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Dietary fat intakes in Irish children: changes between 2005 and 2019

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Abstract

Objective: To examine current dietary fat intakes and compliance in Irish children and to examine changes in intakes from 2005 to 2019.

Design: Analyses were based on data from the Irish National Children's Food Survey (NCFS) and the NSFS II, two cross-sectional studies that collected detailed food and beverage intake data through 7-day and 4-day weighed food diaries, respectively.

Setting: NCFS and NCFS II, Republic of Ireland.

Participants: A nationally representative sample of 594 (NCFS) and 600 (NCFS II) children aged 5–12 years. Current intakes from the NCFS II were compared with those previously reported in the NCFS (www.iuna.net).

Results: Current intakes of total fat, SFA, MUFA, PUFA and *trans* fat as a percentage of total energy are 33·3, 14·0, 13·6, 5·6 and 0·5 %, respectively. Total fat, SFA and *trans* fat intakes since 2005 remained largely stable over time with all displaying minor decreases of <1 %. Adherence to SFA recommendations remains inadequate, with only 7 % of the population complying. Insufficient compliance with PUFA (71 %) and EPA and DHA (DHA; 16 %) recommendations was also noted.

Conclusion: Children in Ireland continue to meet the total fat and *trans* fat target goals. Adherence to MUFA and PUFA recommendations has also significantly improved. However, deviations for some fats remain, in particular SFA. These findings are useful for the development of dietary strategies to improve compliance with current recommendations.

Keywords
Dietary fat
Fatty acid intakes
SFA
PUFA
Children

Dietary fat is an essential macronutrient in our diet which plays an important role within the body. It acts as an energy substrate, facilitates the absorption of fat-soluble vitamins, is a vital component of cell membranes and provides protection and insulation of internal organs[1,2]. Nevertheless, imbalances in the amount and types of dietary fat consumed have been associated with an increased risk of chronic diseases such as CVD, type 2 diabetes mellitus and some cancers[3]. Although presented later in life, many of these chronic diseases stem from prolonged unhealthy dietary behaviours which may have developed in childhood[4].

The evidence surrounding dietary fat and its association with chronic disease risk is widely recognised and as such, dietary fat guidelines have been established by public health organisations to aid public health campaigns in disease prevention[5–7]. However, dietary recommendations specific to children are not so clear. The variation in cut-offs for dietary fat recommendations between countries creates a challenge when trying to assess and compare global dietary fat intakes and compliance in children. The FAO of UN and WHO recommend that total fat intakes should be between 25 and 35 % of total energy (% TE) intake for children from 2 years of age onwards[5]. They also recommend that SFA and *trans* fat should be < 8 and 1 % TE, respectively, whereas PUFA should be more than 11 % TE. While the European Food Safety Authority have set a similar range for total fat intakes in children (20–35 %), they

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suggest that intake of SFA and *trans* fat should be as low as possible[6]. In addition, they provide no recommendation for total PUFA intakes, but they have set a combined recommendation of 250 mg/d for *n*-3 fatty acids, EPA and DHA[6].

Even though differing guidelines are widely used, many studies have shown that children rarely adhere to recommendations in terms of dietary fat. Harika *et al.* published a comprehensive review comparing dietary fat intakes in children and adolescents across thirty countries worldwide, revealing that of the countries surveyed, 90, 93 and 70 % did not meet the recommendations for total fat, SFA and PUFA, respectively[8]. These compliance rates are similar to those previously reported in Irish children in 2005, with greater compliance noted for total fat (88 %), whereas SFA and PUFA adherence was low at 6 and 47 %, respectively[9].

Such deviations have led to a number of public health campaigns and government-industry partnerships to help improve consumers' dietary fat profile[10,11]. For example, reformulation approaches have been carried out to reduce *trans* fat intakes in the Irish population[12]. Since it is unknown whether some of these past initiatives have successfully influenced children's fat consumption, it is essential to examine dietary intakes to assess compliance with current dietary guidelines. This will help to identify areas for improvement and subsequently develop focused interventions for those at high risk of developing poor dietary habits[13]. Therefore, the aims of this study were to first examine current intakes of total fat and fatty acid constituents; second, to measure compliance with recommendations and lastly to compare with previous data in order to examine changes in dietary fat intakes over time.

Methods

Study design and populations

This analysis is based on data from two cross-sectional national nutrition surveys which examined the habitual food and beverage intake of Irish children aged 5–12 years residing in the Republic of Ireland. The NCFS (2005) and the NCFS II (2019) are composed of data from 594 (293 boys, 301 girls) and 600 (300 boys, 300 girls) children, respectively[14,15]. Recruitment was carried out for the NCFS between March 2003 and March 2004 and for the NCFS II between April 2017 and May 2018. The selection and recruitment process were based on the relevant national population census data[16,17], and participants were recruited from primary schools drawn from the Department of Education and Skills' database[18]. Pupils in the schools were randomly selected to be contacted about the surveys. The overall response rates for the NCFS and NCFS II were 63 and 65 %, respectively. The rates refer to the percentage of respondents who completed the study upon invitation. There were no exclusion criteria aside from being a sibling to another participant. Analysis of the demographic profile of participants of both surveys demonstrated a representative sample of Irish children with respect to age, gender and geographical location[16,17,19] (see online supplementary material, Supplemental Table 1). The NCFS was representative of social class; however, the NCFS II sample contained a higher proportion of children of professional workers and a lower proportion of children of semi-skilled and unskilled workers than the national population. Therefore, statistical weighting was applied to all data in the NCFS II to account for these social class differences.

Data collection

A consecutive 7-day (NCFS) and 4-day (NCFS II) weighed food diary was used to collect food and beverage intake data. Data collection protocol was identical across both surveys, with the 4-day food diary requiring the inclusion of at least one weekend day in order to account for differences in children's eating habits between weekdays and weekends. Participants were visited by a researcher in their home on approximately three occasions during the recording period. Training was given during the initial visit to ensure accuracy of the food records. They were provided with a weighing scales and asked to record detailed information regarding the amount and types of all food and beverage intake, including nutritional supplements consumed. The parents and/or guardians typically recorded the food and beverages consumed on behalf of their child. Although, some of the older children recorded their own consumption with assistance from their parents and/or guardians. A food quantification protocol was established by the Irish Universities Nutrition Alliance and adapted for both the NCFS and NCFS II[20]. Information such as cooking methods, brand names of foods, recipe details, eating locations and participant definitions of eating occasions was recorded. Food packaging was also collected to provide additional information of the foods consumed. This level of detail meant that most meals consumed outside of the home could be traced back to the supplier for further information, i.e. ingredients, nutritional information and food weight. For unweighted and non-branded foods, a food atlas was utilised to estimate portions of the food consumed. Further details about this protocol can be found on www.iuna.net. The remaining visits were to review the food diary to ensure completion of the 7-day or 4-day food diaries, respectively, and to check for overall survey completeness.

Food intake data in the NCFS were analysed using WISP© (Tinuviel Software, Anglesey, UK). WISP© contains data from McCance and Widdowson's *The Composition of Foods*, fifth[21] and sixth[22] editions plus all nine supplemental volumes[23–31] to generate nutrient intake data. In the NCFS II, food intake data were analysed using Nutritics (Nutritics, Dublin, Ireland) which contains data from McCance and Widdowson's *The Composition of*

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Foods, sixth[22] and seventh[32] editions. Food composition databases were generated from each survey, listing each individual food item consumed by participants. Each food item was listed with its corresponding nutrient composition. Modifications were made to the food composition database to include recipes of composite dishes, nutritional supplements, generic Irish foods that were commonly consumed, reformulated foods and new foods on the market.

Estimation of fatty acid composition

Updates were required for the fatty acid of certain foods contained in the NCFS and NCFS II food intake databases, due to outdated concentrations of certain fatty acids composition (total fat, SFA, MUFA, PUFA, *trans* fat, *n*-6, *n*-3, alpha-linolenic acid (ALA), EPA and DHA). The databases were updated by means of a comprehensive methodology providing reliable estimates of dietary intakes of the fatty acids. A similar protocol was utilised in previous Irish national surveys[33]. An SPSS database was created containing all foods consumed, including recipes. Each food was assigned a unique food code. All food codes, including recipes, were examined and a fatty acid concentration was assigned to each. A number of data sources were used to update the concentrations such as current published food composition tables (56·8 %), published papers (1·2 %) and brand information (0·8 %)[22,32–36].

Calculating fatty acid intakes in Irish children

Total fat, SFA, MUFA, PUFA, *n*-6, *n*-3, EPA, DHA and *trans* fat values [grams (g)/100 g] were estimated in 1945 foods and recipes for NCFS (2005) and 2046 foods and recipes for NCFS II (2019). ALA values were not available for NCFS and therefore were only estimated for NCFS II. All estimated entries were rechecked by the researcher and, subsequently, a random selection was rechecked by another researcher to reduce the chance of error. Each fatty acid concentration was converted from g/100 g of food to the actual amount of fatty acid consumed per day (g/d). Usual intakes of nutrients were estimated using the validated NCI method[37] with SAS Enterprise Guide© software, version 7.1 (www.riskfactor.cancer.gov/diet/usualintakes/macro.html).

Statistical analysis

Statistical analyses were conducted using SPSS® V24.0 for Windows™ (SPSS Inc.). Descriptive statistics including mean and SD were calculated in both surveys for daily total fat, SFA, MUFA, PUFA, *n*-6, *n*-3, *trans* fat, ALA, EPA and DHA intakes (g/d and %TE) for the total population and by gender and age group. Independent sample *t* tests were performed to compare fatty acid intakes between groups such as survey, gender and age. Compliance with UK[7,38] and European Food Safety Authority[6] dietary fat intake recommendations was assessed using the approach described by Wearne and Day[39]. Each food was aggregated into one of twenty-six food groups, based either on its predominant fat profile or associated food-based dietary guidelines[40,41] (see online supplementary material, Supplemental Table 2). The percentage contribution of each food group to total fat and fatty acid constituents was then calculated. The Bonferroni correction method for multiple comparisons was utilised and significance for all statistical analyses was classified as $P \leq 0{\cdot}05$.

Results

Intakes of dietary fat

Table 1 presents the mean intakes of total fat and constituent fatty acids (g/d and % TE) from the NCFS II in 2019. Intakes of total fat, SFA, MUFA and *trans* fat (% TE) in the total population were 33·3, 14·0, 13·6 and 0·5 %, respectively. The % TE from PUFA was 5·6 %, of which 3·6 % was contributed by *n*-6 and 0·7 % by *n*-3. Within *n*-3 fatty acids, ALA, EPA and DHA were 0·6, 0·03 and 0·04 % TE, respectively. Significant differences between gender and age group were also identified across all fatty acids in g/d and % TE with higher intakes of all fats (g/d) being consumed by the older cohort (9–12 years) and by boys of all ages ($P < 0{\cdot}001$).

Comparisons between intakes of total fat and constituent fatty acids (g/d and % TE) in the NCFS (2005) and NCFS II (2019) are displayed in Table 2. Overall, no significant changes were apparent for intakes of total fat, which remained similar at 34 and 33 % TE between 2005 and 2019, respectively. Intakes of SFA and *trans* fat decreased slightly from 14·5 to 14·0 % and 0·53 to 0·51 % TE, respectively, whereas MUFA, PUFA, *n*-6, *n*-3, EPA and DHA presented significant increases of 2·1, 0·6, 0·5, 0·1, 0·02 and 0·02 % TE, respectively. Similar trends were observed across gender.

Percentage contribution of food groups to dietary fat

The percentage contribution of food groups to dietary fat is presented in Tables 3a and b. In 2019, 'meat products', 'biscuits cakes, pastries and buns' and 'whole milk' were among the top sources of total fat, SFA and MUFA, contributing overall 31·5, 27·9, and 27·3 %, respectively. Whilst similar in 2005, these collective contributions from the food groups were slightly higher at 38·0, 32·3, and 31·3 %, respectively (Table 3). The top contributors to PUFA intake in both 2005 and 2019 were 'breads and rolls' (10·9 %) and 'meat products' (9·8 %). Current major food sources of EPA and DHA are 'fish, fish products and fish dishes' (25·3 %), 'fresh meat' (19·3 %) and 'whole milk' (11·8 %), which has remained consistent since 2005 (Table 4). Nutritional supplements featured as a source of EPA and DHA; however, they did not make a substantial contribution to intakes (1·9 %). Primary sources of *trans* fat intakes were 'meat dishes', 'whole milk' and 'cheeses' in 2005 and 2019 with

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Table 1 Intakes of total fat intake (g or mg/d and % of total energy (% TE)) and its constituent fatty acids in Irish children in 2019

	Total population		Gender					Age				
			Boy		Girl			5–8 years		9–12 years		
	(*n* 600)		(*n* 300)		(*n* 300)			(*n* 300)		(*n* 300)		
	Mean	SD	Mean	SD	Mean	SD	*P**	Mean	SD	Mean	SD	*P**
Energy (kcal)	1486·58	275·07	1582·82	279·94	1397·91	238·29	<0·001	1380·24	234·02	1599·81	270·30	<0·001
Total fat (g/d)	55·79	12·69	59·20	13·23	52·66	11·30	<0·001	51·56	11·04	60·30	12·79	<0·001
SFA (g/d)	23·41	5·59	24·66	5·75	22·25	5·18	<0·001	22·12	5·20	24·78	5·67	<0·001
MUFA (g/d)	22·88	5·55	24·38	5·83	21·50	4·89	<0·001	20·81	4·67	25·08	5·57	<0·001
PUFA (g/d)	9·28	2·47	9·95	2·63	8·67	2·13	<0·001	8·51	2·09	10·10	2·57	<0·001
Omega 6 (g/d)	6·00	1·59	6·49	1·69	5·55	1·35	<0·001	5·45	1·32	6·59	1·65	<0·001
Omega 3 (g/d)	1·23	0·39	1·29	0·41	1·18	0·36	<0·001	1·15	0·35	1·33	0·41	<0·001
Trans fat (g/d)	0·84	0·28	0·88	0·29	0·80	0·27	<0·001	0·80	0·27	0·88	0·29	<0·001
ALA (g/d)	0·99	0·31	1·05	0·33	0·94	0·29	<0·001	0·91	0·27	1·08	0·33	<0·001
EPA (mg/d)	41·66	32·51	45·57	35·74	38·06	28·76	<0·001	39·16	29·22	44·33	35·49	<0·001
DHA (mg/d)	63·68	50·55	68·59	54·77	59·17	45·86	<0·001	61·06	46·57	66·48	54·33	<0·001
Total fat (%TE)	33·31	3·83	33·17	3·85	33·43	3·80	<0·001	33·08	3·85	33·54	3·78	<0·001
SFA (%TE)	14·02	2·15	13·88	2·15	14·16	2·14	<0·001	14·19	2·17	13·84	2·12	<0·001
MUFA (%TE)	13·60	1·79	13·61	1·82	13·59	1·77	<0·001	13·31	1·77	13·91	1·77	<0·001
PUFA (%TE)	5·55	0·98	5·58	1·00	5·52	0·97	<0·001	5·49	0·97	5·62	0·99	<0·001
Omega 6 (%TE)	3·58	0·61	3·64	0·62	3·52	0·59	<0·001	3·50	0·59	3·66	0·62	<0·001
Omega 3 (%TE)	0·74	0·18	0·72	0·18	0·75	0·18	<0·001	0·74	0·18	0·74	0·18	<0·001
Trans fat (%TE)	0·51	0·14	0·50	0·14	0·51	0·15	<0·001	0·51	0·15	0·50	0·14	<0·001
ALA (%TE)	0·61	0·16	0·60	0·16	0·61	0·16	<0·001	0·60	0·16	0·62	0·16	<0·001
EPA (%TE)	0·03	0·02	0·03	0·02	0·02	0·02	<0·001	0·03	0·02	0·03	0·02	<0·001
DHA (%TE)	0·04	0·03	0·04	0·03	0·04	0·03	<0·001	0·04	0·03	0·04	0·03	<0·001

n, number of participants; *n*-6; omega 6; *n*-3, omega 3; ALA, alpha-linolenic acid; g/d, grams per day; %TE – percentage of total energy.
*Independent samples *t* test for comparison of means between gender and age, adjusted *P* value using Bonferroni correction method for multiple comparisons was also utilised.

overall contributions from these food sources increasing from 33·1 to 38·7 % over time. 'Meat products' (10·9 %) were the greatest contributing foods to ALA intakes in 2019, as well as 'spreading fats and oils' (10·1 %). Of note, significant reductions in the contribution of dairy products to fatty acids are observed from 2005 to 2019, particularly for 'whole milk', 'low-fat spreads' and 'ice-cream and creams'. Despite these reductions, 'whole milk' still remains one of the top contributors across a number of the fatty acids examined, contributing from 6·9 to 15·5 % TE to total fat, SFA, MUFA, EPA, DHA and *trans* fat intakes. In contrast, 'low fat, skimmed and fortified milks', 'cheeses' and 'butter' presented significant increases in their contributions, ranging from 0·1 to 14·4 %. Furthermore, the contribution of 'biscuits, cakes, pastries and buns' also significantly increased across all fatty acids over time.

The percentage of Irish children adhering to dietary fat recommendations at a population level

The proportion of children adhering to dietary fat recommendations (% TE) for each fatty acid as a percentage of the total population is illustrated in Fig. 1. In 2005, a high level of population compliance with the recommendations for total fat (100 %) and *trans* fat (100 %) was observed, which continued in 2019. Compliance with MUFA recommendations has shown improvements from 81 to 100 %. SFA adherence in 2005 was low at 4 % showing only a slight improvement at 7 %. Although the level has improved, the current rate still remains low at 7 % in 2019. The proportion of children meeting PUFA recommendations was 71 % in 2019 which is an increase of 36 % since 2005. Adherence to EPA and DHA recommendations in the overall population increased from 2 to 16 % between 2005 and 2019. When stratified by gender, compliance across all fatty acids examined was similar to that reported in the total population.

Discussion

Over the last 14 years, improvements to the overall dietary fat profile in Irish children have been observed. The current findings demonstrate that Irish children continue to achieve total fat and *trans* fat recommendations (100 %), while adherence to MUFA recommendations has successfully improved to 100 %. However, despite these improvements, deviations from the recommendations for SFA, PUFA, EPA and DHA remain with only 7, 71 and 16 % of the population adhering to these recommendations, respectively.

Changes in the dietary fat intakes of Irish children in the current study are in line with those observed in other European countries[42,43]. In a cross-sectional study of German children, dietary fat intakes examined over a

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Table 2 Comparison of total fat intake (g or mg/d and % of total energy (% TE)) and its constituent fatty acids in Irish children in 2005 and 2019 by gender

	Total population					Gender									
	2005		2019			2005		2019			2005		2019		
						Boy		Boy			Girl		Girl		
	(*n* 594)		(*n* 600)			(*n* 293)		(*n* 300)			(*n* 301)		(*n* 300)		
	Mean	SD	Mean	SD	*P**	Mean	SD	Mean	SD	*P**	Mean	SD	Mean	SD	*P**
Energy (kcal)	1667·19	323·05	1486·58	275·07	<0·001	1755·61	327·16	1582·82	279·94	<0·001	1581	295	1398	238	<0·001
Total fat (g/d)	63·06	14·24	55·79	12·69	<0·001	65·48	14·58	59·20	13·23	<0·001	60·7	13·5	52·7	11·3	<0·001
SFA (g/d)	27·26	6·69	23·41	5·59	<0·001	28·40	6·84	24·66	5·75	<0·001	26·1	6·34	22·2	5·18	<0·001
MUFA (g/d)	21·55	5·06	22·88	5·55	<0·001	22·39	5·18	24·38	5·83	<0·001	20·7	4·81	21·5	4·89	0·594
PUFA (g/d)	9·17	2·77	9·28	2·47	1·000	9·42	2·83	9·95	2·63	0·180	8·92	2·68	8·67	2·13	1·000
Omega 6 (g/d)	5·77	1·64	6·00	1·59	0·018	5·95	1·68	6·49	1·69	<0·001	5·61	1·58	5·55	1·35	1·000
Omega 3 (g/d)	1·03	0·36	1·23	0·39	<0·001	1·05	0·36	1·29	0·41	<0·001	1·02	0·35	1·18	0·36	<0·001
Trans-fat (g/d)	1·00	0·29	0·84	0·28	<0·001	1·03	0·30	0·88	0·29	<0·001	0·96	0·28	0·80	0·27	<0·001
ALA (g/d)	–	–	0·99	0·31	–	–	–	1·05	0·33	–	–	–	0·94	0·29	–
EPA (mg/d)	27·00	18·63	41·66	32·51	<0·001	28·54	19·57	45·57	35·74	<0·001	25·5	17·6	38·1	28·8	<0·001
DHA (mg/d)	36·45	25·05	63·68	50·55	<0·001	38·36	26·32	68·59	54·77	<0·001	34·6	23·7	59·2	45·9	<0·001
Total fat (%TE)	33·69	3·58	33·31	3·83	0·918	33·25	3·57	33·17	3·85	1·000	34·1	3·53	33·4	3·80	0·018
SFA (%TE)	14·54	2·14	14·02	2·15	<0·001	14·41	2·14	13·88	2·15	<0·001	14·7	2·13	14·2	2·14	<0·001
MUFA (%TE)	11·51	1·49	13·60	1·79	<0·001	11·38	1·48	13·61	1·82	<0·001	11·6	1·49	13·6	1·77	<0·001
PUFA (%TE)	4·89	1·03	5·55	0·98	<0·001	4·78	1·00	5·58	1·00	<0·001	5·01	1·05	5·52	0·97	<0·001
Omega 6 (%TE)	3·10	0·59	3·58	0·61	<0·001	3·03	0·58	3·64	0·62	<0·001	3·16	0·60	3·52	0·59	<0·001
Omega 3 (%TE)	0·56	0·15	0·74	0·18	<0·001	0·53	0·14	0·72	0·18	<0·001	0·58	0·15	0·75	0·18	<0·001
Trans-fat (%TE)	0·53	0·12	0·51	0·14	<0·001	0·53	0·12	0·50	0·14	<0·001	0·54	0·12	0·51	0·15	<0·001
ALA (%TE)	–	–	0·61	0·16	–	–	–	0·60	0·16	–	–	–	0·61	0·16	–
EPA (%TE)	0·01	0·01	0·03	0·02	<0·001	0·02	0·01	0·03	0·02	<0·001	0·015	0·009	0·02	0·02	<0·001
DHA (%TE)	0·02	0·01	0·04	0·03	<0·001	0·02	0·01	0·04	0·03	<0·001	0·020	0·012	0·04	0·03	<0·001

n, number of participants; *n*-6, omega 6; *n*-3, omega 3; ALA, alpha-linolenic acid; g/d, grams per day; %TE – percentage of total energy.
*Independent samples *t* test for comparison of means between 2005 and 2019 split by gender, adjusted *P* value using Bonferroni correction method for multiple comparisons was also utilised.

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Table 3 Percentage contribution of food groups to total fat, SFA, MUFA and PUFA intakes in Irish children in 2005 and 2019

	Total fat			SFA			MUFA			PUFA		
	2005	2019		2005	2019		2005	2019		2005	2019	
	(*n* 594)	(*n* 600)	*P**	(*n* 594)	(*n* 600)	*P**	(*n* 594)	(*n* 600)	*P**	(*n* 594)	(*n* 600)	*P**
Fresh meat	4·9	5·8	0·003	4·1	4·7	0·042	6·1	7·0	0·019	4·6	5·9	<0·001
Meat dishes	4·2	6·3	<0·001	3·6	5·9	<0·001	4·9	7·4	<0·001	3·9	4·9	0·012
Meat products	9·9	9·2	0·142	8·3	7·5	0·064	12·1	10·6	0·008	10·4	9·8	0·233
Whole milk	14·8	8·3	<0·001	21·1	12·2	<0·001	11·4	6·9	<0·001	2·9	1·7	<0·001
Low fat, skimmed & fortified milks	0·7	1·4	<0·001	1·1	2·1	<0·001	0·6	1·3	<0·001	0·2	0·1	0·139
Cheeses	3·3	5·3	<0·001	4·7	7·7	<0·001	2·7	4·4	<0·001	0·8	1·4	<0·001
Butter	2·1	3·5	<0·001	2·8	5·0	<0·001	1·7	2·8	<0·001	0·6	1·0	<0·001
Low-fat spreads	1·0	0·3	<0·001	0·6	0·2	<0·001	1·0	0·3	<0·001	2·7	0·7	<0·001
Spreading fats and oils	6·1	4·3	<0·001	4·4	3·5	0·002	7·7	4·8	<0·001	9·6	5·1	<0·001
Ice cream and creams	2·8	1·9	<0·001	4·2	3·0	<0·001	2·0	1·3	<0·001	0·7	0·5	<0·001
Puddings and chilled desserts	3·5	4·0	0·086	4·2	4·6	0·131	3·2	3·4	0·399	1·9	3·7	<0·001
Savouries	3·9	5·1	0·002	3·3	5·0	<0·001	4·1	5·0	0·018	5·2	5·8	0·139
Savoury snacks	6·0	3·8	<0·001	4·7	2·2	<0·001	6·9	5·4	<0·001	8·8	3·8	<0·001
Soups, sauces & miscellaneous foods	1·7	2·3	0·004	1·0	1·6	<0·001	1·3	2·6	<0·001	3·0	3·2	0·734
Biscuits, cakes pastries & buns	7·6	10·4	<0·001	8·7	11·8	<0·001	7·8	9·8	<0·001	5·6	9·0	<0·001
Sugars, confectionary & preserves	8·3	6·1	<0·001	10·3	7·3	<0·001	8·7	6·0	<0·001	3·5	3·5	0·976
Potatoes	0·7	0·8	0·754	0·8	1·1	0·065	0·4	0·6	0·024	1·4	0·5	<0·001
Potatoes chipped, fired & roasted potatoes	5·8	3·3	<0·001	3·9	1·6	<0·001	6·9	3·9	<0·001	9·9	5·7	<0·001
Potato products	0·7	0·8	0·514	0·3	0·3	0·724	0·6	0·8	0·022	2·5	2·0	0·104
Fish, fish products & fish dishes	1·2	2·1	<0·001	0·7	1·0	0·051	1·3	2·5	<0·001	2·6	3·7	0·002
Eggs & egg dishes	1·8	2·3	0·030	1·6	1·9	0·165	2·0	2·6	0·019	1·4	2·6	<0·001
Vegetable & pulse dishes	0·7	0·6	0·502	0·3	0·4	0·471	0·6	0·7	0·682	2·0	1·0	0·001
Breads & rolls	3·7	5·2	<0·001	2·3	3·7	<0·001	2·9	4·7	<0·001	6·9	10·9	<0·001
RTEBC	1·3	1·7	<0·001	0·9	1·2	0·007	0·9	1·5	<0·001	2·9	3·9	<0·001
Other†	3·0	5·0	<0·001	2·1	4·5	<0·001	2·3	3·7	<0·001	5·6	9·2	<0·001

n, number of participants; RTEBC, ready-to-eat breakfast cereals.
*Independent samples *t* test for comparison of means between 2005 and 2019.
†Other food groups include rice, pasta, flours, grains, other breakfast cereals, non-alcoholic beverages, nuts and seeds, herbs and spices, fruit, vegetables, other milk and milk-based beverages.

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Table 4 Percentage contribution of food groups to alpha-linolenic acid (ALA), EPA, DHA and *Trans* fat intakes in Irish children in 2005 and 2019

	ALA			EPA			DHA			*Trans* fat		
	2005 (*n* 594)	2019 (*n* 600)	*P**	2005 (*n* 594)	2019 (*n* 600)	*P**	2005 (*n* 594)	2019 (*n* 600)	*P**	2005 (*n* 594)	2019 (*n* 600)	*P**
Fresh meat	–	5·3	–	18·0	17·3	0·505	23·2	21·3	0·153	5·4	5·7	0·532
Meat dishes	–	6·2	–	8·0	4·8	<0·001	5·7	4·5	0·062	6·6	12·1	<0·001
Meat products	–	10·9	–	7·5	4·9	<0·001	14·6	6·9	<0·001	11·6	7·2	<0·001
Whole milk	–	1·6	–	22·9	15·5	<0·001	13·3	8·1	<0·001	17·1	12·2	<0·001
Low fat, skimmed & fortified milks	–	0·1	–	0·9	3·3	<0·001	0·3	1·0	<0·001	1·9	4·8	<0·001
Cheeses	–	2·4	–	5·0	8·3	<0·001	2·9	4·1	<0·001	9·4	14·4	<0·001
Butter	–	1·3	–	3·2	5·3	<0·001	1·6	2·7	0·001	5·3	7·6	0·001
Low-fat spreads	–	0·9	–	0·5	0·0	<0·001	0·0	0·0	1·000	0·2	0·1	0·002
Spreading fats and oils	–	10·1	–	5·5	0·4	<0·001	0·0	0·0	1·000	2·5	1·0	<0·001
Ice cream and creams	–	0·4	–	0·3	1·2	<0·001	0·1	0·1	0·871	3·1	1·9	<0·001
Puddings and chilled desserts	–	3·2	–	2·6	3·0	0·279	2·1	4·5	<0·001	3·2	2·9	0·382
Savouries	–	6·8	–	0·8	0·8	0·913	1·7	2·4	0·122	3·2	3·5	<0·001
Savoury snacks	–	3·5	–	0·0	0·0	1·000	0·1	0·0	0·012	1·9	0·4	<0·001
Soups, sauces & miscellaneous foods	–	4·8	–	0·3	0·8	0·030	0·2	0·1	0·011	4·7	1·9	<0·001
Biscuits, cakes pastries & buns	–	8·5	–	0·6	3·9	<0·001	1·3	3·6	<0·001	5·2	8·9	<0·001
Sugars, confectionary & preserves	–	1·4	–	0·0	0·0	0·283	0·0	0·0	0·721	5·4	2·1	<0·001
Potatoes	–	1·7	–	0·2	0·2	0·814	0·0	0·0	0·814	1·2	1·7	0·054
Potatoes chipped, fired & roasted potatoes	–	2·0	–	0·0	0·0	0·374	0·0	0·0	1·000	3·9	1·2	<0·001
Potato products	–	1·4	–	0·0	0·0	0·464	0·0	0·1	0·060	0·8	0·3	<0·001
Fish, fish products & fish dishes	–	3·5	–	19·4	24·0	0·012	21·8	26·6	0·013	1·4	0·3	<0·001
Eggs & egg dishes	–	1·5	–	0·5	1·3	0·006	8·3	11·4	0·003	1·9	1·4	0·035
Vegetable & pulse dishes	–	1·3	–	0·3	0·2	0·583	0·5	0·0	0·021	0·5	0·4	0·558
Breads & rolls	–	9·8	–	0·9	2·3	<0·001	0·1	0·3	0·086	2·4	2·6	0·332
RTEBC	–	2·5	–	0·0	0·0	1·000	0·0	0·0	1·000	0·2	0·1	0·279
Other†	–	8·2	–	0·7	0·0	<0·001	0·5	0·1	0·057	1·1	5·2	<0·001
Nutritional supplements	–	0·5	–	1·9	2·0	0·886	1·8	1·8	0·980	0·0	0·0	1·000

n, number of participants; RTEBC, ready-to-eat breakfast cereals.
*Independent samples *t* test for comparison of means between 2005 and 2019.
†Other food groups include rice, pasta, flours, grains, other breakfast cereals, non-alcoholic beverages, nuts and seeds, herbs and spices, fruit, vegetables, other milk and milk-based beverages.

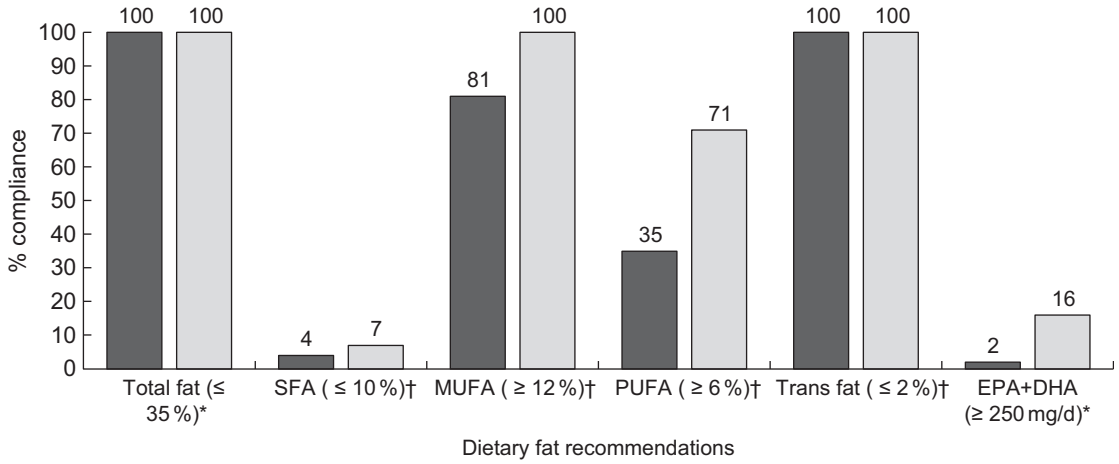

Fig. 1 Percentage of Irish children adhering to current EFSA and UK dietary recommendations for total fat and fatty acids between 2005 and 2019. *Targets from EFSA[6]; †Targets from the Department of Health and/or Scientific Advisory Committee on Nutrition[7,38]. ■, 2005; □, 2019

10-year period noted a slight decrease in total fat and SFA, decreasing from 35 to 34 % and from 16 to 15 %, respectively, whilst MUFA and PUFA intakes remained stable at 14 and 5 %, respectively[43]. However, compliance with SFA and PUFA recommendations was extremely low (3 and 8 %, respectively), similar to the findings in the current analysis. In contrast, temporal trend analysis carried out in a cohort of Chinese children observed dietary fat intakes steadily increased between the years 1991 and 2009, as well as the proportion of energy from fat[44]. The authors suggest that these increases may be the result of an accelerated nutrition transition to a high-fat, Western diet. However, it is important to note that these intake data were collected over 10 years ago and therefore, dietary fat intakes may have since changed further.

SFA intakes in Irish children (14 % TE) are similar to intakes in children across Europe and America[6,45]. The highest SFA intakes in Europe were found in Danish girls aged 4–5 years at 16 % TE, whereas Italian males aged 7–9 years had the lowest at 9·4 % TE[6]. A comprehensive review which investigated compliance to dietary fat recommendations by children across the WHO European region found that children in all eighteen countries examined exceeded the WHO SFA recommendation of < 10 % TE[46]. SFA compliance in neighbouring UK children was reported by Pot *et al.* who demonstrated that the proportion of children aged 4–10 years meeting the UK SFA guideline of < 11 % TE was 14 %[42]. To note, although this is higher than the compliance rate reported in Irish children (7 %), it remains extremely poor. Moreover, if the authors examined SFA compliance based on current SFA cut-offs (< 10 % TE), compliance would undoubtedly be lower in UK children. The evidence linking elevated SFA intakes to CVD risk is irrefutable and the extreme low levels of SFA compliance observed in children across the globe highlights the severity of the issue. Therefore, it is imperative that strategies are devised to reduce SFA intakes in children in order to reduce the risk of CVD and other chronic diseases in later life.

The main food sources of SFA in Irish children continue to be 'whole milk', 'biscuits, cakes, pastries and buns', 'meat products' and 'cheeses', which are similar to the food sources of SFA in Irish adolescents, as well as 'sugars, confectionary and preserves'[9]. In addition to 'cheeses' and 'meat products', the top sources contributing to Irish adult SFA intakes include 'fresh meat' and 'spreading fats and oils'[41]. Dairy and meat products are among the overall top contributors of SFA across many European countries and the USA, which is in agreement with the current findings[47–49]. Despite a 9 % reduction in SFA from whole milk since 2005, it remains the top contributor to SFA intakes in Irish children. Nevertheless, this decrease observed in the contribution of whole milk and the increase observed in low-fat milk across all fatty acids may reflect a change in dietary habits. Potentially, adherence to dietary guidelines advocating the consumption of low-fat over whole milk has improved. Although, given the body of evidence in support of the dairy food matrix, whereby interactions between its food components are thought to potentially alter the properties of the nutrients, SFA from dairy products may not be a cause for concern as emerging evidence suggests it could be beneficial in terms of cardiovascular health[50]. On balance, intakes of overall milk have reduced and whole milk intakes have not been compensated for despite increases in low-fat milk[15], which could have implications for intakes of other nutrients such as calcium and iodine.

The current intakes of *trans* fat have decreased by 0·02 % TE since 2005 and remain within the recommendation of less than 2 % TE[7,38]. Few countries provided data for *trans* fat intakes in children; of the countries that have (*n* 4), intakes ranged between 0·6 and 1·8 % of TE[6] which is higher than the 0·5 % reported in the present study but still within the general recommendation. As expected, the main contributions to *trans* fat in the diet of Irish

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children are derived from animal-based products such as dairy and meat. However, an increase in the contribution of 'biscuits, cakes, pastries and buns' has resulted in this food group becoming the 4th contributor. While there is the possibility that the *trans* fat composition of these food products has increased, the considerable efforts over the years to reduce industrial sources of *trans* fat in Ireland deem this unlikely[12]. As the increase is reflected across all fatty acids, it is more likely due to increases in the consumption of these products.

The intakes of PUFA in Irish children (5·6% TE) are similar to European intakes (4–9 % TE)[6] and although the adherence level to PUFA intake recommendations has increased from 60 to 71 %, further improvement is warranted. Some of the main food sources of PUFA in Irish children include 'biscuits, cakes, pastries and buns' and 'meat products', which are also significant contributors of SFA intakes. Therefore, promoting a reduction in these foods to improve SFA intakes could have unfavourable consequences for PUFA intakes. This demonstrates the complexities of devising strategies to improve the dietary fat profile within a population. In addition, EPA and DHA intakes (105 mg/d combined), which includes intake from nutritional supplements, are considerably lower than the adequate intake of 250 mg/d proposed by European Food Safety Authority[6]. Similar low adherence was found in children from other European countries such as France (6–10 years; 154 mg/d), Belgium (4–6 years; 75 mg/d) and Germany (4–12 years; 62–85 mg/d)[51–53]. Given the health benefits of EPA and DHA such as supporting brain function and cognitive development in children[54], as well as their potential role in CVD prevention[55], this pattern of low adherence to EPA and DHA guidelines may signify a greater global issue of insufficient *n*-3 intakes in children. The two major contributors to EPA and DHA intakes in the current study were 'fish, fish products and fish dishes' and 'fresh meat', which are in line with the main contributors reported in Irish adults[41], as well as those reported in the UK[42] and other countries[51,53,56,57]. However, the consumption of these foods, in particular fish, is typically below the recommended dietary guidelines[52,58]. This can be due to cultural food practices and preferences, denoting that other dietary sources may be required to increase EPA and DHA intakes.

Although intakes of particular subtypes of dietary fat are deemed inadequate, namely SFA and overall PUFA, total fat intakes remain in line with total fat recommendations. The mean total fat intake in Irish children is 33 % TE, with no significant changes in intake noted since 2005. These intakes are similar to the total fat intakes reported in children and adolescents across Europe, which range between 28 and 42 % TE[6]. Rippin *et al.* found that total fat compliance to recommendations for intake of total fat was particularly poor in Europe, as children in only two of the eighteen European countries examined had intake levels below the WHO recommended maximum value of ≤ 30 % TE[46]. Furthermore, in the UK, only 47 % of children complied with UK recommendations of total fat intake (≤ 33 % TE)[42]. However, as the most recent cut-off stands at ≤ 35 % TE, increases in the percentage of UK children complying with the current recommendation are likely[6,38]. It is worth noting that if the UK or WHO guidelines were used as the cut-off in the current study, the mean intake of total fat in Irish children would exceed both recommendations.

The current analysis has many strengths such as the high quality of dietary data derived from weighed food records collected for both national food consumption surveys. Furthermore, data were obtained from current food composition tables and databases, brand information and published papers to ensure the most up-to-date fatty acid concentrations were assigned to all foods contained in the food consumption database and to achieve the most accurate estimates of fatty acid intake. Further considerations to assess usual intakes in this paper also provided more accuracy for estimating nutrient intakes. This method of estimation observes the long-term nutrient and dietary intake rather than the reported intake over a few days. Therefore, this method permits direct comparative analysis across the two surveys, irrespective of the different number of recording days (7-day and 4-day) without compromising the study results. However, due to the self-reporting nature of these dietary assessments, this study may be limited due to under-reporting. Albeit the levels of under-reporting have decreased from 33 % in 2005 to 20 % in 2019 (data not shown), under-reporters were not excluded from the analysis. Although the methodologies in both surveys are similar due to their cross-sectional design, the comparative data are limited for evaluating the effectiveness of public health initiatives compared with longitudinal trend analysis.

In conclusion, improvements have been made to the dietary fat profile of Irish children over the last number of years, with slight reductions observed in SFA and *trans* fat intakes and increases detected across all reported unsaturated fats. Nevertheless, while progress has been made, adherence to SFA, PUFA, EPA and DHA recommendations remains inadequate and, therefore, improvements need to be made to the quality of dietary fat consumed. In the past, food reformulation has played a significant role in the success of limiting the consumption of *trans* fat. Therefore, further considerations to reformulate foods could have a positive impact on fatty acid intakes, particularly in the context of SFA and PUFA. Considerations should also be made to promote foods containing a more favourable dietary fat profile. However, caution is warranted when considering strategies to promote individual nutrient recommendations and perhaps a holistic dietary approach would be more effective.

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980020004255

References

1. Calder PC (2011) Fatty acids and inflammation: the cutting edge between food and pharma. *Eur J Pharmacol* **668**, S50–S58.
2. Berg JM, Tymoczko JL & Stryer L (2012) *Biochemistry. Chapter 22: Fatty Acid Metabolism*, 7th ed. NewYork: WH Freeman and Company.
3. Schwab U, Lauritzen L, Tholstrup T *et al.* (2014) Effect of the amount and type of dietary fat on cardiometabolic risk factors and risk of developing type 2 diabetes, cardiovascular diseases, and cancer: a systematic review. *Food Nutr Res.* Published online: 10 July 2014. doi: 10.3402/fnr.v58.25145.
4. Birch L, Savage JS & Ventura A (2007) Influences on the development of children's eating behaviours: from infancy to adolescence. *Can J Diet Pract Res* **68**, S1–S56.
5. Food and Agriculture Organization of the United Nations (2010) *Fats and Fatty Acids in Human Nutrition. Report of an Expert Consultation*. Rome: FAO.
6. European Food Safety Authority (2010) Scientific opinion on dietary reference values for fats, including saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, trans fatty acids, and cholesterol. *EFSA J* **8**, 1461.
7. Scientific Advisory Commitee on Nutrition (2019) Saturated fats and health. Public Health England and UK Health Departments. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/814995/SACN_report_on_saturated_fat_and_health.pdf (accessed May 2020).
8. Harika RK, Cosgrove MC, Osendarp SJM *et al.* (2011) Fatty acid intakes of children and adolescents are not in line with the dietary intake recommendations for future cardiovascular health: a systematic review of dietary intake data from thirty countries. *Br J Nutr* **106**, 307–316.
9. Joyce T, Wallace AJ, McCarthy SN *et al.* (2009) Intakes of total fat, saturated, monounsaturated and polyunsaturated fatty acids in Irish children, teenagers and adults. *Public Health Nutr* **12**, 156–165.
10. Safefood (2017) START. https://www.safefood.eu/Utility/About-Us/Campaigns/START.aspx (accessed May 2020).
11. Food Standards Agency (2018) Saturated Fat. https://www.food.gov.uk/safety-hygiene/saturated-fat (accessed May 2020).
12. Food Safety Authority of Ireland (2016) *Survey of the Trans Fatty Acid Content in Processed Food Products in Ireland*. Dublin: FSAI.
13. van der Velde LA, Nguyen AN, Schoufour JD *et al.* (2019) Diet quality in childhood: the Generation R Study. *Eur J Nutr* **58**, 1259–1269.
14. Irish Universities Nutrition Alliance (2005) National Children's Food Survey. https://www.iuna.net/survey reports (accessed May 2020).
15. Irish Universities Nutrition Alliance (2019) National Children's Foody Survey II Summary Report. https://www.iuna.net/surveyreports (accessed May 2020).
16. Central Statistics Office (2003) *Census 2002 Principal Demographic Results*. Dublin: The Stationary Office.
17. Central Statistics Office (2017) Census 2016 Summary Results – Part 1. Ireland: Central Statistics Office; available at https://www.cso.ie/en/media/csoie/newsevents/documents/census2016summaryresultspart1/Census2016SummaryPart1.pdf (accessed May 2020).
18. Department of Education and Skills (2016) Data on Individual Schools. https://www.education.ie/en/Publications/Statistics/Data-on-Individual-Schools/ (accessed May 2020).
19. Central Statistics Office (2012) *This is Ireland, Highlights from Census 2011 Part 1*. Dublin: The Stationary Office.
20. Harrington KE, McGowan MJ, Kiely M *et al.* (2001) Macronutrient intakes and food sources in Irish adults: findings of the North/South Ireland Food Consumption Survey. *Public Health Nutr* **4**, 1051–1060.
21. Holland B, Welch AA, Unwin ID *et al.* (1995) *McCance and Widdowson's The Composition of Foods*, 5th ed. London: HSMO.
22. Food Standards Agency (2002) *McCance and Widdowson's The Composition of Foods*, 6th summary ed. Cambridge: Royal Society of Chemistry.
23. Holland B, Unwin ID & Buss DH (1988) *Cereal and Cereal Products. Third Supplement to McCance and Widdowson's The Composition of Foods*, 4th ed. London: HSMO.
24. Holland B, Unwin ID & Buss DH (1989) *Milk Products and Eggs. Fourth Supplement to McCance and Widdowson's The Composition of Foods*, 4th ed. London: HSMO.
25. Holland B, Unwin ID & Buss DH (1991) *Vegetables, Herbs and Spices. Fifth Supplement to McCance and Widdowson's The Composition of Foods*, 4th ed. London: HSMO.
26. Holland B, Unwin ID & Buss DH (1992) *Fruits and Nuts. First Supplement to McCance and Widdowson's The Composition of Foods*, 5th ed. London: HSMO.
27. Holland B, Brown J & Buss DH (1993) *Fish and Fish Products. Third Supplement to McCance and Widdowson's The Composition of Foods*, 5th ed. London: HSMO.
28. Holland B, Welch AA & Buss DH (1996) *Vegetable Dishes. Second Supplement to McCance and Widdowson's The Composition of Foods*, 5th ed. London: HSMO.
29. Chan W, Brown J & Buss DH (1994) *Miscellaneous Foods. Fourth Supplement to McCance and Widdowson's The Composition of Foods*, 5th ed. London: HSMO.
30. Chan W, Brown J, Lee SJ *et al.* (1995) *Meat, Poultry and Game. Fifth Supplement to McCance and Widdowson's The Composition of Foods*, 5th ed. London: HSMO.
31. Chan W, Brown J, Church SM *et al.* (1996) *Meat Products and Dishes. Sixth Supplement to McCance and*

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Widdowson's The Composition of Foods, 5th ed. London: HSMO.
32. Finglas P, Roe M, Pinchen H *et al.* (2015) *McCance and Widdowson's The Composition of Foods*. 7th summary ed. Cambridge: Royal Society of Cambridge.
33. Leite JC, Hearty A, Nugent A *et al.* (2010) A method for assessing dietary intakes of n-3 long-chain polyunsaturated fatty acids and trans fatty acids in an Irish adult population. *Int J Food Sci Nutr* **61**, 583–599.
34. United States Department of Agriculture (2019) USDA Food Composition Databases. https://ndb.nal.usda.gov/ndb/ (accessed May 2020).
35. National Institute for Health and Welfare (2019) Fineli Food Composition Database Version 20. https://fineli.fi/fineli/fi/index (accessed May 2020).
36. Food Institute Technical University of Denmark (2019) Food Data. https://frida.fooddata.dk/?lang=en (accessed May 2020).
37. Tooze JA, Kipnis V, Buckman DW *et al.* (2010) A mixed-effects model approach for estimating the distribution of usual intake of nutrients: the NCI method. *Stat Med* **29**, 2857–2868.
38. Department of Health (1994) *Nutritional Aspects of Cardiovascular Disease. Report of the Cardiovascular Review Group Committee on Medical Aspects of Food Policy*. London: HMSO.
39. Wearne SJ & Day MJ (1999) Clues for the development of food-based dietary guidelines: how are dietary targets being achieved by UK consumers? *Br J Nutr* **81**, S119–S126.
40. Krebs-Smith S, Kott P & Guenther P (1989) Mean proportion and population proportion: two answers to the same question? *J Am Diet Assoc* **89**, 671–676.
41. Li K, McNulty BA, Tiernery AM *et al.* (2016) Dietary fat intakes in Irish adults in 2011: how much has changed in 10 years? *Br J Nutr* **115**, 1798–1809.
42. Pot GK, Prynne CJ, Roberts C *et al.* (2012) National Diet and Nutrition Survey: fat and fatty acid intake from the first year of the rolling programme and comparison with previous surveys. *Br J Nutr* **107**, 405–415.
43. Libuda L, Alexy U & Kersting M (2014) Time trends in dietary fat intake in a sample of German children and adolescents between 2000 and 2010: not quantity, but quality is the issue. *Br J Nutr* **111**, 141–150.
44. Cui Z & Dibley MJ (2012) Trends in dietary energy, fat, carbohydrate and protein intake in Chinese children and adolescents from 1991 to 2009. *Br J Nutr* **108**, 1292–1299.
45. US Department of Health and Human Services & US Department of Agriculture (2015) Dietary Guidelines for Americans, 2015–2020. https://health.gov/dietaryguidelines/2015/resources/2015–2020_Dietary_Guidelines.pdf (accessed May 2020).
46. Rippin HL, Hutchinson J, Jewell J *et al.* (2019) Child and adolescent nutrient intakes from current national dietary surveys of European populations. *Nutr Res Rev* **32**, 38–69.
47. Reedy J & Krebs-Smith SM (2010) Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *J Am Diet Assoc* **110**, 1477–1484.
48. Vyncke KE, Libuda L, De Vriendt T *et al.* (2012) Dietary fatty acid intake, its food sources and determinants in European adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Br J Nutr* **108**, 2261–2273.
49. Eilander A, Harika RK & Zock PL (2015) Intake and sources of dietary fatty acids in Europe: are current population intakes of fats aligned with dietary recommendations? *Eur J Lipid Sci Technol* **117**, 1370–1377.
50. Thorning TK, Tholstrup T, Astrup A *et al.* (2017) Whole dairy matrix or single nutrients in assessment of health effects: current evidence and knowledge gaps. *Am J Clin Nutr* **105**, 1033–1045.
51. Sioen I, Huybrechts I, Verbeke W *et al.* (2007) *n*-6 and *n*-3 PUFA intakes of pre-school children in Flanders, Belgium. *Br J Nutr* **98**, 819–825.
52. Sichert-Hellert W, Wicher M & Kersting M (2009) Age and time trends in fish consumption pattern of children and adolescents, and consequences for the intake of long-chain *n*-3 polyunsaturated fatty acids. *Eur J Clin Nutr* **63**, 1071.
53. Guesnet P, Tressou J, Buaud B *et al.* (2019) Inadequate daily intakes of n-3 polyunsaturated fatty acids (PUFA) in the general French population of children (3–10 years) and adolescents (11–17 years): the INCA2 survey. *Eur J Nutr* **58**, 895–903.
54. Uauy R & Dangour AD (2006) Nutrition in brain development and aging: role of essential fatty acids. *Nutr Rev* **64**, S24–S33.
55. Guesnet P & Alessandri J-M (2011) Docosahexaenoic acid (DHA) and the developing central nervous system (CNS) – implications for dietary recommendations. *Biochimie* **93**, 7–12.
56. Rahmawaty S, Charlton K, Lyons-Wall P *et al.* (2013) Dietary intake and food sources of EPA, DPA and DHA in Australian children. *Lipids* **48**, 869–877.
57. Australian Bureau of Statistics (2014) Australian Health Survey : Nutrition First Results – Food and Nutrients. ABS. https://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/4683FD7315DFDFDBCA257D080014F9E0/$File/australian%20health%20survey%20nutrition%20first%20results%20-%20food%20and%20nutrients,%202011–12.pdf (accessed May 2020).
58. Kranz S, Jones N & Monsivais P (2017) Intake levels of fish in the UK paediatric population. *Nutrients* **9**, 392.

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