



# A snapshot of country-specific dietary habits and obesity in European children: the Feel4Diabetes study

Lubna Mahmood<sup>1</sup> · Luis A. Moreno<sup>1,14,15</sup> · Peter Schwarz<sup>3,4,5</sup> · Ruben Willems<sup>6</sup> · Greet Cardon<sup>7</sup> · Soukaina Hilal<sup>8</sup> · Imre Rurik<sup>9</sup> · Violeta Iotova<sup>10</sup> · Yuliya Bazdarska<sup>10</sup> · Roumyana Dimova<sup>11</sup> · Kostas Anastasiou<sup>12</sup> · Yannis Manios<sup>12,13</sup> · Esther M. Gonzalez-Gil<sup>1,2</sup> · on behalf of the Feel4Diabetes-Study Group

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## Abstract

This study assessed the dietary intake of European children by country, gender, and obesity degree across six European countries participating in the Feel4Diabetes study. It also compared food group intakes with European food-based dietary guidelines. The Feel4Diabetes study included 9,847 children (50.4% girls) from six European countries. Families provided baseline data on energy balance-related behaviors and socioeconomic factors via questionnaires. Children's dietary intake and breakfast consumption were assessed using semi-quantitative food frequency questionnaires, and anthropometric measurements were taken. Intake from 11 food groups was analyzed by country, gender, and obesity degree. Chi-square analyses compared food intake with dietary guidelines. "Nutrient-dense" foods (e.g., fruits, vegetables, whole grains) and "energy-dense, low-nutrient" foods (e.g., high in added sugars, saturated fats) were categorized based on the European food-based guideline. Over 85% of children consumed breakfast 5–7 days a week, with no significant differences by Body Mass Index (BMI) or country. Mean intakes of nutrient-dense food groups fell below recommendations, while the intake of energy-dense, low-nutrient foods exceeded limits, particularly in children with overweight/obesity ( $p=0.048$ ). No significant gender differences were observed in most food groups.

**Conclusions:** Dietary intake varied by country and obesity degree among European children. Across the six countries, children's diets did not align with food-based dietary guidelines. These findings underscore the need for interventions promoting healthier eating habits among European children.

**Trial registration:** The Feel4Diabetes-study is registered with the clinical trials registry (NCT02393872), <http://clinicaltrials.gov>

## What is Known:

- Childhood obesity is a growing concern across Europe, with some variations in food consumption observed between European countries
- Previous studies have highlighted the role of diet in childhood obesity, but few have examined cross-country comparisons while accounting for gender and BMI status.

## What is New:

- This study provides a comprehensive cross-country analysis of children's dietary intake, considering gender, BMI status, and adherence to European dietary guidelines.
- New insights into gender differences in sweets consumption and the positive association between BMI and food intake (such as soft drinks and sweets) are presented, which can inform targeted dietary interventions.

**Keywords** Children · Dietary intake · Food frequency · Obesity · Europe

## Abbreviations

BMI	Body mass index
FBDG	Food-based dietary guidelines
FFQ	Food frequency questionnaire
FV	Fruit and vegetables
FIN-D2D	Finnish diabetes prevention program

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ICC Intra-Class Correlation coefficients  
zBMI BMI z-scores

## Introduction

Healthy eating is critical for preventing non-communicable diseases and malnutrition [1]. Modern diets high in refined carbohydrates, sugar, and trans fats have contributed to rising childhood obesity rates [1]. The WHO European Childhood Obesity Surveillance Initiative (2015–2017) found that 29% of children aged 7–9 were overweight, with boys (31%) more affected than girls (28%) [2]. Childhood obesity increases the risk of non-communicable diseases and often persists into adulthood [3]. Regional variations exist, with Cyprus, Spain, Italy, and Greece having the highest rates, while Denmark reported the lowest [2]. Obesity results from genetic, behavioral, and environmental factors, with an imbalance between energy intake and expenditure central to weight gain [3]. Excess consumption of energy-dense, low-nutrient foods exacerbates this issue [4].

The concept of a healthy diet has evolved, emphasizing balanced macronutrients, fruits, vegetables, whole grains, nuts, and legumes, while limiting salt, sugars, saturated fats, and processed foods [5]. Traditional diets like the Mediterranean diet promote health with more healthful foods [5]. Breakfast skipping has been linked to poor dietary quality and increased obesity risk, while regular breakfast consumption supports weight management [6].

Dietary habits vary across Europe [7–9]. The IDEFICS study (16,228 children, 2–9 years) found Italy had the highest Mediterranean-like diet adherence, while Spain and Cyprus had the lowest [7]. The WHO's fourth childhood obesity surveillance reported low savory snack consumption in Northern Europe and lower vegetable intake in Western Asia, particularly among boys [8]. Dietary patterns are influenced by socioeconomic, cultural, and environmental factors, including food availability, traditions, and national guidelines [10].

Understanding food composition is essential for informed dietary choices [11]. The European Food-Based Dietary Guidelines (FBDG) offer evidence-based recommendations to prevent nutrient deficiencies and obesity [12]. This study aims to assess children's dietary intake across six European countries, examining variations by country, gender, and obesity status while evaluating adherence to the FBDG to inform public health strategies.

## Methods

### Study design

The Feel4Diabetes study aimed to combat obesity and related comorbidities by promoting a healthy lifestyle in

11,396 families across six European countries. Based on the world bank country classification derived from the 2013 Gross National Income per capita [13], the countries in the study were grouped in regions as: high-income countries (Finland and Belgium), countries under austerity measures following the economic crisis (Spain and Greece), and low-income countries (Hungary and Bulgaria). In Feel4diabetes study, the “vulnerable areas” were defined as every area in low-income countries and countries under austerity measures, and only low socioeconomic status areas in high-income countries. Children in the first three primary school grades and their parents were invited to participate. Data were collected at baseline (2016) and during follow-ups in 2017 and 2018. This analysis uses the baseline cross-sectional data only. The study is registered at <http://clinicaltrials.gov> (NCT02393872), and the full protocol has been published [14]. Ethical approval was obtained in each country, and all participants provided written informed consent before enrolment.

### Study sample

At baseline in the Feel4Diabetes-study, 11,396 families were included. Children's information was reported by the parent with full-filled questionnaire along with completed anthropometric measures. Since some families included more than one child, we randomly selected one child per family in order not to duplicate parental information, one child from each family was included and linked to the reported parental information. Among the 11,396 families meeting the inclusion criteria, 1,549 children were excluded because of incomplete data and missing anthropometric measurements, resulting in 9,847 children being included in the study.

### Dietary assessment

A semi-quantitative food frequency and eating behavior questionnaire was provided to families, completed by one parent at home. The questionnaire was adapted from the Finnish diabetes prevention program (FIN-D2D) [13] and modified culturally for the six European countries in the study. Initially developed in English, the questionnaire was translated into each participating country's language, followed by back-translation into English and fine-tuning for local nuances. The child-specific version of the questionnaire mirrored the parents' version but excluded alcohol and coffee-related questions.

To ensure reliability, the test–retest reliability was assessed using intra-class correlation coefficients (ICC) in 191 parent–child pairs, who completed the questionnaires on two occasions with a 1–2 week interval [13].

The study assessed children's consumption of various food items, including breakfast, grains, fruits, vegetables,

legumes, red meat, poultry, fish, dairy products, savory snacks (e.g., croissants, cheese pies), sweets (e.g., pancakes, cookies), and soft drinks. Breakfast consumption was measured by asking, "On how many days does your child usually eat breakfast?" with options ranging from "never" to "daily." For dietary intake, parents reported the frequency of their child's consumption of each food item, using a scale from "less than one serving per week" to "5 or more servings per day." Portion sizes were provided in household units, such as one medium apple (90 g) or half a cup of chopped fruit.

The terms 'nutrient-dense' foods and 'energy-dense, low-nutrient' foods were defined by comparing participants' dietary intake to the FBDG [12]. 'Nutrient-dense' foods align with FBDG recommendations, including fruits, vegetables, whole grains, and lean proteins, while 'energy-dense, low-nutrient' foods deviate from these recommendations, such as those high in added sugars, saturated fats, and low in essential nutrients. Although the FBDGs are largely consistent across countries, minor discrepancies may exist. A detailed list of foods categorized as 'nutrient-dense' and 'energy-dense, low-nutrient' according to these guidelines is provided in the supplementary material (Supplementary Table 1).

### Anthropometric measurements

Children's height and weight were measured at schools by trained researchers following standardized procedures [14]. Body weight, measured in light clothing and barefoot using a Seca 813 digital scale, was recorded to the nearest 0.1 kg. Height was measured with a Seca 217 stadiometer, with the head in the Frankfurt plane, and recorded to the nearest 0.1 cm. Two readings were taken for each measurement, with a third taken if differences exceeded 100 g for weight or 1 cm for height. The average of the two closest readings was used for analysis. BMI was calculated as weight (kg) divided by height (m<sup>2</sup>), and children were categorized into underweight, normal weight, and overweight/obesity. Age- and gender-specific BMI z-scores (zBMI) were calculated following Cole cut-offs [15].

### Statistical analysis

Descriptive data are presented as percentages for categorical variables and means for continuous variables. The Kolmogorov–Smirnov test assessed variable distributions. Gender interactions in dietary habits and weight status were observed, so analyses were stratified by gender. Student's t-tests compared continuous variables, and Pearson's chi-square test was used for categorical variables. Results were stratified by country, gender, and BMI categories. Food consumption frequencies from 11 food groups were compared to the FBDGs [12] (see Supplementary File 1). To handle

the Missing at Random (MAR) data, multiple imputation (MI) was performed using a fully conditional specification method. A total of 150 cases (1.5%) were imputed across several variables. The imputation model included all relevant covariates, and the resulting 20 imputed datasets were analyzed. Sensitivity analyses were then conducted to compare results from the imputed and complete case analyses to assess the robustness of the findings. Bonferroni test was used when making multiple comparisons. A complete-case analysis was used for transparency. Figures were created using Microsoft Excel (version 16.79.2), and statistical analyses were performed using IBM-SPSS (Version 26.0), with  $p < 0.05$  considered statistically significant.

## Results

Out of 11,396 families that met the inclusion criteria, 1,549 children were excluded for incomplete information and lack of anthropometric measurements, and 9,847 were included in this study, data were missing for approximately 150 (1.5%) cases due to random missingness across various variables. A total of 9,847 children were analyzed, with participants ranging from 2,609 in Bulgaria to 1,211 in Finland. The majority of participants were 7 years old (67%), with 50.4% being girls. Additionally, 8% were 6 years old, 13% were 8 years old, and 12% were 9 years old.

Overweight/obesity rates were highest in Greece (36.5%) and Hungary (35.5%), with Belgium having the lowest (13.2%) (Table 1). Most children (92.2%) ate breakfast 5–7 days per week, while 2.6% rarely did. Daily fruit consumption was reported by 38%, while 11.8% rarely ate it. Daily vegetable intake was 26.5%, with 19.2% consuming them infrequently. Sweets were consumed daily by 16.1%, savory snacks by 4.9%, and soft drinks by 8.7%.

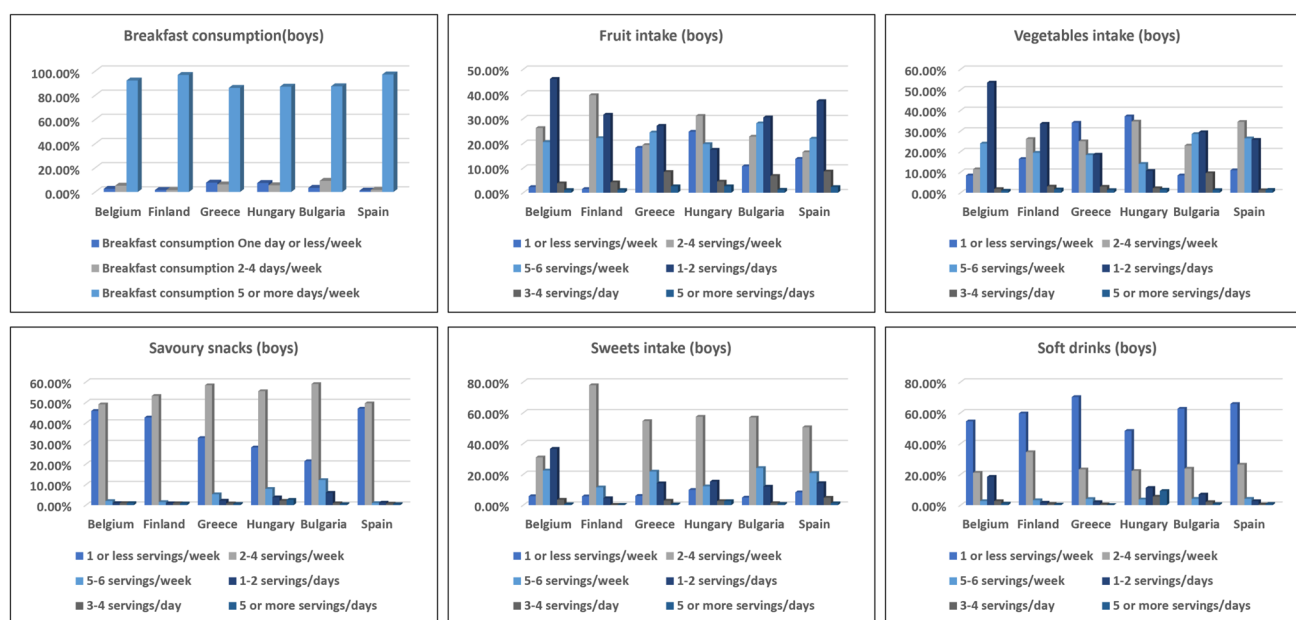
### Differences by country and BMI

#### Meal occasion—breakfast

The frequency of breakfast consumption among European children (boys/girls) is shown in Figs. 1 and 3. Breakfast consumption (5–7 days per week) ranged from 86.1% in Greece to 97.2% in Spain, with no significant differences between countries ( $p = 0.23$ ) or genders. Breakfast intake across BMI categories was consistent. Among boys, 53.2% in the overweight/obesity group and 60.0% in the underweight group consumed breakfast regularly ( $p = 0.824$ ). Similarly, for girls, 52.3% in the overweight/obesity group and 62.7% in the normal weight group ate breakfast regularly, with no significant differences ( $p = 0.335$ ).

**Table 1** The percentage (%) of children (6–9 years) participating by gender, and country ( $n=9,847$ )

Country	Children total (%)	Percentage of children participating by gender (%)		BMI categories (%)		
		Boys (%)	Girls (%)	Underweight	Normal	Overweight/obesity
Belgium	14.7	49.7	50.3	2.6	84.2	13.2
Finland	12.3	50.2	49.8	3.2	64.1	32.7
Greece	18.7	47.8	52.2	2.4	61.1	36.5
Spain	13.9	52.8	47.2	5.2	72.4	22.4
Hungary	13.9	47.8	52.2	5.1	59.3	35.5
Bulgaria	26.5	48.8	51.2	6.8	65.3	27.9

**Fig. 1** Frequency of consuming breakfast, fruit, and vegetables, savoury snacks, sweets, and soft drinks among boys by country

### Consumption food groups: fruits, vegetables, legumes and grains

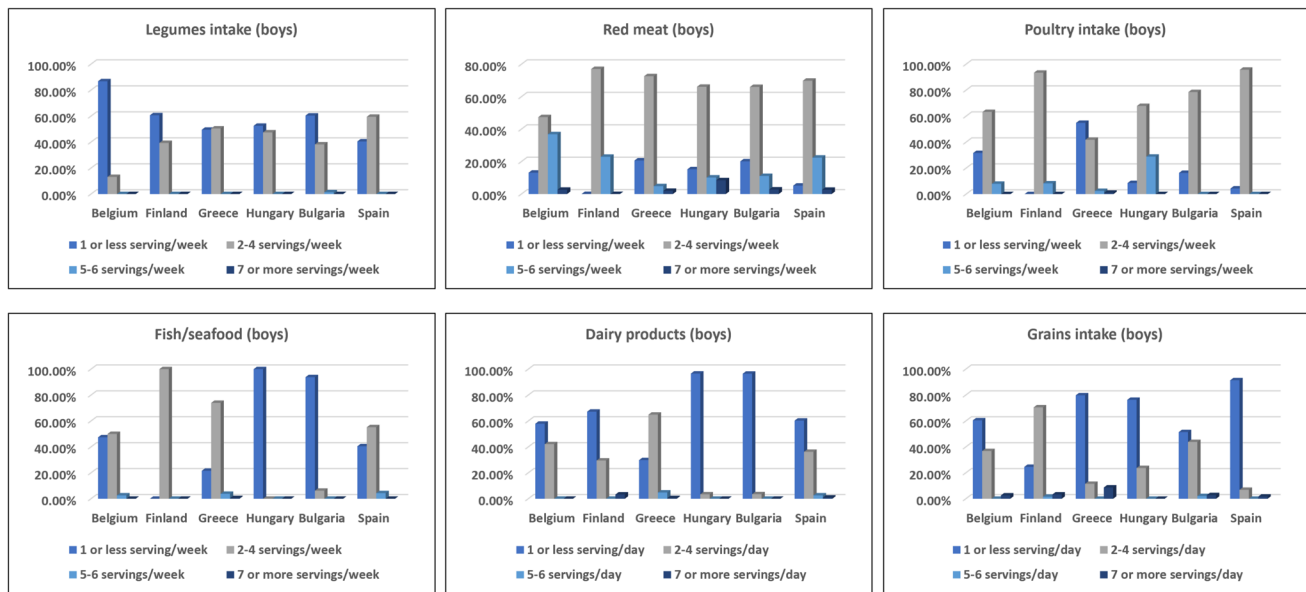
Daily fresh fruit consumption varied significantly between regions ( $p < 0.05$ ), with Hungary at 17.4%, Bulgaria at 30.5%, and Belgium at 46.1% (Figs. 1 and 3). Children in Finland had the lowest percentage consuming fruit "never or once a week" (1.5%), while Hungary had the highest (24.7%). No significant gender differences were observed. Among boys with overweight/obesity, 36.3% consumed 5–6 servings per week, compared to 27.7% of normal-weight boys ( $p = 0.330$ ). Girls with overweight/obesity consumed 5–6 servings per week at 35.2%, with no significant differences ( $p = 0.581$ ).

Daily vegetable consumption ranged from 10.6% in Hungary to 53.5% in Belgium. Higher intake "never or once a week" was observed in Hungary (37.1%) and Greece

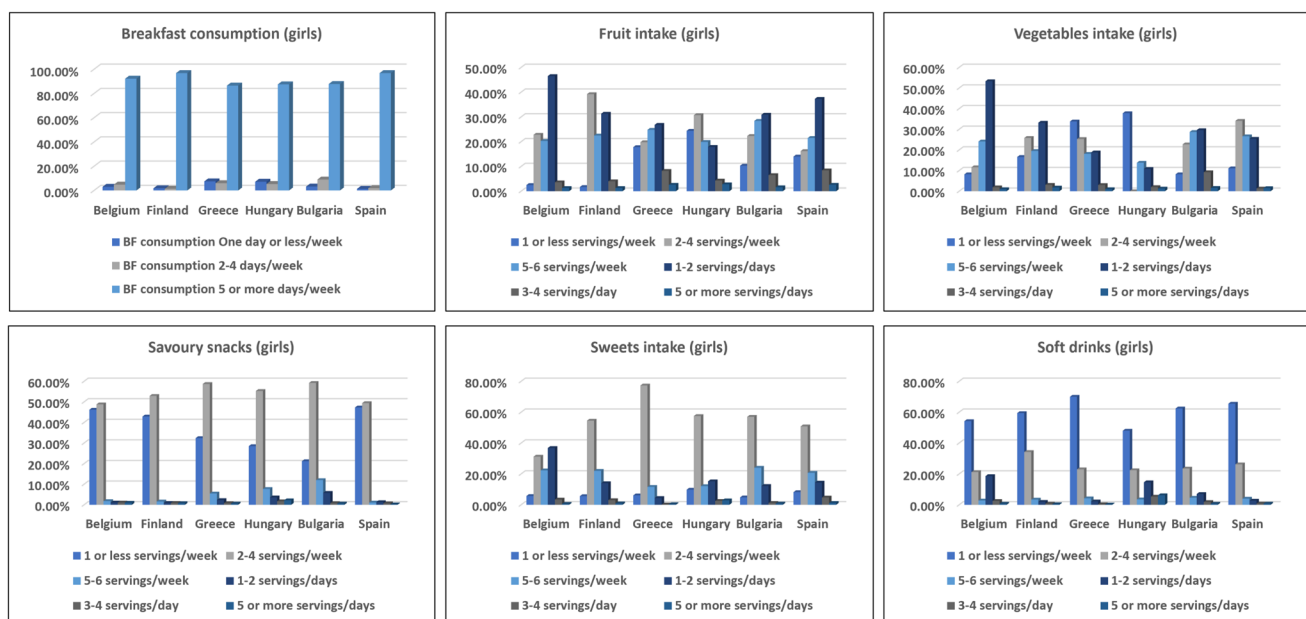
(34.0%) compared to Belgium (8.4%) and Bulgaria (8.2%) (Figs. 2 and 4). Girls tended to consume vegetables more frequently than boys. Boys with overweight/obesity showed a trend toward higher intake, with 34.7% consuming 5–6 servings per week ( $p = 0.095$ ), while girls had the highest intake (35.5%), with no significant differences ( $p = 0.233$ ). Legume intake was lowest in Belgium and Finland.

### Consumption of food groups: red meat, poultry, fish/seafood, and dairy products

Boys in Finland and girls in Greece had the highest moderate red meat intake (77.05% and 75%), while boys in Belgium and Spain consumed 720–840 g/week. Girls in Hungary and Bulgaria showed more varied intake, with significant percentages consuming 5–6 servings weekly. Red meat consumption did not significantly vary by BMI ( $p > 0.05$ ).



**Fig. 2** Frequency of consuming legumes, red meat, poultry, fish/seafood, dairy products, and grains among boys by country



**Fig. 3** Frequency of consuming breakfast, fruit, and vegetables, savoury snacks, sweets, and soft drinks among girls by country

Poultry intake was higher among boys in Hungary and Bulgaria (2–4 servings/week), with Finland and Greece leading overall intake. Overweight boys (28.8%) and girls consumed 7+ servings/week, with significant BMI-related differences (boys:  $p=0.021$ , girls:  $p=0.039$ ). Fish/seafood intake was highest in Finland and Greece (74%) and lowest in Hungary and Bulgaria (1% and 6.4%), with no significant BMI differences ( $p>0.05$ ). Dairy intake was low across countries,

particularly among boys in Hungary and Bulgaria (96.6% and 96.5%) (Figs. 2 and 4).

### Consumption of sweets, soft drinks and savoury snacks

Figures 1 and 3 show significant variation in sweet snack consumption across countries, with daily intake ranging from 4.5% in Finland to 36.6% in Belgium. The percentage



of children who consumed sweets rarely or never varied from 4.9% in Bulgaria to 9.9% in Hungary.

Boys and girls of normal weight reported similar frequencies of sweet intake, but no significant differences were observed. Soft drink consumption was lowest in Finland (1.6%) and Greece (2.0%) and highest in Belgium (18.4%) and Hungary (11.2%). Fewer children in Hungary consumed soft drinks weekly or less compared to Greece. Daily soft drink intake was higher among boys and girls with overweight/obesity, with significant differences by BMI (Table 2).

Savory snack consumption was lowest in Finland (0.9%), Belgium (1.0%), and Spain (1.2%), and was high across all BMI categories with no significant gender differences.

### Food recommendation results

A majority of children did not meet the recommended servings of fruits, vegetables, fish, or grains. Most consumed 1–4 servings of FV per week, far below the 2–3 servings/day guideline. In Finland, 80% met fish/seafood recommendations, but most children fell short in other countries. Grain and dairy intake also lagged behind recommendations, while red meat, poultry, sweets, soft drinks, and savory snacks exceeded recommended limits, reflecting suboptimal dietary habits across food groups (Figs. 1, 2, 3, and 4).

## Discussions

This study offers novel insights into the dietary habits of primary-school-aged children across six European countries, providing a comprehensive analysis of dietary intake by country, gender, and obesity status. Unlike previous studies, which often focused on individual countries or specific food items, our research examines food group consumption and adherence to European dietary recommendations in a cross-country context. Key findings include significant gender differences in sweets consumption and positive BMI-related associations in soft drink intake, particularly among boys with overweight/obesity. These results highlight the need for targeted interventions to address these dietary disparities. This study aligns with previous research, like the IDEFICS study, highlighting varied dietary intake influenced by social, cultural, and economic factors [7, 10, 16].

### Differences by country and BMI

#### Meal occasion – breakfast

Our study found that over 97% of Spanish children have breakfast five to seven days a week, with no significant gender difference, consistent with previous European

research [17, 18]. A cross-sectional study across 33 countries reported higher breakfast skipping rates (10%–30%), particularly among teenagers, especially females [18]. Family structure and parental modeling significantly influence breakfast consumption, with children in single-parent families more likely to skip meals [19, 20]. Unlike some studies [21], we found no gender differences, contrasting with Italian data showing girls and children with overweight or obesity were more likely to skip breakfast [22]. Skipping meals is linked to unhealthy eating habits and higher obesity rates [23].

#### Consumption of food groups: fruits, vegetables, legumes and grains

Improving children's diets relies on increasing fruit and vegetable (FV) consumption. Our study found low FV intake among Bulgarian children, with significant variations across European countries. Seasonal availability may influence these differences, as data collection occurred during potentially lower FV accessibility periods [24]. Socioeconomic factors, including education and income, also play a critical role in shaping dietary habits [24].

Legume consumption was low among children in Belgium and Finland, with many eating one or fewer servings per week. Girls in Spain, Greece, and Hungary showed a higher tendency for moderate legume intake compared to boys. Interventions like Beans4Life [25] in Portugal and SmartFeeding4Kids [26] across Europe have highlighted inadequate knowledge and infrequent consumption of legumes, reflecting low health literacy. Despite their nutritional benefits, legumes are often replaced by increased meat consumption [25, 26].

Our study found that girls generally consumed more grains than boys, consistent across countries, with no significant differences in FV, legume, and grain consumption by BMI categories [27–29].

#### Consumption of food groups: red meat, poultry, fish/seafood, and dairy products

This research shows that boys and girls in Finland and Greece have the highest moderate consumption of red meat, poultry, and fish/seafood, while Spain has notably higher red meat intake. Our findings are similar to those reported in the literature highlighting Spain's high animal protein density, particularly from red meat and dairy [16, 30]. Cultural and geographical factors influence consumption patterns, with Finland's abundant freshwater and coastline contributing to high fish consumption [10, 31].

Most children consumed one or fewer servings of dairy daily, with consistent gender patterns; however, Spain showed more balanced consumption. Spanish preschoolers

**Table 2** Dietary intake of European children ( $n=9,847$ ), by gender and obesity degree

Dietary intake		Boys (%)			<i>p</i> -value	Girls (%)			<i>p</i> -value
		BMI category				BMI category			
		Underweight	Normal weight	Over-weight/ obesity		Underweight	Normal weight	Over-weight/ obesity	
Breakfast consumption	One day or less/ week	20.0	13.6	15.7	0.824	25	10.8	17.2	0.335
	2–4 days/week	20.0	27.1	31.1		18.0	26.5	30.5	
	5 or more days/ week	60.0	59.3	53.2		57.0	62.7	52.3	
Fruit intake	1 or less serving/ week	3.0	8.5	9.5	0.330	2.5	9.3	8.1	0.581
	2–4 servings/week	56.0	35.7	22.1		55.0	34.2	23.8	
	5–6 servings/week	16.0	20.1	36.3		15.0	21.4	35.2	
	1–2 servings/day	11.0	27.7	24.9		12.0	27.8	25.4	
	3–4 servings/day	12.0	6.5	4.6		10.5	6.7	4.9	
	5 or more serv-ings/day	2.0	1.5	2.6		5.0	0.6	3.6	
Vegetables	1 or less serving/ week	4.0	2.0	1.5	0.095	3.5	1.5	1.0	0.233
	2–4 servings/week	28.0	30.6	36.8		27.0	31.0	37.2	
	5–6 servings/week	24.0	24.3	34.7		26.0	24.5	35.5	
	1–2 servings/day	32.0	28.7	17.7		30.0	28.5	18.0	
	3–4 servings/day	8.0	6.8	5.7		9.0	7.5	5.0	
	5 or more serv-ings/day	4.0	7.6	3.6		4.5	7.0	2.3	
Savory snacks	1 or less serving/ week	52.0	57.0	55.2	0.148	50.0	55.0	57.5	0.080
	2–4 servings/week	41.0	39.1	37.3		42.0	38.0	35.0	
	5–6 servings/week	1.0	2.6	4.7		2.0	2.0	5.0	
	1–2 servings/day	4.0	0.9	1.5		4.0	1.0	1.5	
	3–4 servings/day	1.0	0.2	0.5		1.0	0.5	0.5	
	5 or more serv-ings/day	1.0	0.2	0.8		1.0	0.5	0.5	
Sweets	1 or less serving/ week	8.0	4.8	4.7	0.052	9.0	4.5	4.0	0.074
	2–4 servings/week	48.0	58.8	54.2		47.0	57.5	53.0	
	5–6 servings/week	24.0	19.2	23.6		25.0	18.5	24.5	
	1–2 servings/day	12.0	14.5	14.7		12.0	15.0	15.5	
	3–4 servings/day	4.0	1.4	1.5		4.0	2.0	2.5	
	5 or more serv-ings/day	4.0	2.2	1.3		3.0	2.5	0.5	
Soft drinks	1 or less serving/ week	4.0	8.8	4.8	<b>0.048</b>	3.0	9.0	5.0	<b>0.021</b>
	2–4 servings/week	18.5	40.9	11.2		17.0	41.0	11.5	
	5–6 servings/week	12.0	11.8	28.1		11.0	12.0	27.0	
	1–2 servings/day	42.1	18.7	17.8		43.0	18.0	18.0	
	3–4 servings/day	20.0	15.0	32.0		22.0	14.0	31.5	
	5 or more serv-ings/day	3.4	4.8	6.1		4.0	2.0	7.0	
Legumes	1 or less serving/ week	5.5	10.3	15.7	0.242	6.5	11.7	17.9	0.178
	2–4 servings/week	55.2	40.6	34.8		54.5	40.1	34.5	

**Table 2** (continued)

Dietary intake		Boys (%)			<i>p</i> -value	Girls (%)			<i>p</i> -value
		BMI category				BMI category			
		Underweight	Normal weight	Over-weight/ obesity		Underweight	Normal weight	Over-weight/ obesity	
Red meat	5–6 servings/week	24.7	30.2	25.5	0.086	25.1	30.7	26.0	0.073
	7 or more servings/week	14.6	18.9	24.0		13.9	17.5	21.6	
	1 or less serving/week	6.2	10.8	14.3		7.0	12.1	16.0	
	2–4 servings/week	49.8	38.3	26.1		49.2	37.9	25.9	
	5–6 servings/week	21.8	30.4	32.0		22.1	30.9	32.6	
	7 or more servings/week	22.2	20.5	27.6		21.7	19.1	25.5	
Poultry	1 or less serving/week	4.3	11.9	15.1	<b>0.021</b>	5.5	12.1	15.4	<b>0.039</b>
	2–4 servings/week	48.5	37.3	26.2		49.0	37.8	26.5	
	5–6 servings/week	26.1	28.4	29.9		26.4	28.7	30.3	
	7 or more servings/week	21.1	22.4	28.8		19.1	21.4	27.8	
Fish/seafood	1 or less serving/week	7.3	13.7	16.4	0.058	7.9	14.5	17.4	0.067
	2–4 servings/week	51.8	41.7	28.9		52.0	41.9	29.0	
	5–6 servings/week	19.8	24.3	30.1		20.3	25.1	31.1	
	7 or more servings/week	21.1	20.3	24.6		19.8	18.5	22.5	
<sup>1</sup> Dairy products	1 or less serving/day	10.5	15.2	19.8	0.091	11.4	16.4	21.4	0.096
	2–4 servings/day	49.7	45.3	35.1		50.6	46.2	35.7	
	5–6 servings/day	24.8	25.1	30.1		24.9	25.3	30.5	
	7 or more servings/day	15.0	14.4	15.0		13.1	12.1	12.4	
<sup>2</sup> Grains	1 or less serving/day	8.5	12.3	18.2	0.141	9.4	13.6	20.1	0.098
	2–4 servings/day	41.9	38.6	30.3		42.7	39.4	31.0	
	5–6 servings/day	30.2	35.4	31.9		31.0	36.3	32.6	
	7 or more servings/day	19.4	13.7	19.6		17.0	10.7	15.8	

*N*=9,847 children. *P*<0.05 (Bold indicate significance). <sup>1</sup> cheese was not counted. <sup>2</sup> (rice and pasta were not mentioned under Grains group in the questionnaire). 1 serving of dairy=½ cup (120 mL), 1 serving of grains=a roll (60 g) equals 2 slices of bread, 1 serving of fruit=90 gm (1 medium sized apple/2 small apricots), 1 serving of vegetables=½ cup of vegetables or at the size of a tennis ball tomato, broccoli or leafy, 1 serving of legumes=½ cup (100 g), 1 servings of red meat/poultry/fish=1 pack of cards (100–120 g), 1 serving of soft drinks=1 glass (250 mL), 1 servings of salty snacks=1 small bag of chips (100 g), 1 slice of pizza (160 g), 1 serving of sweets=1 small chocolate bar (40 g), 1 cookie, 4 pieces of chocolates, or 1 scoop of ice cream. The numbers in the table are presented as percentages

consume more dairy than peers in Germany and Hungary [16], reflecting Mediterranean dietary intake [32]. No notable differences were found in intake across BMI categories.

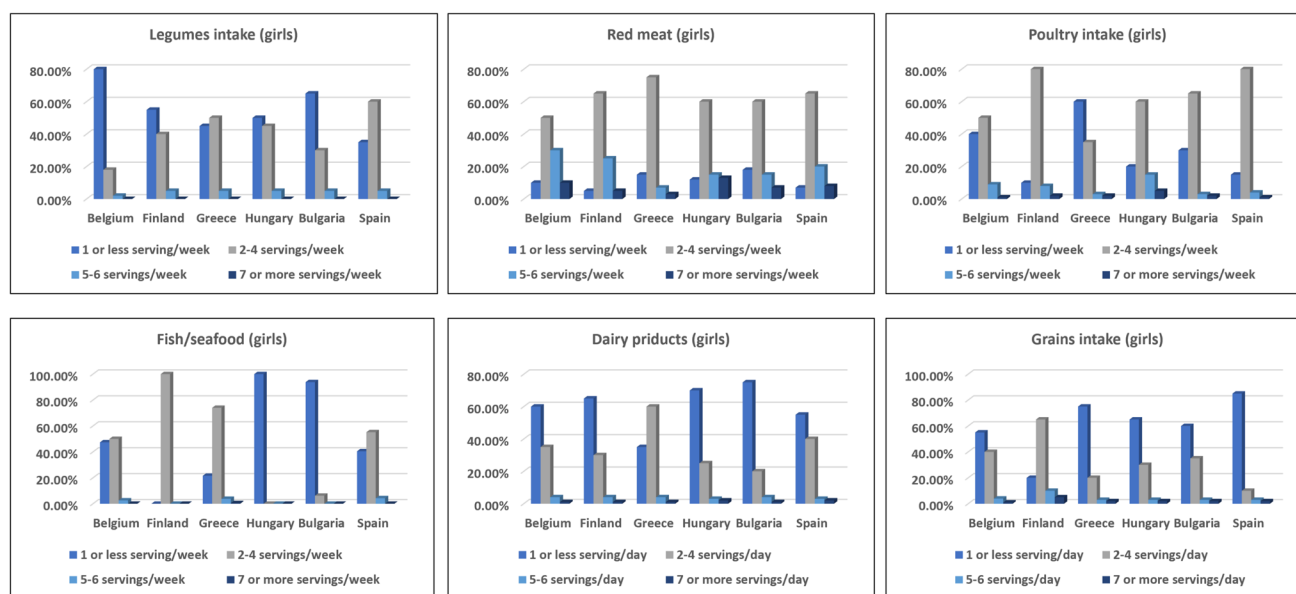
### Consumption of sweets, soft drinks and savoury snacks

Our data revealed daily sweet consumption ranged from 4.5% in Finland to 36.6% in Belgium, with Belgium leading

the EU in sweet and chocolate intake. High sweet consumption is linked to obesity risk, as noted in studies from Greece and Ontario [33, 34]. Children's early preferences for sugary foods significantly influence long-term dietary habits, emphasizing the need for early intervention to promote healthier eating patterns [35].

Daily soft drink consumption varied from 1.6% in Finland to 18.4% in Belgium, consistent with a WHO study showing





**Fig. 4** Frequency of consuming legumes, red meat, poultry, fish/seafood, dairy products, and grains among girls by country

significant between-country differences [36]. Socio-economic factors affect these habits, with higher parental occupational status associated with lower soft drink consumption in Northern, Southern, and Western Europe.

Our results indicated that 6.0% of Bulgarian, 3.8% of Hungarian, and 2.2% of Greek children consumed 1–2 servings of savory snacks daily, with no significant variations by country or gender. Notably, children with overweight/obesity showed increased soft drink consumption compared to those with normal weight, aligning with findings from the INMA Project [37] and other studies [38, 39].

#### Children's actual intake Vs European Food-based Dietary Guidelines

Our results showed that most children consume only 1 to 4 servings of fruits and vegetables (FV) per week, well below the recommended 2 to 3 servings daily [40]. Factors such as parents' eating habits, FV availability, cost, and lack of nutritional knowledge contributed to this low intake. Grain consumption was also below the recommended 3 daily servings, partly due to study methodology and limited food categories in the FFQ. The Dutch study found most children met or exceeded grain recommendations, primarily from refined grains [41].

Our FFQ excluded items like "rice" and "pasta," likely underestimating grain intake. Insufficient legume intake was observed, consistent with findings from North America, Europe, and Oceania [16]. Fish and seafood intake was generally low, except in Finland, where over 80% met recommendations [10, 31]. Dairy consumption averaged 2–4

servings per week, instead of the recommended 2–3 per day, consistent with declining milk intake in Germany [42]. Excessive sweets and soft drinks were common [33, 43].

#### Limitations and strengths

The study's cross-sectional design and reliance on parental self-reported food data may limit accuracy, as self-reported questionnaires are less precise than methods like 24-h dietary recalls [44, 45]. Social desirability bias may also affect results, as participants might report dietary intake aligning with perceived healthy eating norms. The uneven distribution of participants across countries limits the generalizability of findings, introducing potential bias. Despite these limitations, the study's strength lies in its large, diverse cohort from six European countries, with standardized procedures and trained researchers ensuring the accuracy of anthropometric measurements.

#### Conclusion

Our study highlights diverse dietary habits among primary-school-aged children in Europe, with significant variations in food intake by country, gender, and obesity status. 'Nutrient-dense' foods consumption generally fell below recommendations, while 'energy-dense, low-nutrient' food, particularly in overweight/obese children, exceeded limits. These patterns are influenced by environmental, parental, cultural, and socioeconomic factors. Future research should explore these relationships further to develop targeted, context-specific

interventions. Collaborative efforts among healthcare professionals, educators, and policymakers are essential to improve children's nutrition and reduce the prevalence of childhood obesity.

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#### Members of the Feel4Diabetes-study Group:

##### The group representative: Yannis Manios

Department of Nutrition and Dietetics, School of Health Science & Education, Harokopio University, Athens, Greece. (manios@hua.gr)

<sup>1</sup>**Universidad De Zaragoza (Spain):** Luis Moreno, Fernando Civeira, Gloria Bueno, Pilar De Miguel-Etayo, Esther M<sup>a</sup> Gonzalez-Gil, María L. Miguel-Berges, Natalia Giménez-Legarre; Paloma Flores-Barrantes, Aleli M. Ayala-Marín, Miguel Seral-Cortés, Lucia Baila-Rueda, Ana Cenarro, Estíbaliz Jaraúta, Rocío Mateo-Gallego.

<sup>3</sup>**Technische Universität Dresden (Germany):** Peter Schwarz, Patrick Timpel.

<sup>6</sup>**Ghent University (Belgium):** Department of Movement and Sports Sciences: Greet Cardon, Vicky Van Stappen, Nele Huys, Department of Public Health: Lieven Annemans, Ruben Willems, Department of Endocrinology and Metabolic Diseases: Samyah Shadid.

<sup>8</sup>**University of Debrecen (Hungary):** Imre Rurik, Timea Ungvari, Zoltán Jancsó, Anna Nánási, László Kolozsvári, Csilla Semánova, Éva Bíró, Emese Antal, Sándorné Radó; Extensive Life Oy (Finland): Remberto Martinez, Marcos Tong.

<sup>10</sup>**Medical University of Varna (Bulgaria):** Violeta Iotova, Tsvetalina Tankova, Natalia Usheva, Kaloyan Tsochev, Nevena Chakarova, Sonya Galcheva, Romyana Dimova, Yana Bachata, Zhaneta Radkova, Vanya Marinova, Yuliya Bazdarska, Tanya Stefanova.

<sup>12</sup>**Harokopio University (Greece):** Yannis Manios, Kalliopi Karatzi, Odysseas Androutsos, George Moschonis, Spyridon Kanelakis, Christina Mavrogianni, Konstantina Tsoutsouloupoulou, Christina Katsarou, Eva Karaglani, Irini Qira, Efstathios Skoufas, Konstantina Maragkopoulou, Antigone Tsiafita, Irini Sotiropoulou, Michalis Tsolakos, Effie Argyri, Mary Nikolaou, Eleni-Anna Vampouli, Christina Filippou, Kyriaki Apergi, Amalia Filippou, Gatsiou Katerina, Efstratios Dimitriadis.

<sup>16</sup>**University of Athens (Greece):** Konstantinos Makrilakis, Stavros Liatis, George Dafoulas, Christina-Paulina Lambrinou, Angeliki Giannopoulou;

<sup>17</sup>**Finnish Institute for Health and Welfare (Finland):** Jaana Lindström, Tiina Laatikainen, Katja Wikström, Jemina Kivelä, Päivi Valve, Esko Levälähti, Eeva Virtanen, Tiina Pennanen, Seija Olli, Karoliina Nelimarkka

<sup>18</sup>**International Diabetes Federation European Region (Belgium):** Winne Ko, Ernest Karuranga.

**Authors' contributions** Lubna Mahmood conducted statistical analyses and wrote the manuscript; Yannis Manios coordinated the study; Luis A Moreno, Yannis Manios, Peter Schwarz, Greet Cardon, Violeta Iotova, Imre Rurik, Kostas Anastasiou contributed to the study design; Esther M. Gonzalez-Gill and Luis A Moreno critically revised and supervised the manuscript; Ruben Willems, Violeta Iotova, Roumyana Dimova provided essential intellectual input; all authors read, revised, and approved the final manuscript.

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**Data availability** Data is provided within the manuscript.

## Declarations

**Ethics approval** The study followed the Declaration of Helsinki guidelines. Ethical approval was obtained from the Ethical Committees of Spain (code: CP03/2016), Greece (code: 46/3–4-2015), Finland (code: 174/1801/2015), Belgium (code: B670201524237), Bulgaria (code: 52/10–3–201r), and Hungary (code: 20095/2016/EKU).

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## Authors and Affiliations

Lubna Mahmood<sup>1</sup> · Luis A. Moreno<sup>1,14,15</sup> · Peter Schwarz<sup>3,4,5</sup> · Ruben Willems<sup>6</sup> · Greet Cardon<sup>7</sup> · Soukaina Hilal<sup>8</sup> · Imre Rurik<sup>9</sup> · Violeta Iotova<sup>10</sup> · Yuliya Bazdarska<sup>10</sup> · Roumyana Dimova<sup>11</sup> · Kostas Anastasiou<sup>12</sup> · Yannis Manios<sup>12,13</sup> · Esther M. Gonzalez-Gil<sup>1,2</sup> · on behalf of the Feel4Diabetes-Study Group

✉ Luis A. Moreno  
lmoreno@unizar.es

<sup>1</sup> Growth, Exercise, Nutrition and Development (GENUD) Research Group, University of Zaragoza, Zaragoza, Spain

<sup>2</sup> Centro de Investigación Biomédica en Red de Fisiopatología de La Obesidad y Nutrición (CIBEROBN), Instituto de Salud Carlos III, Madrid, Spain

<sup>3</sup> Department for Prevention and Care of Diabetes, Medical Faculty Carl Gustav Carus at Thea, Technical University of Dresden, Dresden, Germany

<sup>4</sup> Paul Langerhans Institute Dresden of the Helmholtz Center Munich at University Hospital and Faculty of Medicine, TU Dresden, 01307 Dresden, Germany

<sup>5</sup> German Center for Diabetes Research (DZD E.V.), 85764 Neuherberg, Germany

<sup>6</sup> Department of Public Health and Primary Care, Ghent University, Ghent, Belgium

<sup>7</sup> Department of Movement and Sports Sciences, Ghent University, Ghent, Belgium

<sup>8</sup> Doctoral School of Health Sciences, University of Debrecen, Debrecen, Hungary

<sup>9</sup> Department of Family Medicine, Semmelweis University, Budapest, Hungary

<sup>10</sup> Department of Pediatrics, Medical University of Varna, Varna, Bulgaria

<sup>11</sup> Division of Diabetology, Department of Endocrinology, Medical University of Sofia, Sofia, Bulgaria

<sup>12</sup> Department of Nutrition and Dietetics, School of Health Science & Education, Harokopio University, Athens, Greece

<sup>13</sup> Institute of Agri-Food and Life Sciences, Hellenic Mediterranean University Research Centre, Heraklion, Greece

<sup>14</sup> Instituto Agroalimentario de Aragón (IA2), Zaragoza, Spain

<sup>15</sup> Instituto de Investigación Sanitaria de Aragón (IIS Aragón), Zaragoza, Spain