinner				
Never	Ref.		Ref.	
Remained low	1.08	(0.77, 1.31)	1.03	(0.71; 1.41)
Decreased	1.03	(0.81, 1.29)	1.07	(0.81, 1.35)
Increased	0.54*	(0.33, 0.83)	0.61**	(0.40, 0.97)
Remained high	0.79	(0.51, 1.35)	0.84	(0.59, 1.27)

Note: $N = 989$ parents and children. In the regression analysis, group (control vs. intervention) and country were considered as levels to account for the study design and adjusted for children's (BMI at baseline, age, and DQ), and parental characteristics (age, marital status, education level, employment, sex, DQ, and BMI). OR, odds ratio; CI, confidence interval; BMI, body mass index. Statistical significance indicated at (*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$). The reference category is "never". BMI categories from better to worse (normal weight, overweight/obesity).

TABLE 6 Associations between changes in family meals frequency and changes in BMI over time (T0–T2)

	BMI categories (T0 to T2)			
	Boys		Girls	
Δ Family meals frequency	OR	(95% CI)	OR	(95% CI)
Breakfast				
Never	Ref.		Ref.	
Remained low	1.02	(0.83, 1.16)	1.01	(0.67, 1.21)
Decreased	1.03	(0.72, 1.31)	1.05	(0.65, 1.18)
Increased	0.68*	(0.49, 0.91)	0.69*	(0.34, 0.92)
Remained high	0.85	(0.66, 1.00)	0.64	(0.47, 0.92)
Lunch				
Never	Ref.		Ref.	
Remained low	1.04	(0.57; 1.22)	1.03	(0.77; 1.18)
Decreased	1.05	(0.77; 1.38)	1.02	(0.68, 1.20)
Increased	0.85	(0.53, 1.25)	0.68	(0.42, 1.07)
Remained high	1.02	(0.77, 1.24)	0.98	(0.71, 1.19)
Dinner				
Never	Ref.		Ref.	
Remained low	1.04	(0.83, 1.18)	1.07	(0.82, 1.18)
Decreased	1.02	(0.87, 1.23)	1.02	(0.81, 1.28)
Increased	0.57*	(0.39, 0.83)	0.69*	(0.42, 0.91)
Remained high	0.58**	(0.29, 0.86)	0.44**	(0.21, 0.77)

Note: $N = 989$ parents and children. In the regression analysis, group (control vs. intervention) and country were considered as levels to account for the study design and adjusted for children age, and DQ, and parental characteristics (age, marital status, education level, employment, sex, DQ, BMI). OR, odds ratio; CI, confidence interval; BMI, body mass index. Statistical significance indicated at (*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$). The reference category is "never". BMI categories from better to worse (normal weight at T0 and T2, overweight/obesity at T0 but normal weight at T2, normal weight at T0 but overweight/obesity at T2, overweight/obesity and T0 and T2).

Limited prior research has examined breakfasts, lunches, and dinners family meal patterns separately[28,29] among school children; therefore, these new findings add information to the pre-existing literature on family meals. In our study, family dinners were the most family-shared meals among most boys and girls. These findings are consistent with previous studies conducted among children and adolescents, which found similar proportions.[30,31] These results could be explained by the fact that family dinner is the only time of the day when the whole family can get together, especially on working days. While high proportions of school-age children usually consume a packed-lunch at school or lunch in the canteen of the school more than three times a week which explains the low frequency of shared lunches with family.[28,32]

Despite the substantial evidence that links the breakfasts to the overall diet and health of children, little is known about the benefits associated with family breakfasts frequency, particularly among younger children.[33] Evidence suggests that family dinner is the most commonly reported meal and researched family meal type,[34] while the frequency of both family breakfasts and dinners has been linked with improved dietary intake[18] and physical health among children.[35]

In this study, we found an inverse association between the frequency of family-shared breakfasts and/or dinners and BMI among children at follow-up. Similarly, previous studies found that more frequent family breakfasts[15,28,35] and dinners[11,28,35] were inversely linked to children's BMI outcomes.

The potential reason for this consistent result regarding the frequency of family dinners is due to the fact that family dinners frequency was already high compared to other meal occasions among both genders. Contrarily, some previous studies with children found no significant relationship between family meals and children's weight status.[36,37] Differences in results in this study compared to that of others could be due to the unadjusted analyses of these studies with uncontrolled confounders or methodological limitations.[14] Also, the sample population of this study was not a subset of the general population, but parents at risk of T2D. As it has been established previously,[38,39] parental BMI as an important predictor of children's BMI percentiles over time. Thus, the BMI of the parents was adjusted in all the analysis of this study. Besides, despite the family meals frequency, large family meal portion sizes and unhealthy meals preparation could also lead to higher weight in children.[36]

Our findings support the conclusions of several studies showing that having regular family-shared meals during childhood and adolescence is protective for overweight/obesity development over time.[12,40,41] In our sample of children, the increase in family meals

during childhood was inversely associated with changes in BMI of children even with considering family meals frequency and children's BMI at baseline as adjustment covariates.

Besides, the longitudinal analysis found that having three or more family-shared breakfasts and/or dinner per week at baseline showed reduced odds of overweight/obesity at T2 among both boys and girls after adjusting for confounders. Moreover, our results found that the increase in the frequency of family breakfasts and/or dinners during a period of 2 years was associated with lower odds of overweight/obesity over time among both boys and girls. These results were consistent with those of previous studies indicating that children with normal weight tend to consume more frequent family breakfast and dinner than children with obesity.[11,35,36,42] Also, results of our study corroborate prior cross-sectional and longitudinal studies showing that family meals frequency is inversely associated with BMI of school-aged children.[13,28,33,34] The main explanation of these results could be related to the emotional connections among family members during family mealtime, which in return could improve children's food intake. Moreover, children may be exposed to parental modelling of healthful eating behaviours, and this could improve children's food choices and portion sizes.[5,33] In addition, these results could be also explained by the fact that parental presence at the meal table could be positively linked with improvement in consumption of healthier foods among children.[5] In detail, family meals are more likely to serve fruits and vegetables, and smaller serving sizes which can contribute to better children's health.[43] Another reason could be that at family meals, parents may have the opportunity to both instruct their children and model healthy eating behaviours.[42] Also, given the high prevalence of daily family-shared meals in our study, the positive emotions that children may experience during the family meal occasions over time could create a supportive environment for children to regulate their own eating, as suggested by previous research.[34,43]

It is noteworthy to mention that our study's participants showed high rate of unemployment (62%), despite the high percentage of education, therefore, parental employment status was also included for adjustment in the analysis. This probably may be due to the high percentage of women (72%) who participated, as they are the ones that usually are the "stay at home parent". When including this adjustment results did not change. On the other hand, in a large representative sample of Ohio adults surveyed in 2012, differences were found in family meals frequency relative to parental sociodemographic characteristics such as employment.[44] This is consistent with evidence from other studies.[45,46] In detail, studies have found that higher family meals frequency was shown in households in which one or more adult is unemployed either because of retirement, unemployment, or being a "stay-at-home parent".[44] Time constraints associated with employment, particularly when all adults in the household are employed, may make it more difficult for households to have family meals at home.[47]

The present study has some limitations. First, children's data were based on parental reports, and therefore, a bias must be considered. Second, as self-reported data were used, the possibility of socially desirable responding is also a limitation. Moreover, BMI could not be considered as an accurate tool to estimate person's body fat compared to other anthropometric measurements (i.e., skinfold thickness, and bioimpedance analysis). Furthermore, this study only focused on the frequency of specific meal occasions as no information was available on other features like food preparation methods. Finally, since the majority of participated parents were women, and the population were only families at high-risk of T2D, as well as the data used were only for those participants who had completed data on both (T0) and (T2), all these factors could limit the generalizability of our results. Also, because of the longitudinal nature of this study, the long-time gaps between follow-ups during the study phases could be considered as a limitation.

There are also several strengths in this study that need to be mentioned. To the best of our knowledge, the present study is the first to examine the long-term gender-specific effects of the frequency of all family meals occasions individually (i.e., breakfast, lunch, and dinner) on children's BMI. In addition, this study focuses on a specific vulnerable population namely families at high risk of developing T2D across six European countries. The anthropometric measurements were obtained by well-trained researchers using highly validated and standardized procedures to ensure and increase accuracy. Furthermore, the sample size had been selected from a wide geographical spread including six European countries, with large cultural and dietary diversity.

In conclusion, family breakfasts and/or dinners frequency are inversely associated with children's BMI in families at risk of T2D. Longitudinally, the increase over time of the frequency of family-shared dinners decreased the odds of having a higher BMI over time and after 2 years. Having a high frequency of family-shared dinners over time decreased the odds of being in a higher category of BMI after 2 years. Thus, the promotion of higher frequency of meals, especially breakfasts and/or dinners, together with the family could help in preventing the development of overweight/obesity among children. Family meals should be considered for future strategies that aim children BMI reduction as it could offer a promising entry point for positive changes, especially among T2D high-risk families.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

ORCID

Esther M. Gonzalez-Gil https://orcid.org/0000-0003-2005-8229
Luis A. Moreno https://orcid.org/0000-0003-0454-653X

REFERENCES

1. Theodore LA, Bray MA, Kehle TJ. Introduction to the special issue: childhood obesity. *Psychol Schools*. 2009;46:693-694.
2. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999-2008. *Jama*. 2010;303:235-241.
3. Reid M, Worsley A, Mavondo F. The obesogenic household: factors influencing dietary gatekeeper satisfaction with family diet. *Psychol Market*. 2015;32:544-557.
4. Mahmood L, Flores-Barrantes P, Moreno LA, Manios Y, Gonzalez-Gil EM. The influence of parental dietary behaviors and practices on Children's eating habits. *Nutrients* 2021, 30;13(4):1138.
5. Neumark-Sztainer D, Hannan PJ, Story M, Croll J, Perry C. Family meal patterns: associations with sociodemographic characteristics and improved dietary intake among adolescents. *J Am Diet Assoc*. 2003;103:317-322.
6. Robertson W, Friede T, Blissett J, Rudolf MCJ, Wailis M, Stewart-Brown S. Pilot of "families for health": community-based family intervention for obesity. *Arch Dis Child*. 2008;93:921-926.
7. Christian MS, Evans CE, Hancock N, Nykjaer C, Cade JE. Family meals can help children reach their 5 a day: a cross-sectional survey of children's dietary intake from London primary schools. *J Epidemiol Community Health*. 2013;67(4):332-338.
8. Utter J, Denny S, Robinson E, Fleming T, Ameratunga S, Grant S. Family meals and the well-being of adolescents. *J Paediatr Child Health*. 2013;49(11):906-911.
9. Neumark-Sztainer D, Eisenberg ME, Fulkerson JA, Story M, Larson NI. Family meals and disordered eating in adolescents: longitudinal findings from project EAT. *Arch Pediatr Adolesc Med*. 2008;162:17-22.
10. Haines J, Gillman MW, Rifas-Shiman S, Field AE, Austin AB. Family dinner and disordered eating behaviors in a large cohort of adolescents. *Eat Disord*. 2010;18:10-24.
11. Hammons AJ, Fiese BH. Is frequency of shared family meals related to the nutritional health of children and adolescents? *Pediatrics*. 2011;127:e1565-e1574.
12. Berge JM, Wall M, Hsueh TF, Fulkerson JA, Larson N, Neumark-Sztainer D. The protective role of family meals for youth obesity: 10-year longitudinal associations. *J Pediatr*. 2015;166(2):296-301.
13. Zhang P, Wu H, Zhou X, et al. The association between family and parental factors and obesity among children in Nanchang, China. *Front Public Health*. 2016;4:162.
14. Horning ML, Fulkerson JA, Friend SE, Neumark-Sztainer D. Associations among nine family dinner frequency measures and child weight, dietary, and psychosocial outcomes. *J Acad Nutr Diet*. 2016;116(6):991-999.
15. Larson N, Wang Q, Berge JM, Shanafelt A, Nanney MS. Eating breakfast together as a family: mealtime experiences and associations with dietary intake among adolescents in rural Minnesota, USA. *Public Health Nutr*. 2016;19(9):1565-1574.
16. Lehto R, Ray C, Roos E. Longitudinal associations between family characteristics and measures of childhood obesity. *Int J Public Health*. 2012;57:495-503.
17. Pankow JS, Jacobs DR Jr, Steinberger J, Moran A, Sinaiko AR. Insulin resistance and cardiovascular disease risk factors in children of parents with the insulin resistance (metabolic) syndrome. *Diabetes Care*. 2004;27:775-780.
18. Mahmood L, González-Gil EM, Schwarz P, et al. Frequency of family meals and food consumption in families at high risk of type 2 diabetes: the Feel4Diabetes-study. *Eur J Pediatr*. 2022;181(6):2523-2534.
19. González-Gil EM, Giménez-Legarre N, Cardon G, et al. Parental insulin resistance is associated with unhealthy lifestyle behaviours independently of body mass index in children: the Feel4Diabetes study. *Eur J Pediatr*. 2022;181(6):2513-2522.
20. Manios Y, Androutsos O, Lambrinou CP, et al. A school- and community-based intervention to promote healthy lifestyle and prevent type 2 diabetes in vulnerable families across Europe: design and implementation of the Feel4Diabetes-study. *Public Health Nutr*. 2018;21(17):3281-3290.
21. Makrilakis K, Liatis S, Grammatikou S, et al. Validation of the Finnish diabetes risk score (FINDRISC) questionnaire for screening for undiagnosed type 2 diabetes, dysglycaemia and the metabolic syndrome in Greece. *Diabetes Metab*. 2011;37:144-151.
22. Androutsos O, Anastasiou C, Lambrinou C, et al. Intra- and inter-observer reliability of anthropometric measurements and blood pressure in primary schoolchildren and adults: the Feel4Diabetes-study. *BMC Endocr Disord*. 2020;20:27.
23. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatr Obes*. 2012;7(4):284-294.
24. Virtanen E, Kivelä J, Wikström K, et al. Feel4Diabetes healthy diet score: development and evaluation of clinical validity. *BMC Endocr Disord*. 2020;20(2):1-10.
25. Cooke LJ, Wardle J. Age and gender differences in children's food preferences. *Br J Nutr*. 2005;93(5):741-746.
26. Keller KL, Kling SMR, Fuchs B, et al. A biopsychosocial model of sex differences in Children's eating behaviors. *Nutrients*. 2019;11(3):682.
27. Adams J, Goffe L, Brown T, et al. Frequency and socio-demographic correlates of eating meals out and take-away meals at home: cross-sectional analysis of the UK national diet and nutrition survey, waves 1-4 (2008-12). *Int J Behav Nutr Phys Act*. 2015;12:51.
28. Larson N, MacLehose R, Fulkerson JA, Berge JM, Story M, Neumark-Sztainer D. Eating breakfast and dinner together as a family: associations with sociodemographic characteristics and implications for diet quality and weight status. *J Acad Nutr Diet*. 2013;113(12):1601-1609.
29. Andaya AA, Arredondo EM, Alcaraz JE, Lindsay SP, Elder JP. The association between family meals, TV viewing during meals, and fruit, vegetables, soda, and chips intake among Latino children. *J Nutr Educ Behav*. 2011;43(5):308-315.
30. Gillman MW, Rifas-Shiman SL, Frazier AL, et al. Family dinner and diet quality among older children and adolescents. *Arch Fam Med*. 2000;9(3):235-240.
31. Boutelle KN, Lytle LA, Murray DM, Birnbaum AS, Story M. Perceptions of the family mealtime environment and adolescent mealtime behavior: do adults and adolescents agree? *J Nutr Educ*. 2001;33:128-133.
32. Morrison M. Sharing food at home and school: perspectives on commensality. *Sociol Rev*. 1996;44(4):648-674.
33. Rollins BY, Belue RZ, Francis LA. The beneficial effect of family meals on obesity differs by race, sex, and household education: the national survey of children's health, 2003-2004. *J Am Diet Assoc*. 2010;110(9):1335-1339.
34. Würbach A, Zellner K, Kromeyer-Hauschild K. Meal patterns among children and adolescents and their associations with weight status

and parental characteristics. *Public Health Nutr*. 2009;12(8):1115-1121.

35. Berge JM, Truesdale KP, Sherwood NE, et al. Beyond the dinner table: who's having breakfast, lunch and dinner family meals and which meals are associated with better diet quality and BMI in preschool children? *Public Health Nutr*. 2017;20(18):3275-3284.
36. Fulkerson JA, Larson N, Horning M, Neumark-Sztainer D. A review of associations between family or shared meal frequency and dietary and weight status outcomes across the lifespan. *J Nutr Educ Behav*. 2014;46(1):2-19.
37. Parkes A, Green M, Pearce A. Do bedroom screens and the mealtime environment shape different trajectories of child overweight and obesity? Research using the growing up in Scotland study. *Int J Obes (Lond)*. 2020;44(4):790-802.
38. Inagami S, Cohen DA, Finch BK, Asch SM. You are where you shop: grocery store locations, weight, and neighborhoods. *Am J Prev Med*. 2006;31(1):10-17.
39. Videon TM, Manning R. Influences on adolescent eating patterns: the importance of family meals. *J Adolesc Health*. 2003;32(5):365-373.
40. Fulkerson JA, Friend S, Flattum C, et al. Promoting healthful family meals to prevent obesity: HOME plus, a randomized controlled trial. *Int J Behav Nutr Phys Act*. 2015;15(12):154.
41. Fulkerson JA, Neumark-Sztainer D, Hannan PJ, Story M. Family meal frequency and weight status among adolescents: cross-sectional and 5-year longitudinal associations. *Obesity (Silver Spring)*. 2008;16(11):2529-2534.
42. Fulkerson JA, Kubik MY, Story M, Lytle L, Arcan C. Are there nutritional and other benefits associated with family meals among at-risk youth? *J Adolesc Health*. 2009;45(4):389-395.
43. Neumark-Sztainer D, Maclehose R, Loth K, Fulkerson JA, Eisenberg ME, Berge J. What's for dinner? Types of food served at family dinner differ across parent and family characteristics. *Public Health Nutr*. 2012;1–11:145-155.
44. Tumin R, Anderson SE. The epidemiology of family meals among Ohio's adults. *Public Health Nutr*. 2015;18:1474-1481.
45. Sobal J, Hanson K. Family dinner frequency, settings and sources, and body weight in US adults. *Appetite*. 2014;78:81-88.
46. Sobal J, Hanson K. Family meals and body weight in US adults. *Public Health Nutr*. 2011;14:1555-1562.
47. Devine CMA. Life course perspective: understanding food choices in time, social location, and history. *J Nutr Educ Behav*. 2005;37:121-128.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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