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Original Research

Longitudinal associations between psychosomatic and emotional status and selected food portion sizes in European children and adolescents: IDEFICS/I.Family study

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Abbreviations: BMI, body mass index; I.Family, Investigating the determinants of food choice, lifestyle and health in European children, adolescents and their parents; IDEFICS, Identification and Prevention of Dietary- and Lifestyle-Induced Health Effects in Children and Infants; KINDL, emotional well-being during the last week score; PS, portion sizes; SDQ, Strengths and Difficulties Questionnaire; T0, baseline measurement of IDEFICS; T1, follow-up measurement of IDEFICS; T3, follow-up measurement of I.Family.

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ABSTRACT

This study aims to investigate the influence of psychosomatic and emotional status on food portion sizes (PSs) consumption from high energy-dense food groups in European children and adolescents. We hypothesized that psychosomatic and emotional status would have a significant association with the PS selection of energy-dense food. The study included 7355 children aged between 2 and 9.9 years at baseline (T0) (48.8% females); 3869 after 2 years (T1) (48.2% females), and 2971 (51.8% females) after 6 years of follow-up (T3). Psychosomatic and emotional status were measured using emotional well-being during the last week score (KINDL) and Strengths and Difficulties Questionnaire. PS was calculated from daily food intake recorded in 24-hour dietary recalls. The associations between emotional status indicators and PS from selected energy-dense food groups were assessed by multilevel linear regression models. In the cross-sectional analysis, we observed that higher KINDL scores were linked to lower PS consumption from sweet bakery products and savory snacks in both genders. Moreover, we found that adolescent females with high emotional and peer problem scores tended to consume larger PS of carbohydrate-rich and sugar-fatty food items ($P < .017$). Longitudinally, higher peer problem scores were associated with increased PS from bread and rolls, margarine and lipids, and dairy products in all genders and age groups ($P < .017$). In adolescents, psychosomatic and emotional status could be a trigger for consuming large PS from carbohydrate-rich and sugar-fatty energy-dense foods. Thus, nutritional interventions should consider emotional status to decrease unhealthy dietary habits in children and adolescents.

1. Introduction

Food intake is regulated by physical needs, but it is also affected by emotional states, motivations, and self-regulatory processes [1,2]. Negative and increased or decreased cognitive control can override the basic maintenance of energy balance, triggering an increase or reduction in food intake to cope with stress and negative emotions [3,4]. Stressors during childhood may arise from multiple events in the daily life environment, such as school and family, and they may influence a child's behavior, with consequences for both their physical and mental health [5]. It has been found that an inability to cope with negative emotions is linked to increased food consumption, particularly of sugary and fatty foods [6].

A bidirectional relationship between emotional status and eating has been proposed, where emotions control eating and vice versa [3]. Emotional eating, defined as the tendency to overeat in response to negative emotions such as anxiety or irritability, has been observed to be on the rise [7]. This emotion-driven impulsiveness has been linked more to the type of snack food consumed (sweet and fat) rather than the energy intake of food consumed per eating occasion [8].

External factors and emotional states may influence food intake, both in type and quantity consumed [9]. It has been observed that those with higher scores in terms of dietary restraint or emotional disinhibition ate more when presented with larger portion sizes (PSs) indicating that positive and negative moods may be linked to increased food and energy intake across different age groups [9]. O'Neil et al. 's [10] recent systematic review found a connection between poor psychosocial well-being and consumption of energy-dense foods such as refined grains, processed meat, sugary snacks, high-sugar soft drinks, fried food, and saturated fat-rich foods in children and adolescents. Another study in the same age groups found that emotional status is associated with increased consumption of sweets and fatty foods, potentially leading to overweight issues [11]. This suggests that when individuals are experiencing negative emotional states, they may select larger PS to achieve sufficient satisfaction or satiety for coping with negative moods [12,13].

The eating habits of children play a crucial role in their overall health and well-being, influencing not only their physical health but also their emotional and psychological development [14]. In light of the escalating global prevalence of childhood obesity and the associated health concerns, understanding children's eating habits has become increasingly urgent [15]. Moreover, the consequences of unhealthy eating habits extend far beyond physical health, affecting mental well-being, cognitive development, academic performance, and emotional stability [14,15]. While the relationship between emotional status and dietary intake, mainly PS, has been explored in the general population, little research has focused specifically on children and adolescents.

Therefore, this study aims to investigate the cross-sectional and longitudinal influence of psychosomatic and emotional status on PS selection from energy-dense food groups in early life. By clarifying these associations, we hope to inform future research and interventions aimed at promoting healthier dietary habits and overall well-being in this vulnerable population. We hypothesize that both psychosomatic and emotional status have a significant association with the PS selection of energy-dense food in children and adolescents.

2. Material and methods

2.1. Study design

The analysis utilized data from the "Pan-European IDEFICS/I.Family children cohort." The IDEFICS cohort initially consisted of 16,229 children aged between 2 and 9.9 years at baseline (T0) [16]. The baseline survey (T0) was conducted from autumn 2007 to spring 2008 across eight European countries: Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden. Subsequent assessments were carried out in 2009-2010 (T1) when participants were aged between 4 and 12 years. The final assessment took place from 2013 to 2014 (T3), with participants aged between 4 and 17 years as part of the I.Family study, with a median follow-up time of approximately 6.5 years. [16]. The average proportionate attrition in the IDEFICS follow-up was 32.6%. The final participant sample included in the follow-up was 13,587 and 10,681 children from the original IDEFICS cohort in T1 and T3, respectively. While the study design did not aim to provide a representative sample for each country, it marked the inception of the largest European children's prospective cohort study to date.

Recruitment efforts targeted children residing in the specified regions and attending selected preschools, kindergartens, or primary schools. Recruitment occurred through schools and kindergartens, and parental informed consent was obtained for each participating child, with verbal approval also sought from the children themselves immediately before examination. Institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research, and the IDEFICS study passed the Ethics review process of the Sixth Framework Programme (FP6) of the European Commission. Ethical standards were upheld with approval from local authorities of the European Commission in each country, adhering to the 1964 Declaration of Helsinki and its subsequent amendments [17]. For additional study details, including design, sampling, and procedures, refer to prior publications [16,18].

2.2. Study sample

Out of the total sample of 7355 in T0, 3869 in T1, and 2971 children in T3 met the criteria of availability of at least one complete 24-hour dietary recall with plausible reporting of energy intake and the full set of exposure measurements: emotional well-being and self-esteem of the child during the last week score (KINDL), data about emotional and peer problems over the last 6 months, and covariate information including body mass index (BMI) and parental education. A flow chart for the total sample selection can be found in Figure 1.

2.3. Assessment of psychosomatic and emotional symptoms

Psychosomatic and emotional symptoms in children were described by two variables: "emotional well-being and self-esteem of the child during the last week," and "emotional problems and frequent occurrence of headaches, stomachaches or sickness over the last 6 months." The KINDL questionnaire provides insight into the child's self-perception of self-esteem and parent relations, while the Strengths and Difficulties Questionnaire (SDQ) incorporates parental perspectives on emotional and peer problems. By including both child

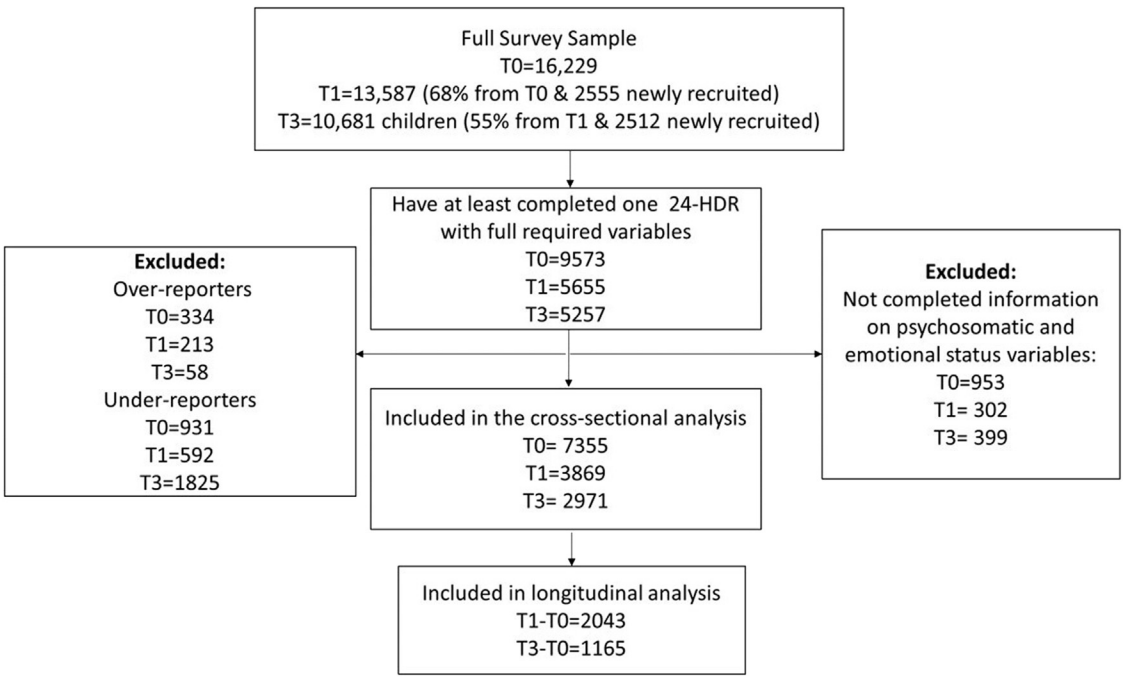

Fig. 1 – Study flowchart for the study associations between psychosomatic and emotional status and selected food portion sizes in European children and adolescents. Abbreviations: 24-HDR, 24-hour dietary recall; T0, baseline measurement of IDEFICS; T1, follow-up measurement of IDEFICS; T3, follow-up measurement of I.Family.

and parent perspectives, we obtained a more holistic understanding of psychosocial well-being. The utilization of these two variables in our study was essential for providing a robust assessment of psychosocial and emotional status in children and adolescents. This consideration was based on the comprehensive nature of the scales, their validation and reliability, alignment with the study context, inclusion of diverse perspectives, adaptation to population characteristics, and the incorporation of parental perspective.

2.4. *Emotional well-being and self-esteem of the child during the last week*

Parents were asked to fill out the emotional and self-esteem subscales of the "KINDL Questionnaire for Measuring Health-Related Quality of Life in Children and Adolescents" [19], which had previously been tested for its reliability and validity [20]. This questionnaire assesses the child's quality of life in multiple dimensions and was included in the IDEFICS parental questionnaire [19]. The items of the emotional and self-esteem subscales ranged from 1 (never) to 4 (often or always), with reversals depending on the wording of the question, and they were added up to a total score, with a high value indicating high well-being [19,20].

2.5. *Emotional and peer problems over the last 6 months*

Emotional and peer problems were evaluated using the Emotional Symptoms Scale of the SDQ [21,22], a validated tool developed for children aged 4 to 16 years. The IDEFICS study used the informant-rated version, which has been found to be highly correlated with the child-rated version [22]. The peer problems score included five questions: (1) Is your child rather solitary and tends to play alone? (2) Does your child have at least one good friend? (3) Is your child generally liked by other children? (4) Is your child picked on or bullied by other children? (5) Does your child get on better with adults than with other children?

The emotional problems score included five responses, scoring from 0 "not true" to 2 "certainly true" and summed to total scores ranging from 0 to 10. A high value indicated more difficulties or life struggles [22]. The categories included started with "The child/adolescent…": (1) often complains of headaches, stomach-aches, or sickness, (2) has many worries or often seems worried, (3) is often unhappy, depressed, or tearful, (4) is nervous in new situations, easily loses confidence, and (5) has many fears, easily scared. Cut-off values for "No detectable emotional problems" were ≤ 3 and, and for "No detectable peer problems" ≤ 2. The internal consistency of the scale in the present study was good (Cronbach's $\alpha = 0.87$).

2.6. *Dietary assessment*

Dietary intake for this study was assessed using computer-assisted 24-hour dietary recall software: SACINA [23] at T0 and T1, and SACANA at T3 [24], an extended, web-based version of SACINA These tools were developed and validated for assessing absolute energy and nutrient intake, food and drink contributions to total energy and nutrient intake, PSs, and food groups within the past 24 hours for children and adolescents [25]. For each time point, T0, T1, and T3, two 24-hour dietary recalls were recorded for the participants. However, to keep a sufficient sample size, only the first 24-hour dietary recall was considered in this study for each time point: 9573 in T0, 5655 in T1, and 5257 in T3. Misreporting, a common bias in dietary assessment, was evaluated by comparing individual energy intake to basal metabolic rate and age- and sex-specific energy intake to basal metabolic rate using Goldberg cut-offs, a method with good predictive value for characterizing misreporting [26].

2.7. *PS calculation and food group selection*

For each participant, the total gram intake of every food item consumed during the 24-hour recall was recorded. Subsequently, the number of eating occasions was determined for each participant based on the data obtained from the 24-hour recall. To calculate the food PS consumed per eating occasion, the total gram intake for each food item was divided by the corresponding number of eating occasions. Then, the PS for every food item within a specific food group was aggregated, a common approach in studies on food PS in children and adolescents [27,28]. Only participants who consumed a specific food group were included in the analysis. For mixed dishes, they were reclassified based on the main ingredient present in the highest proportion after cooking. Alcoholic drinks and soya beverages were excluded due to infrequent consumption (more than 85% of the sample did not report consumption).

Following the World Cancer Research Fund guidelines [29], which defining high-energy density foods as having 225 to 275 kcal/100 g, we selected food items known to contribute significantly to energy intake and positively correlate with BMI in Europe and other countries [27,28]. Food items were grouped based on their energy density and further categorized within subgroups based on nutritional values, including: (1) cereals and cereal products, (2) sugar and sugar products, (3) fats and savory snacks, (4) nonalcoholic beverages and soups, and (5) dairy products and similar. Dietary data were analyzed for average energy intake (kcal and kJ), macronutrients (g), and percentage of energy [30].

2.8. *Parental education*

The education level, based on the International Standard Classification of Education [31], was obtained from the parental questionnaire and used to determine the highest level of either parent's education [32]. Levels 0 to 2 were classified as low education level; 3 to 5 were classified as medium education level; and 6 to 8 were classified as high education level.

2.9. *Anthropometric measurements*

Anthropometric measurements were taken barefoot and in underwear by trained researchers following a standardized protocol. Body weight was assessed in a fasting state using a calibrated Tanita electronic scale model BC 420 SMA with an adapter (Tanita Europe GmbH) to the nearest 0·1 kg. Height was measured with a calibrated Seca telescopic

height-measuring stadiometer model 225 (Seca) to the nearest 0·1 cm. BMI was calculated by dividing body weight in kilograms by the square of height in meters. BMI Z-scores and BMI categories were calculated according to Cole et al [33].

2.10. Statistical analysis

Descriptive characteristics are presented as mean ± standard deviation for continuous variables and as number and percentage for categorical variables.

To investigate the cross-sectional link between psychosomatic and emotional measurements (KINDL and SDQ) and food PS, multivariable multilevel linear regression models were used for periods T0, T1, and T3. Psychosomatic and emotional status were independent variables while food PS was the dependent variable, considering country as a random effect.

Longitudinal analysis was used to examine the relationship between changes in psychosomatic and emotional status (delta values) and changes in food PS (delta values) between T1 and T0 and between T3 and T0. Multivariable multilevel linear regression models, with country as a random effect, were applied to explore the associations. The Holm–Bonferroni adjustment was used to control type 1 errors in all regression analyses.

Regression models were stratified by age and gender for T3 to T0, and by gender only for T1 to T0. Adjustments were made for parental education and BMI. Statistical significance was set at a P-value of $< .017$.

Analyses were conducted using IBM SPSS v.25 (IBM Corp., New York, USA) and STATA software v.13 (College Station, TX, USA).

3. Results

3.1. General characteristics of study participants

Sample descriptive characteristics are presented in Table 1. At baseline and the T1 follow up, more than half (51.0%) of the participants were males, while at T3, the majority (51.8%) were females. Regarding psychosomatic and emotional status variables, all indicators were similar between baseline and follow-up. However, at T0 and T1 more than half of participants had detectable emotional well-being and detectable peer problem scores.

Table 1 – Descriptive characteristics at baseline (T0) and follow-up (T1 and T3) in the study associations between psychosomatic and emotional status and selected food portion sizes in European children and adolescents.

	Baseline T0	Follow-up T1	Follow-up T3	
	N = 7355	N = 3869	N = 1139	N = 1832
Age range	**2-9.9 years**	**4-12 years**	**4-9.9 years**	**10-17 years**
	6.1 (1.8)	7.9 (1.8)	8.3 (1.1)	11.6 (1.4)
Sex				
Male	3764 (51.2%)	2006 (51.8%)	558 (49.0%)	868 (47.4%)
Females	3591 (48.8%)	1863 (48.2%)	581 (51.0%)	964 (52.6%)
BMI categories (*n*, %)				
Underweight	792 (10.8%)	337 (8.7%)	89 (7.8%)	248 (13.5%)
Normal weight	5046 (68.6%)	2473 (63.9%)	812 (71.3%)	1164 (63.5%)
Overweight	1005 (13.6%)	697 (18.0%)	177 (15.5%)	321 (17.5%)
Obesity	512 (7.0%)	362 (9.4%)	61 (5.4%)	99 (5.5%)
Parental education (*n*, %)				
Lower education level	594 (8.1%)	292 (7.5%)	57 (5.0%)	123 (6.7%)
Medium education level	3410 (46.4%)	1725 (44.6%)	451 (39.6%)	756 (41.3%)
Higher education level	3351 (45.5%)	1852 (47.9%)	631 (55.4%)	953 (52.0)
Energy intake (Kcal/day)	1563.61 (428.37)	1729.6 (436.5)	1650.9 (272.8)	1781.6 (272.3)
Emotional well-being during the last week score (KINDL)[a]	2.4 (1.0)	2.3 (1.0)	2.6 (1.1)	2.4 (1.0)
Emotional problems score (SDQ)[b]	1.5 (1.6)	1.6 (1.7)	1.3 (1.4)	1.2 (1.3)
Peer problems score (SDQ)b	3.2 (1.3)	4.3 (1.2)	3.2 (1.7)	3.1 (1.6)
	N (%)	**N (%)**	**N (%)**	**N(%)**
Participants with detectable emotional well-being problems	3670 (49.9%)	2127 (54.9%)	371 (32.7%)	858 (46.8%)
Participants with detectable emotional problems score	924 (12.6%)	545 (14.1%)	162 (14.2%)	236 (12.9%)
Participants with detectable peer problems score	6771 (92.1%)	2989 (77.3%)	35 (3.1%)	94 (5.1%)

Abbreviations: %, percentage; BMI, body mass index; N, number.
Continuous variables are displayed with mean ± standard deviation and categorical variables with absolute frequencies and percentage.
[a] KINDL: Questionnaire for Measuring Health-Related Quality of Life in Children and Adolescents, range: 1 to 4, interpretation: high value = high well-being.
[b] SDQ: Strengths and Difficulties Questionnaire. Cut-off values for no detectable emotional problems ≤3 and, no detectable peer problems ≤2.

3.2. Psychosomatic and emotional level and food PS mean intake

Table S1 describes the psychosomatic and emotional level and PS mean intake from the main contributing food groups at T0, T1, and T3. When KINDL scores increased, there was a corresponding decrease in the PS mean intake of bread and rolls, sweet bakery products, savory snacks, sauces, and fruit and vegetable juices at both baseline and follow-up. In contrast at T0, an increase in the PS mean intake of bread and rolls, sweet bakery products, and milk and yogurt was observed alongside higher scores in emotional problems. Additionally, at T0, a higher peer problem score level was corresponding with increased PS consumption of bread and rolls, breakfast cereals, sweet bakery products, fruit and vegetable juices, and dairy products. Furthermore, at T3, increases in emotional and peer problem level were linked to decreased PS mean intake of various items, such as bread and rolls, pasta, and margarine and lipids.

3.3. Cross-sectional association between psychosomatic and emotional variables and food PS consumption

Table 2 illustrates the results of psychosomatic and emotional status and PS mean intake from the main contributing food groups at T0. Higher KINDL scores, indicating better psychosomatic well-being, were associated with smaller PS consumption from bread and rolls, sweet bakery products, savory snacks, sauces, and fruit and vegetable juices in both genders.

In contrast, higher emotional problem scores were correlated with larger PS intake from bread and rolls, sweet bakery products, and milk and yogurt in both genders. In Table 2, a higher peer problem score was associated with larger PS consumption from bread and rolls, breakfast cereals, sweet bakery products, fruit and vegetable juices, and dairy products in both genders. In females, higher peer problem scores were positively associated with larger PS intake from carbonated soft drinks (β: 0.070; 95%CI: 5.839/41.227).

In T1 (Table S2), females with higher KINDL scores had a positive correlation with large PS intake from margarine and lipids (β: 0.175; 95% CI: 0.321/4.229). On other hand, higher peer problem scores were linked to greater PS intake from cheese in males (β: 0.170; 95% CI: 7.798/21.672), while higher peer problem scores were associated with large PS intake from vegetable oils in both genders. All of these associations were statistically significant ($P < .017$).

Table S3 illustrates the results for psychosomatic and emotional status variables and mean PS intake from various food groups at T3. In the 4 to 9.9 years age group, higher KINDL scores were associated with smaller PS intake from sweet bakery products, savory snacks, and fruit and vegetable juices in both genders. Moreover, higher KINDL scores were associated with smaller PS intake from chocolates in males (β: –1.510; 95% CI: –2.536/–0.483) and bread and rolls in females (β: –4.613; 95% CI: –7.479/–1.745). In the same age group and in both genders, higher emotional and peer problems score were inversely associated with larger PS intake from various items, including bread and rolls, pasta, and breakfast cereals. Additionally, higher emotional scores were associated with larger PS intake from fruit and vegetable juices in males (β: 8.746; 95% CI: 2.819/14.671) and chocolates in females (β: 0.781; 95% CI: 0.210/1.352).

In females aged 10 to 17 years, higher emotional problem scores were associated with larger PS intake from bread and rolls (β: 1.290; 95% CI: 0.657/2.921), carbonated soft drinks (β: 0.693; 95% CI: 0.064/1.321), and the dairy products group. Moreover, higher peer problem scores were associated with larger PS intake from bread and rolls, sauces, and dairy products in both genders. In females of the same age group, higher peer problem scores were associated with larger PS intake from breakfast cereals (β: 3.171; 95% CI: 1.284/5.058), margarine and lipids (β: 2.745; 95% CI: 1.669/3.821), and carbonated soft drinks (β: 1.737; 95% CI: 0.886/1.588).

3.4. Longitudinal association between psychosomatic and emotional variables and food PS consumption

In T1 to T0 (Table 3), higher KINDL scores were correlated with larger PS intake from milk and yoghurt in both genders. Additionally, in females, higher emotional problem scores were associated with larger PS intake from chocolate (β: 0.750; 95% CI: 0.373/1.125), and butter and animal fats (β: 0.216; 95% CI: –0.356/0.075).

In T3 to T0, (Fig. 2) higher KINDL scores were associated with larger PS intake from milk and yoghurt in both genders aged 2 to 9.9 years. On other hand, higher emotional problem scores (Fig. 3) were associated with larger PS intake from bread and rolls (β: 0.435; 95% CI: 0.05/1.819), margarine and lipids (β: 3.505; 95% CI: 0.806/6.202), and dairy products in females aged 10 to 17 years.

Moreover, in males aged 2 to 9.9 years, (Fig. 4) higher peer problem scores were associated with larger PS intake from pasta (β: 3.034; 95% CI: 0.872/4.196) and sugar, honey, and jam (β: 0.909; 95% CI: 0.307/1.510), while in females of the same age group, higher peer problem scores were associated with larger PS intake from breakfast cereals (β: 1.844; 95% CI: 0.878/2.809) and chocolate (β: 1.264; 95% CI: 0.519/2.007). At age 10 to 17 years and in both genders, higher peer problem scores were associated with larger PS intake from butter and animal fats, as well as sauces. Moreover, higher peer problem scores were associated with larger PS intake from breakfast cereals, sugar, honey, and jams, confectionery nonchocolate, and carbonated soft drinks in females. All of these associations were statistically significant ($P < .017$).

4. Discussion

The main findings of our study indicate a notable connection between psychosomatic and emotional well-being and the consumption of PS from certain food groups, both in children and adolescents. As hypothesized, psychosomatic and emotional status have a significant association with the PS selection of energy-dense food. Longitudinally, we found that adolescent females with more emotional and peer problems tend to consume more carbohydrate-rich and sugar-fatty food products. Moreover, in school-age children, higher emotional well-being was associated with consuming larger PS from milk and yoghurt in both genders. On the other hand, having more peer problems was associated with consuming larger PS

Table 2 – Cross-sectional associations between the psychosomatic and emotional variables and the selected food portion sizes at Baseline T0 in the study associations between psychosomatic and emotional status and selected food portion sizes in European children and adolescents.

	(T0) N = 7355											
	Emotional well-being during the last week score (KINDL)[a]				Emotional problems score (SDQ)[b]				Peer problems score (SDQ)[b]			
	Males		Females		Males		Females		Males		Females	
Food groups	β	Lower/upper	β	Lower/upper	β	Lower/upper	β	Lower/upper	β	Lower/upper	β	Lower/upper
Bread and rolls	–0.101[c]	–11.966/–5.925	–0.104[c]	–11.800/–5.857	0.059[c]	1.346/5.115	0.016	–0.986/2.634	0.085[c]	3.513/8.249	0.080[c]	3.233/8.326
Breakfast cereals	–0.011	–1.996/1.331	–0.057	–4.342/0.010	0.019	–0.682/1.428	–0.009	–1.569/1.133	0.119[c]	1.633/4.367	0.106[c]	1.660/5.548
Pasta	0.001	–4.776/5.032	0.014	–3.492/6.124	0.023	–1.733/4.610	–0.026	–4.426/1.471	–0.074[c]	–8.807/–1.648	–0.077[c]	–9.648/–1.859
Rice and other cereals	–0.047	–11.033/2.017	–0.073	–11.865/–0.267	–0.017	–5.134/3.110	0.012	–2.963/4.231	0.031	–2.843/7.669	0.028	–3.053/7.137
Sweet bakery product	–0.114[c]	–15.955/–7.706	–0.095[c]	–12.487/–4.984	0.035	–0.349/4.842	0.018	–1.242/3.117	0.112[c]	5.538/11.666	0.096[c]	4.163/10.244
Savory snacks	–0.119[c]	–12.100/–2.463	–0.208[c]	–18.035/–8.014	–0.023	–4.200/1.789	0.020	–2.184/3.581	0.054	–1.160 5.980	0.100[c]	0.843/8.354
sugar, honey, jam and syrup	0.041	–0.298/2.746	0.031	–0.712/2.810	0.006	–0.851/1.098	–0.026	–1.594/0.537	0.050	–0.004/2.408	–0.018	–2.033/0.994
confectionery nonchocolate	–0.029	–4.247/2.153	–0.064	–4.108/0.546	0.014	–1.714/2.347	0.019	–1.049/1.681	0.071	–0.467/4.628	–0.029	–2.770/1.336
Chocolate	–0.068[c]	–4.214/–0.708	–0.048	–3.382/0.102	0.032	–0.353/1.749	0.071[c]	0.410/2.391	0.002	–1.258/1.382	0.038	–0.349/2.487
vegetable oils	0.144[c]	0.426/1.678	0.034	–0.363/0.814	0.082	–0.024/0.821	0.076	–0.061/0.642	0.048	–0.209/0.746	0.094	0.021/0.928
margarine and lipids	–0.002	–1.282/1.217	–0.007	–1.253/1.020	0.048	–0.230/1.389	0.065	–0.018/1.474	0.005	–0.907/1.055	0.022	–0.703/1.454
butter and animal fats	0.180[c]	1.832/5.559	0.046	–0.871/2.717	0.092	0.000/2.374	–0.041	–1.544/0.584	–0.010	–1.604/1.252	–0.025	–2.002/1.111
Sauces	–0.099[c]	–9.079/–3.018	–0.081[c]	–7.996/–1.878	–0.032	–3.166/00.734	–0.065[c]	–4.343/–0.456	0.029	–0.989/3.612	0.049	–0.058/5.127
fruit and vegetable juices	–0.146[c]	–71.921/–34.230	–0.087[c]	–53.615/–11.951	–0.015	–15.437/8.688	–0.043	–21.906/3.046	0.095[c]	12.483/42.284	0.090[c]	10.527/44.442
carbonated/soft/ isotonic drinks	–0.029	–27.145/8.060	–0.053	–41.714/0.363	–0.038	–18.884/3.448	–0.008	–14.635/10.804	0.040	–3.458/24.567	0.070[c]	5.839/41.227
Milk, yogurt	0.003	–12.202/14.475	–0.040	–26.238/–0.935	–0.027	–15.035/2.383	–0.052[c]	–18.282/–2.650	0.073[c]	10.211/30.848	0.123[c]	24.516/45.706
Cheese	0.009	–2.370/3.490	0.044	–0.315/6.040	0.004	–1.808/2.161	0.023	–1.053/2.896	0.003	–2.174/2.465	–0.045	–5.196/.0.234

Abbreviations: β, regression coefficient; CI, confidence interval; N, number of participants.
Adjusting for confounders: parental education, BMI, and country as random effect. Level of significance was set to 0.017.

[a] KINDL: Questionnaire for Measuring Health-Related Quality of Life in Children and Adolescents, range: 1 to 4, interpretation: high value = high well-being.

[b] SDQ: Strengths and Difficulties Questionnaire. Cut-off values for no detectable emotional problems ≤3 and, no detectable peer problems ≤2.

[c] Represent the significant values accepted after Holm–Bonferroni adjustment method.

Table 3 – Longitudinal associations between psychosomatic and emotional variables and selected food portion sizes at (T1-T0) in the study associations between psychosomatic and emotional status and selected food portion sizes in European children and adolescents.

Δ (T1-T0)	Δ T1-T0 N = 2043											
	Emotional well-being during the last week score (KINDL)[a]				Emotional problems score (SDQ)[b]				Peer problems score (SDQ)[b]			
	Males		Females		Males		Females		Males		Females	
Food groups	β	Lower/upper	β	Lower/upper	β	Lower/upper	β	Lower/upper	β	Lower/upper	β	Lower/upper
Bread and rolls	2.126	0.291/3.961	0.321	−1.476/2.118	0.783	−0.291/1.858	−0.563	−1.587/0.462	−0.210	−1.596/1.175	−0.778	−2.247/0.690
Breakfast cereals	0.013	−0.588/0.614	0.119	−0.528/0.766	−0.119	−0.471/0.233	−0.172	−0.541/0.197	−0.011	−0.464/0.443	0.055	−0.474/0.584
Pasta	0.662	−1.426/2.750	0.112	−1.903/2.126	−0.503	−1.726/0.72	−0.336	−1.484/0.812	0.377	−1.200/1.953	0.114	−1.532/1.761
Rice and other cereals	0.183	−1.545/1.910	0.339	−1.321/1.999	−0.406	−1.419/0.606	0.450	−0.497/1.396	−0.409	−1.713/0.895	−0.023	−1.380/1.334
Sweet bakery product	0.116	−1.914/2.146	−0.586	−2.462/1.29	0.093	−1.096/1.282	0.919	−0.150/1.988	0.883	−0.65/2.415	0.821	−0.712/2.354
Savory snacks	−0.480	−1.194/0.233	−0.328	−1.043/0.388	−0.213	−0.631/0.205	−0.159	−0.566/0.249	−0.399	−0.937/0.140	−0.254	−0.839/0.330
sugar, honey, jam and syrup	0.415	−0.120/0.950	0.031	−0.559/0.621	0.020	−0.294/0.334	−0.004	−0.340/0.332	0.371	−0.033/0.775	−0.136	−0.618/0.346
confectionery nonchocolate	−0.181	−0.584/0.222	−0.290	−0.641/0.061	0.038	−0.198/0.274	0.210	0.009/0.410	0.165	−0.139/0.469	−0.115	−0.401/0.172
Chocolate	−0.421	−1.079/0.237	−0.432	−1.091/0.227	0.204	−0.181/0.590	0.750[c]	0.373/1.125	−0.496	−0.993/0.001	0.542	0.002/1.080
vegetable oils	0.083	−0.023/0.190	0.046	−0.057/0.149	0.004	−0.058/0.066	0.041	−0.018/0.100	0.004	−0.076/0.084	−0.014	−0.098/0.071
margarine and lipids	−0.035	−0.351/0.280	−0.076	−0.371/0.220	−0.071	−0.256/0.113	0.093	−0.075/0.262	0.145	−0.093/0.383	0.026	−0.215/0.268
butter and animal fats	0.097	−0.148/0.342	0.112	−0.134/0.357	0.034	−0.110/0.177	0.216[c]	−0.356/0.075	−0.099	−0.284/0.086	−0.016	−0.217/0.185
Sauces	0.510	−0.706/1.726	0.563	−0.684/1.810	−0.337	−1.050/0.376	−0.287	−0.998/0.425	0.083	−0.835/1.001	0.059	−0.961/1.078
fruit and vegetable juices	−1.415	−1.762/0.933	1.591	−4.821/8.003	0.167	−3.553/3.887	0.888	−2.768/4.544	−4.342	−9.134/0.451	−0.861	−6.102/4.381
carbonated/soft/ isotonic drinks	0.672	−0.908/1.252	−0.001	−7.262/7.260	−1.736	−5.592/2.120	1.644	−2.496/5.783	−5.097	−10.065/−0.128	−1.687	−7.622/4.248
Milk, yogurt	1.386[c]	−0.400/1.372	0.605[c]	−0.180/1.028	−3.931	−8.611/0.748	−1.341	−5.575/2.894	−0.374	−6.407/5.659	−0.625	−6.697/5.446
Cheese	0.269	−1.273/1.811	0.918	−0.620/2.456	−0.858	−1.762/0.046	−0.478	−1.355/0.399	0.191	−0.974/1.355	−1.239	−2.495/0.018

Abbreviations: β, regression coefficient; CI, confidence interval; N, number of participants; Δ, change from baseline difference between groups.
Adjusting for confounders: parental education, BMI, and country as random effect. Level of significance was set to 0.017.

[a] KINDL: Questionnaire for Measuring Health-Related Quality of Life in Children and Adolescents, range: 1 to 4, interpretation: high value = high well-being.

[b] SDQ: Strengths and Difficulties Questionnaire. Cut-off values for no detectable emotional problems ≤3 and, no detectable peer problems ≤2.

[c] Represent the significant values accepted after Holm–Bonferroni adjustment method.

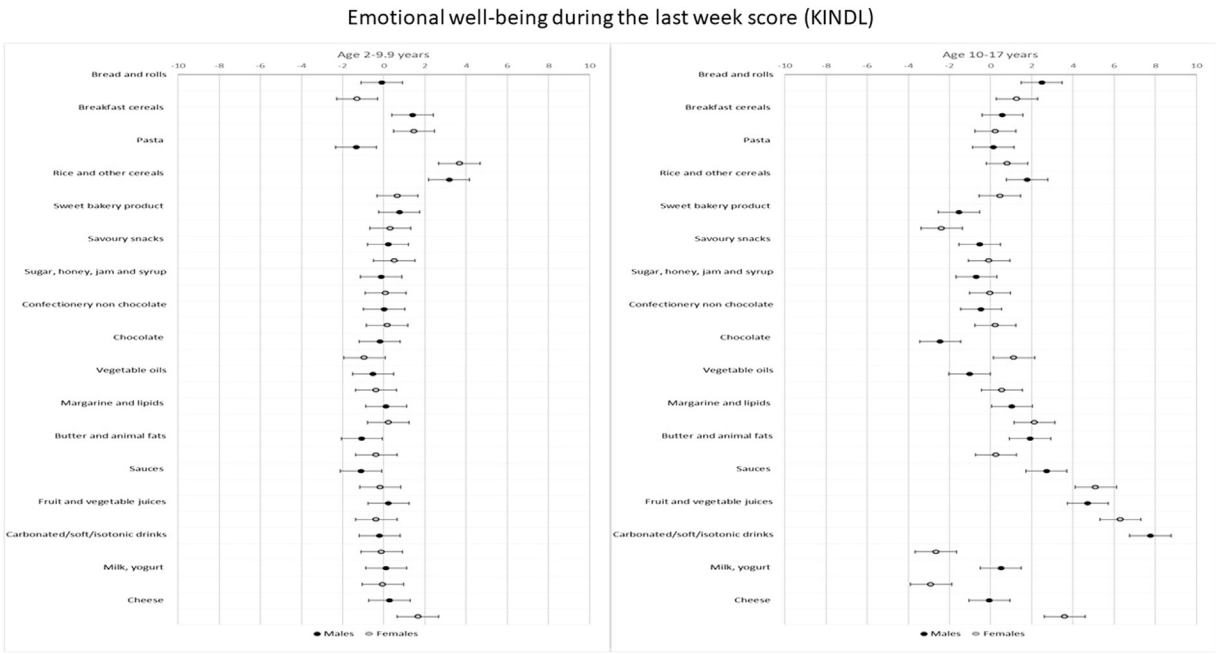

Fig. 2 – Longitudinal associations between KINDL score and selected food PS at T3 to T0. Longitudinal analysis was used to examine the relationship between changes in KINDL score, (delta values) and changes in food PS (delta values) between T3 and T0. Multivariable multilevel linear regression models, with country as a random effect, were applied to explore the associations. The Holm–Bonferroni adjustment was used to control type 1 errors in all regression analysis. The coefplot was used to plot the results to figure. Abbreviations: KINDL, emotional well-being during the last week score; PS, portion sizes; T0, baseline measurement of IDEFICS; T3, follow-up measurement of I.Family.

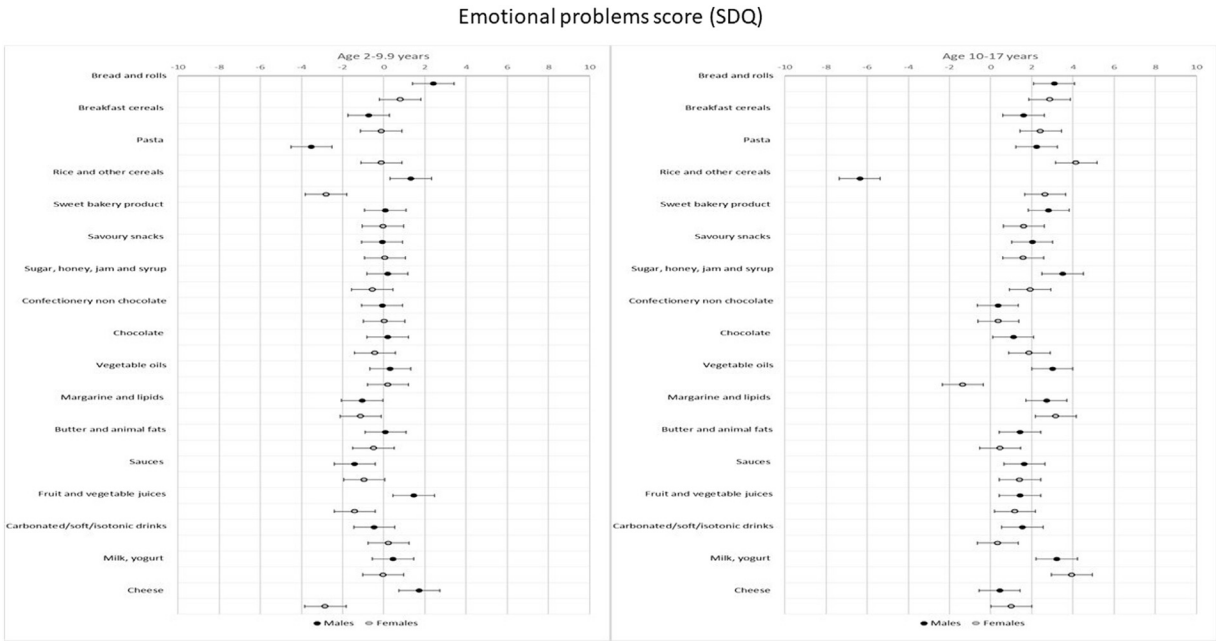

Fig. 3 – Longitudinal associations between SDQ score variables and selected food PS at T3 to T0. Longitudinal analysis was used to examine the relationship between changes in SDQ score (delta values) and changes in food PS (delta values) between T3 and T0. Multivariable multilevel linear regression models, with country as a random effect, were applied to explore the associations. The Holm–Bonferroni adjustment was used to control type 1 errors in all regression analysis. The coefplot was used to plot the results to figure. Abbreviations: PS; portion sizes; SDQ, emotional problems score; T0, baseline measurement of IDEFICS; T3, follow-up measurement of I.Family.

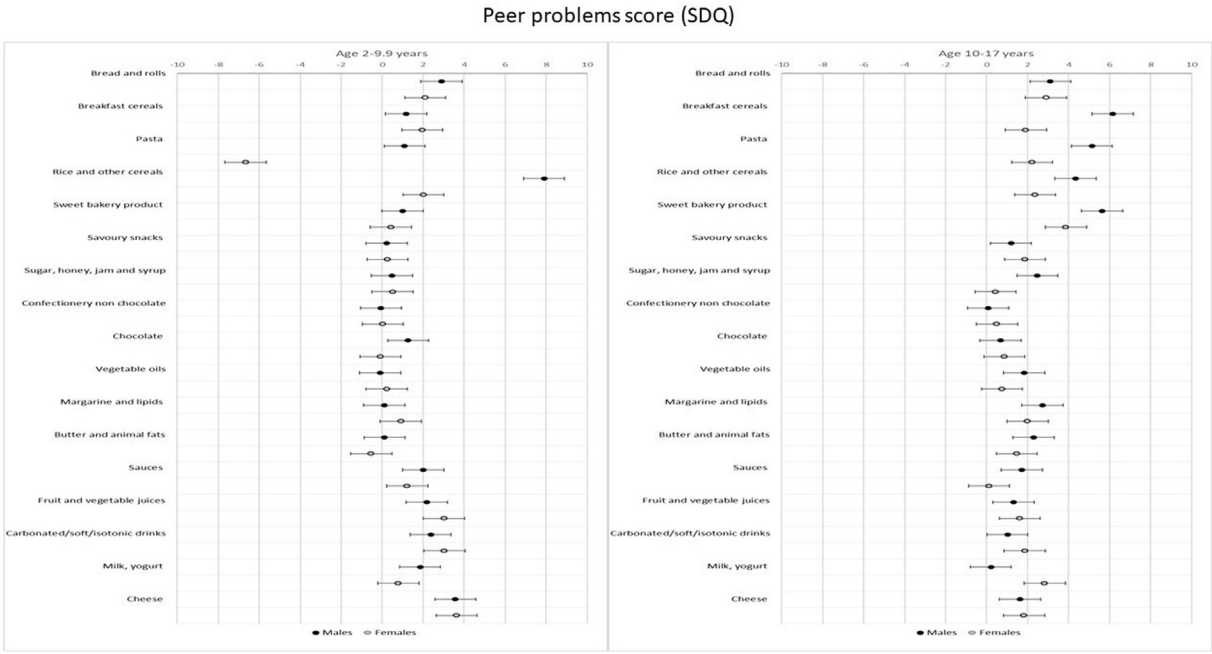

Fig. 4 – Longitudinal associations between SDQ score and selected food PS at T3 to T0. Longitudinal analysis was used to examine the relationship between changes in SDQ score (delta values) and changes in food PS (delta values) between T3 and T0. Multivariable multilevel linear regression models, with country as a random effect, were applied to explore the associations. The Holm–Bonferroni adjustment was used to control type 1 errors in all regression analysis. The coefplot was used to plot the results to figure. Abbreviations: PS; portion sizes; SDQ, peer problems score; T0, baseline measurement of IDEFICS; T3, follow-up measurement of I.Family.

from bread and rolls, margarine and lipids, and dairy products in both genders and in all age groups. In T3 to T0, higher SDQ scores were inversely associated with consuming larger PS from bread and rolls, pasta, breakfast cereals, and cheese in both genders and only in school-age children. These results were obtained after adjusting for potential confounders such as BMI and parental education, and including country as random effect.

4.1. *Psychosomatic and emotional status and food PSs*

The theory of emotional eating proposes that individuals may engage in overeating as a response to negative emotions [34]. In adolescents, longitudinal studies have shown that higher healthy diet scores at baseline predicted higher emotional scores at follow-up, whereas higher unhealthy diet scores at baseline predicted lower emotional scores at follow-up [35]. Additionally, another study found that higher consumption of fried foods, cakes, chocolate, biscuits, and soft drinks was linked to poorer behavioral and emotional problem scores in 14-year-old adolescents [36]. Furthermore, a previous analysis from the I.Family study reported that a higher perception of warmth at home correlated with a 16% increase in fruit and vegetable consumption frequency and energy-dense food consumption [10,37], supporting our finding that adolescent females with higher emotional and peer problem scores tend to consume more PS from carbohydrate-rich, and sugar-fatty food products.

Regarding peer problems, our study showed that a higher peer problem score was associated with larger PS intake from bread and rolls, margarine and lipids, and dairy products in all genders and age groups. This aligns with previous research where children who scored high on the SDQ hyperactivity subscale at age 7 were found to have a diet high in “junk food” during early childhood [38]. Additionally, positive associations have been observed between emotional and peer problems and the consumption of sweet and fatty foods, while negative associations were found between life events and fruit and vegetable consumption in children [13]. Another study from the I.Family project indicated that emotion-driven impulsiveness is linked to the type of snack food consumed, regardless of age, sex, socio-economic status, and BMI [10]. This suggests that the association between emotion-driven impulsivity and snacking behavior may be influenced by transient self-control deficits, such as ineffective reaction inhibition and emotion regulation methods [10].

Cross-sectionally, we found that a higher KINDL score in children was inversely associated with the consumption of large PS from high-energy-dense foods, mainly carbohydrate-rich, and sugar-fatty foods. Several potential explanations could account for our results. For instance, energy-dense foods that are high in fat and added sugars are often palatable, easily accessible, and convenient [39]. Consuming palatable foods can lead to short-term improvements in negative mood, particularly among individuals with high emotional intensity [40]. The mechanism behind this could be related to differ-

ences in sensitivity to the reward properties of food between emotional eaters and nonemotional eaters [41,42]. Emotional eaters might also turn to energy-dense foods as a means of distraction from negative emotions [43]. These foods are often referred to as "comfort foods," and consuming them may counteract the physiological effects of emotional status [43].

4.2. *Gender and age differences*

In the current study, we observed associations between emotional status and PS consumption of energy-dense snack foods in both genders, with stronger associations found in females. Previous research has also shown that adult females tend to have higher emotional status scores than males [44,45]. Furthermore, in response to emotional status, adult females had higher mean portions consumption of all energy-dense food groups, except for cheese and processed meat [45]. However, previous studies in children and adolescents did not account for gender differences, despite the well-known variations in dietary patterns between males and females, especially during adolescence. Boys tend to increase their energy intake for satiety, while a considerable percentage of females control their energy intake to manage body weight [46]. Additionally, meal size tends to decrease among females during adolescence, while it remains stable or increases among males, highlighting the importance of stratifying by gender. Among the possible explanations is that comfort food preferences are influenced by gender, with females often favoring sweet snack foods [47]. Additionally, ovarian hormones have been shown to predict changes in emotional status across the menstrual cycle, suggesting that females may be susceptible to fluctuations in emotional status during certain hormonal phases [48]. Another potential explanation in relation to psychosomatic and emotional status could be an interaction with genetic vulnerability [49]. Among older adolescents, the serotonin-transporter gene-linked polymorphic region genotype was shown to moderate the relationship between depressive feelings and an increase in emotional status in females only [49].

Our study also revealed various associations between psychosomatic and emotional status and PS, depending on age. Several factors may contribute to these observed differences. For example, in primary school children, their diet is still largely determined by their parents, which could lead to psychosomatic children having a greater desire to eat but not necessarily having access to the food [50,51]. Studies have shown that children's diet and emotional status are influenced by their parents' behaviors [51,52]. Additionally, a recent meta-analysis has suggested a decreasing influence from changing environments, such as school and peers, on children's dietary habits [53].

4.3. *Strengths and limitations*

This study is one of the first to investigate the link between psychosomatic and emotional status and food PS consumption among European children and adolescents. It considers relevant confounding factors like BMI and parental education, making the results more reliable. The research's strength lies in its substantial and diverse sample, with participants from eight European countries. The longitudinal design allows for a comprehensive exploration of emotional status and its association with food PS, being the first of its kind. Additionally, highly standardized, and validated data collection procedures for anthropometric measurements enhance result reliability.

However, the study has some methodological limitations. For example, it focuses on a limited number of psychosomatic and emotional outcomes, based on parent-reported data, potentially introducing bias and missing children's perspectives on their emotional experiences. There may also be selection or nonparticipation bias related to education or income levels and potential response bias [18]. Moreover, one of the main limitations of this study is the reliance on limited 24-hour dietary recalls, which may not accurately reflect participants' usual long-term dietary intake as these recalls capture only short-term actual intake. However, the use of a large sample size from different age groups helps to mitigate some of these limitations.

5. Conclusion

According to the main results, emotional status may be a factor that leads to larger PS of unhealthy food groups, particularly in female adolescents, which could be linked to overweight. Furthermore, in the longitudinal analysis, higher peer problem scores were associated with increased PS from bread and rolls, margarine and lipids, and dairy products in all genders and age groups. In adolescents, psychosomatic and emotional status could be a trigger for consuming large PS from carbohydrate-rich and sugar-fatty energy-dense foods. Generally, children and adolescents tend to eat smaller portions of energy-dense food, which may be due to parental control of their food choices. However, it is important to teach children and adolescents how to cope with their emotions in a healthy way, such as problem-solving thinking or asking for help instead of using food as a source of comfort. These findings suggest that individual psychological states should be taken into account when attempting to reduce unhealthy dietary habits, particularly in females. Further research is needed to determine the causal links and investigate the mechanisms that connect emotional status, larger food PS, and weight status.

Author Declarations

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

CRediT authorship contribution statement

Sondos M. Flieh: Writing – original draft, Formal analysis. **Antje Hebestreit:** Writing – review & editing. **Hermann Pohlabeln:** Writing – review & editing, Project administration. **María L. Miguel-Berges:** Writing – review & editing, Supervision. **Esther M. González-Gil:** Writing – review & editing, Conceptualization, Supervision. **Paola Russo:** Writing – review & editing. **Dénes Molnár:** Writing – review & editing. **Kathleen**

Wijnant: Writing – review & editing. **Lauren Lissner:** Writing – review & editing. **Stefanie Do:** Writing – review & editing. **Tonia Solea:** Writing – review & editing. **Toomas Veidebaum:** Writing – review & editing. **Luis A. Moreno:** Writing – review & editing, Supervision.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.nutres.2024.05.004.

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