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Dietary intake and food sources of EPA, DPA and DHA in Australian children

Setyaningrum Rahmawaty
University of Wollongong

Karen Charlton
University of Wollongong, karenc@uow.edu.au

Philippa Lyons-Wall
Edith Cowan University, philippa@uow.edu.au

Barbara J. Meyer
University of Wollongong, bmeyer@uow.edu.au

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Abstract

Secondary analysis of the 2007 Australian National Children's Nutrition and Physical Activity survey was undertaken to assess the intake and food sources of EPA, DPA and DHA (excluding supplements) in 4,487 children aged 2-16 years. An average of two 24-h dietary recalls was analysed for each child and food sources of EPA, DPA and DHA were assessed using the Australian nutrient composition database called AUSNUT 2007. Median (inter quartile range, IQR) for EPA, DPA and DHA intakes (mg/day) for 2-3, 4-8, 9-13, 14-16 year were: EPA 5.3 (1.5-14), 6.7 (1.8-18), 8.7 (2.6-23), 9.8 (2.7-28) respectively; DPA 6.2 (2.2-14), 8.2 (3.3-18), 10.8 (4.3-24), 12.2 (5-29) respectively; and DHA 3.9 (0.6-24), 5.1 (0.9-26), 6.8 (1.1-27), 7.8 (1.5-33) respectively. Energy-adjusted intakes of EPA, DPA and DHA in children who ate fish were 7.5, 2 and 16-fold higher, respectively ($P < 0.001$) compared to those who did not eat fish during the 2 days of the survey. Intake of total long chain n-3 PUFA was compared to the energy adjusted suggested dietary target (SDT) for Australian children and 20 % of children who ate fish during the 2 days of the survey met the SDT. Fish and seafood products were the largest contributors to DHA (76 %) and EPA (59 %) intake, while meat, poultry and game contributed to 56 % DPA. Meat consumption was 8.5 times greater than that for fish/seafood. Australian children do not consume the recommended amounts of long chain omega-3 fatty acids, especially DHA, which could be explained by low fish consumption.

Keywords

australian, dha, dpa, children, epa, dietary, sources, food, intake

Disciplines

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Title page

Dietary intake and food sources of EPA, DPA and DHA in Australian children

Setyaningrum Rahmawaty[1,2], **Karen Charlton**[2], **Philippa Lyons-Wall**[3] and **Barbara J Meyer**[1,2*]

[1]Metabolic Research Centre, University of Wollongong: [2]School of Health Sciences, University of Wollongong, Northfields Ave, Wollongong NSW 2522, Australia: [3] School of Exercise and Health Sciences, Edith Cowan University, 270 Joondalup Drive, Joondalup, WA 6027, Australia

[*]Corresponding author: bmeyer@uow.edu.au, Ph: +61 (0)2 4221 3459, Fax: +61 (0)2 4221 5945

Abstract

Secondary analysis of the 2007 Australian National Children's Nutrition and Physical Activity survey was undertaken to assess the intake and food sources of EPA, DPA and DHA (excluding supplements) in 4,487 children aged 2-16 years. An average of two 24-hour dietary recalls was analysed for each child and food sources of EPA, DPA and DHA were assessed using the Australian nutrient composition database called AUSNUT 2007. Median (inter quartile range, IQR) for EPA, DPA and DHA intakes (mg/d) for 2-3y, 4-8y, 9-13y, 14-16y were: EPA 5.3 (1.5-14), 6.7 (1.8-18), 8.7 (2.6-23), 9.8 (2.7-28) respectively; DPA 6.2 (2.2-14), 8.2 (3.3-18), 10.8 (4.3-24), 12.2 (5-29) respectively; and DHA 3.9 (0.6-24), 5.1 (0.9-26), 6.8 (1.1-27), 7.8 (1.5-33) respectively. Energy-adjusted intakes of EPA, DPA and DHA in children who ate fish were 7.5, 2 and 16-fold higher, respectively ($P<0.001$) compared to those who did not eat fish during the two days of the survey. Intake of total long chain n-3 PUFA was compared to the energy adjusted suggested dietary target (SDT) for Australian children and 20% of children who ate fish during the two days of the survey met the SDT. Fish and seafood products were the largest contributors to DHA (76%) and EPA (59%) intake, while meat, poultry and game contributed to 56% DPA. Meat was consumed 8.5 times greater than fish/seafood. Australian children do not consume the recommended amounts of long chain omega-3 fatty acids, especially DHA, which could be explained by low fish consumptions.

Key words: EPA, DPA and DHA intake · fish consumption · children · Australia · fatty acids

Abbreviations

ALA	Alpha-linolenic acid (18:3n-3)
DHA	Docosahexaenoic acid (22:6n-3)
DPA	Docosapentaenoic acid (22:5n-3)
EPA	Eicosapentaenoic acid (20:5n-3)
PUFA	Polyunsaturated fatty acid(s)

Introduction

Long chain n-3 PUFA comprises of EPA, DPA and DHA, and these nutrients, especially DHA are essential for supporting the normal brain and cognitive development of children [1, 2] and several lines of evidence demonstrate the potential role of these fatty acids to reduce cardiovascular disease (CVD) risk in children [3-6]. Reductions in intake of the long chain n-3 PUFA have been hypothesized as one of the dietary factors associated with the increase in incidence of chronic diseases in Western countries over the past 50 years [7]. Long chain n-3 PUFA are mainly obtained pre-formed from dietary sources such as fish, with minimal *de novo* synthesis from elongation of the shorter chain n-3 fatty acid, ALA [8, 9, 10].

Evidence is increasing regarding the beneficial effects of early intake of long chain n-3 PUFA for the prevention of CVD in later life [11, 12]. A low concentration of long chain n-3 PUFA, together with an increased concentration of C-reactive protein (CRP), a sensitive predictor of CVD risk [13], has been found in overweight teenagers [14]; and a low omega-3 index, the sum of EPA and DHA in erythrocyte membranes expressed as a percentage of total fatty acids [15], has been found in obese school age children in association with insulin resistance [16]. Conversely, an increase in long chain n-3 PUFA intake in obese adolescents has been shown to modulate vascular function and inflammatory markers, including lymphocytes, monocytes and levels of tumor necrosis factor -α, interleukin-1β and interleukin-6 [4]. Long chain n-3 PUFA supplementation in healthy children aged 8-14 years has resulted in a reduction in biomarkers of CVD risk, including E-selectin and intracellular adhesion molecules-1 (ICAM-1) [3]. E-selectin and ICAM-1 are members of cell adhesion molecules that are expressed in the endothelium that are involved in the inflammatory process, such as seen in people with CVD [17, 18]. Additionally, DHA supplementation in children with hyperlipidemia at risk of early heart disease has resulted in improved endothelium-dependent flow-mediated dilation (FMD) of the brachial artery [19]. These data suggest that CVD vascular risk factors in children can be reduced by increased long chain n-3 PUFA intake.

In Australia, the National Heart Foundation (NHF) recommends that for cardiovascular health, children should follow the adult recommendation of 500 mg/d of EPA and DHA or at least two, preferably oily, fish meals per week [20]. Other agencies, for example the National Health and Medical Research Council (NHMRC), have established Nutrient Reference Values for long chain n-3 PUFA for children under 14 years, based on the adequate intake (AI) or observed median intake data reported in the 1995 National Dietary Survey as no recommended dietary intake (RDI) for children has been established by the NHMRC [21]. For children aged 14-16 years, a suggested dietary target (SDT) for the prevention of chronic diseases, has been set at 610 and 430 mg/d for boys and girls, respectively, based on the observed 90th percentile of the population intake [21]. Meyer & Kolanu (2011) have extrapolated SDT for long chain n-3 PUFA for children younger than 14 years from adjusted energy intakes, by sex and age group [22] and due to lower energy intake in younger children, these SDT are lower compared to the NHF recommended intakes of 500 mg/d [20].

It has previously been reported that most Australian children do not meet the recommended two fish meals per week [22]. However, limited data are available on individual intakes of the long chain n-3 PUFA, namely EPA, DPA and DHA, and their respective food sources, in both consumers and non-consumers of fish. Therefore the aim of this study was to analyse the 2007 Australian National Children's Nutrition and Physical Activity survey (Children's Survey), to determine the average intake (average of two 24-h dietary recalls) of EPA, DPA and DHA as well as their respective food sources in fish and non-fish consumers.

Material and methods

Data

The source of data for this study was the 2007 Children's Survey conducted between February and August 2007. The Children's Survey was conducted according to the guidelines laid down in the Declaration of Helsinki and procedures were approved by the NHMRC registered ethics committees of the Commonwealth Scientific and Industrial Research Organization and the University of South Australia [23]. Permission to access the dataset was obtained from the Australian Social Science Data Archive [24]. The dietary intake of 4,487 children aged 2-16 years, selected using random digit dialing (RDD) from all Australian states and territories in metropolitan, rural and remote areas, was assessed from two 24-hour recalls using a standardized multiple pass 24-hour dietary recall methodology. A computer assisted personal interview (CAPI) technique was used to capture the first 24-hr recall, followed by a computer assisted telephone interview (CATI) conducted 7-21 days after the CAPI to obtain the second 24-hour recall. All days of the week are approximately equally represented in the database of the Children's survey [25]. Details of the survey methodology have been reported previously [25].

Dietary Intake of EPA, DPA and DHA assessment

Dietary intake was obtained from the average of the two 24-hour dietary recalls analysed for intakes of EPA, DPA and DHA from foods consumed (excluding fish oil supplements but including foods enriched with n-3 LCPUFA) using the Australian nutrient composition database called AUSNUT 2007 which was developed specifically for the Children's survey. In the AUSNUT 2007 database certain foods such as margarine were erroneously allocated long chain n-3 PUFA values; hence these values were corrected and correct values for EPA, DPA and DHA intakes were re-calculated. The intake of total long chain n-3 PUFA was determined by summing individual intakes of EPA, DPA, and DHA and was compared to the energy adjusted SDT for long chain n-3 PUFA for Australian children [22].

Food items were categorized into the following groups as previously reported [25]: non-alcoholic beverages; cereal and cereal products; cereal-based products and dishes; fats and oils; fish and seafood products and dishes; fruit products and dishes; egg products and dishes; meat and poultry and game products and dishes; milk products and dishes; dairy substitutes; soup; seed and nut products and dishes; savory sauces and condiments; vegetable products and dishes; legume and pulse products and dishes; snack foods; sugar products and dishes; confectionery and cereal/nut/fruit/seed bars; alcoholic beverages; special dietary foods (e.g. formula dietary foods and enteral formula); miscellaneous (e.g. yeast, herbs, spices, and food enhancer); and infant formulae and foods [25]. The percentage contribution of each food group to dietary intakes of EPA, DPA, DHA and total long chain n-3 PUFA was determined by dividing values of EPA, DPA, DHA and total long chain n-3 PUFA of each food group by the total value of each fatty acid for all food groups, and then multiplying by 100 to express it as a percentage contribution.

Statistical analysis

The statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) software (version 17.0, Chicago IL, USA). Intakes of EPA, DPA and DHA (mg/d) are presented as mean ± SD and median (IQR), adjusted (mg/d/MJ) and unadjusted (mg/d) for energy intake. Intakes of long chain n-3 PUFA were determined by gender, age group (2-3 y, 4-8 y, 9-13 y and 14-16 y) and fish eater status (fish eater or non-fish eater during the two days of the survey), categorized according to whether any fish had been consumed on one or both days of the two-24 hour recalls. The data were found to be extremely skewed using the Shapiro-Wilk test. Since transformation could not produce normal distribution, the average of two days of intake was used to calculate the long chain n-3 PUFA intakes and for further analysis in this study. It has been argued that averaging two days of intake is appropriate when statistical adjustment methods cannot be used to account intra-individual variability, and when usual intake is of interest [26].

The comparisons of n-3 intakes between groups were made using non-parametric tests; the Mann-Whitney *U* test was used to compare population intakes of EPA, DPA and DHA by gender and fish eater status; the Kruskal-Wallis test was used to compare EPA, DPA and DHA by age group. Correlations between variables were calculated using Kendall tau-b correlation coefficients (τ_B) as it tends to provide a better estimate of the true population correlation than Spearman's rho and it is not artificially inflated by multiple tied ranks [27]. A probability of $P < 0.05$ was taken as statistically significant.

Results

The distribution of EPA, DPA, DHA and total long chain n-3 PUFA intake was positively skewed with extreme values in the upper tail; hence values are also provided for median (IQR) intakes. Mean and median intakes of EPA, DPA, DHA and total long chain n-3 PUFA increased with age and tended to be higher in boys than girls, but these trends were not significant (Table 1A). After adjusting for total energy, intakes of EPA ($P < 0.05$), DPA ($P < 0.001$) and total long chain n-3 PUFA ($P < 0.05$) were significantly higher in the older compared to younger age groups; and there were no significant gender differences (Table 1B). The median intakes (mg/1000 Kcal/d) of DPA in non-fish eating children was approximately 50 % of those in fish consumers, whereas the median EPA and DHA intakes were only 12 % and 14 % of the mean intakes (Table 2). The trend of EPA, DPA and DHA intake is the same for all age groups.

The mean consumption of fish over the two days of the survey was 12 g/d, with twenty one percent of all children having consumed fish and/or seafood on at least one of the two days of the survey. Of the fish consumers the mean ± SD fish intake was 59 ± 32 g/d. Fish eaters in the different age groups achieved between 15 % and 22 % of the SDT for long chain n-3 PUFA, while those who did not eat fish during the two days of the survey did not meet the SDT (Table 3). The average intake of EPA, DPA and DHA in fish eaters was 7.5, 2 and 16 fold higher, respectively, than in those who did not eat fish during the two days of the survey ($P < 0.001$) (Table 3).

EPA ($\tau_B = 0.46$) and DHA ($\tau_B = 0.52$) intakes were highly correlated to consumption of fish and seafood products, and DPA ($\tau_B = 0.28$) was moderately correlated to consumption of meat, poultry and game products (Table 4). Very weak correlations between EPA, DPA and DHA and other food groups were observed (Table 4).

The major food groups contributing to EPA intake were fish and seafood products (59 %) followed by meat, poultry and game products and dishes (24 %). Fish and seafood were the major contributor to DHA intake (75 %), followed by eggs and egg-containing dishes (12 %). The main contributor to DPA was meat, poultry and game products (56 %), followed by fish and seafood (23 %) (Table 5).

Discussion

This study quantifies the dietary intake of EPA, DPA and DHA in a large, nationally representative sample of Australian children. An extremely low intake of DHA was identified, with half the population in all age groups (median) having extremely low DHA intakes, and this is applicable to all age groups (Table 1). These low DHA intakes can be explained by the fact that on the two days of the survey approximately 80 % of children did not consume fish or seafood, which is the greatest contributor to DHA in the diet (Table 5).

This study confirms that the intakes of EPA, DPA, DHA and total LC n-3 PUFA intakes have a skewed distribution, where very few individuals consume a lot and the vast majority of individuals consume very little LC n-3 PUFA [22]. Even though the distribution of EPA, DPA and DHA intakes are skewed, this study highlights that the Australian median DHA intakes (mg/1000 Kcal/d) is only 13 % of the mean DHA intakes (mg/1000 Kcal/d), compared with the distribution of DPA intakes where the median intakes were 50 % of the mean (refer to Table 1B). These differences can be explained by most children consuming regularly meat (rich source of DPA) and only a small proportion of children consuming regularly fish (rich source of DHA).

DHA is important for brain development up to 18 years of age [28, 29] and even life-long [30]. Children with amino acid metabolism disorders cannot consume protein rich foods like fish and seafood and they have significantly lower DHA status compared to healthy children [10]. Therefore it has been suggested that DHA should be considered as a semi-essential nutrient [10] and Australian children should increase their intakes of DHA for optimal health [22].

Fish and seafood is the food group that contributes the greatest amount of DHA (Table 5). Our data show that the population average of fish consumption on the two days of the survey is below the national and international recommendations for children, of at least two fish meals per week or approximately 500 mg EPA plus DHA [20, 31], with only one in five children consuming fish. Our current fish intakes were similar to those reported in previous Australian national surveys of children conducted in 1985 (mean = 6 to10 g/d) [32] and 1995 (mean = 12 to

19 g/d) [33]. It can be argued that fish consumption in children can be considered a proxy indicator for assessing the amount of LC n-3 PUFA intake, particularly DHA intake [34]. Frequency of fish consumption in children is significantly correlated with EPA and DHA in the blood serum [35]. Data from the Australian 1995 survey reported that the mean intake of total LC n-3 PUFA in children aged 2-11 and 12-18 years was 110 and 197 mg/d, respectively, of which around 42 % and 38 % for each of the age groups, respectively, were supplied by DHA, with the remainder provided by EPA and DPA [36]. Similar findings have been reported from Belgium, where fish consumption, although low (8.6 g/d), was the main contributor to total EPA, DPA and DHA intakes, providing 53.5, 42.8 and 48.2 %, respectively [37]. A low fish consumption in children has also been reported in other countries, including Germany [38] and Guatemala [39]. A study on 1024 German children of age 2-18 years reported that mean intake of long chain n-3 PUFA (sum EPA + DHA) estimated using yearly 3-day weighed dietary records was 40-140 mg/d. It was lower in those that did not consume fish (below 20 mg/d), but twice as high in those that did eat fish; remaining constant after adjustment for total energy [38]. A study on 449 Guatemalan school children aged 8-12 years reported that mean intake of EPA and DHA estimated using a single pictorial 24-hour record were 9 mg and 32 mg, respectively, higher in boys than in girls, even after adjustment for total energy [39]. Another study on American children aged 6-11 (n = 962) and 12-19 years (n = 2,208) showed that mean (median) intakes of EPA, DPA and DHA obtained using a 24-hour recall were for EPA: 10 (0) and 20 (0) mg/d respectively, DPA: 10 (0) mg/d for both age groups and DHA: 40 (10) and 50 (10) mg/d respectively [40]. An exception is Japan, where the mean fish consumption of children (12-15 years) is 17.9 ± 8.9 g/1000 Kcal, where mean energy intake was 2206 ± 595 Kcal/d, corresponding to an EPA+DHA intake of 0.17 ± 0.1 % of total energy [41]. This level of intake

is comparable to the Australian SDT for long chain n-3 PUFA intake in adults, which corresponds to 0.2% of total energy intake [21].

In this study, despite the low fish consumption, fish being a rich source of LC n-3 PUFA contributed 60 % to long chain n-3 PUFA, which is slightly greater than that reported for Australian adults, where 48 % of long chain n-3 PUFA intake was derived from fish and seafood products [36]. In our study, and similarly in Australian adults [36], meat, poultry and game was the second largest food group contributor to long chain n-3 PUFA, but this was primarily due to the contribution of DPA. Two reasons for the high intake of DPA are that Australian children consume at least 8 times more meat than fish and that the cattle are grass-fed rather than grain-fed, providing a higher meat DPA content in Australian meat than in other countries [42]. However, the second largest contributor to DHA intake was eggs and not meat. Although the children consumed fewer eggs than meat (Table 2), eggs contain more DHA per gram than meat, which explains their relatively high contribution to DHA intake (Table 5).

Dietary habits in childhood influence the development of an individual's CVD risk profile in later life [43]. Coupled with the increasing prevalence of overweight and obesity in Australian children with increasing age [44, 45], it is timely to consider increasing intake levels of long chain n-3 PUFA as a part of CVD prevention programs for Australian children.

There are several ways to improve the intake of long chain n-3 PUFA, including nutrition education and behavior modification strategies to increase the consumption of fish and seafood, n-3 supplementation, or incorporation of foods that are enriched with n-3, such as certain brands of bread, milk, yoghurt or eggs. Australia is the leading market for n-3 enriched products (e.g. bread enriched with n-3) [46], and Australian consumers have claimed to have awareness of the health benefits of n-3 enriched foods [47]. However, it has been reported that fewer than 7 % of children in the Children's survey consumed n-3 enriched food products, including bread and milk [22], hence, we did not separate this type of food in our analysis. We have recently reported that long chain n-3 PUFA intakes can be approximately tripled if the usual intakes of bread, milk, eggs and yoghurt are substituted with the same foods that have been enriched with long chain n-3 PUFA [48]. However, these food substitutions did not result in an increase intake sufficiently to meet the SDT for long chain n-3 PUFA in those who did not eat fish during the two days of the survey; the best way remained an increased fish and seafood consumption. With regard to the sustainability of increasing fish consumption, the first national report of the status of key Australian fish stocks in 2012 indicated that at present most fish in Australia are caught in sustainable numbers and that for 88% of stocks (from 111 varieties), the fish biomass was healthy and harvested sustainably. This suggests that our recommendation to increase fish consumption is a viable option, although monitoring is required to ensure future sustainability [49]. Alternatives such as farmed fish may need to become a greater food source for delivery of n-3 LCPUFA. Therefore the challenge is to encourage non-fish eaters to include fish and seafood in their habitual diets, and to overcome reported barriers to intake, including undesirable physical properties (smell and bones), difficulties with preparation and cooking, unaffordability, presence of food allergies, and a perceived risk of pollutants [38, 50-52]. Communication of health messages that encourage children to include more fish in their diet [53, 54] will be one aspect, while educating parents and caregivers about practical, easy ways to prepare fish dishes may be of higher importance. Additionally, as well as being an excellent source of long chain n-3 PUFA, fish provides several other essential nutrients, including iodine, vitamin D, zinc, magnesium, phosphorus, selenium and potassium [55].

A potential limitation of this study is the use of two 24-hour recalls to obtain estimates of usual long chain n-3 PUFA intake. This may lead to under or over reporting, because fish is consumed only occasionally by most people. Red blood cells fatty acids are a valid biomarker of habitual long chain n-3 PUFA [56], however, the data were not collected in the present dietary survey. A previous national dietary survey in 1995 found that long chain n-3 PUFA intakes quantified from a single 24-h recall was almost identical to that obtained by a FFQ in Australian adults, with a mean and median of 247 and 119 mg/d, respectively [36]. Further, the authors argued that the difference between mean and median intakes, specifically for EPA and DHA, is likely to reflect a low proportion of the population consuming large quantities of fish, rather than low fish consumption by individuals in the 24-h recall [36]. A study using direct quantitative analysis of long chain n-3 PUFA intake in Canadian children aged 4-8 years [57], reported a mean intake long chain n-3 PUFA (EPA plus DHA) that was midway between the values of consumers and non-consumers of fish in the present study. Our data is consistent with previous national dietary surveys conducted in 1985 [32] and 1995 [33], as well as in Western Australia [58], in which the trend of low fish consumption appears to have remained unchanged in the population of Australian children. Similar intakes of fish have also been reported in a recent study of overweight and obese children [59] as well as in a survey of Australian families with young children [47]. It should be noted, however, that the mean and median intakes obtained by 24-hour recall from appropriately sampled group, such as the Children's Survey can provide a reliable estimate of the average usual intake of the group or population but not the usual intakes of the individual [60].

In conclusion, Australian children are not consuming optimal amounts of long chain n-3 PUFA, especially DHA, which could be explained due to a low intake of fish and seafood products.

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Table 1A. Average daily intake of long chain n-3 PUFA for all children by age group and sex (mg/d)

	n	EPA (mg/d)		DPA (mg/d)		DHA (mg/d)		Total LC n-3 PUFA[a] (mg/d)	
		Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)
Age									
All ages	4,487	21.8 ± 54.7	7.2 (2.0-20.6)	18.2 ± 29.5	8.9 (3.5-20.3)	39.0 ± 102.4	6.0 (0.9-26.8)	79.2 ± 173	28.9 (10.9-72.5)
2-3 y	1,071	16.5 ± 40.5	5.3 (1.5-13.8)	12.0 ± 18.6	6.2 (2.2-13.8)	31.2 ± 77.2	3.9 (0.6-23.6)	59.7 ± 128.5	21.5 (7.3-54.8)
4-8 y	1,216	19.2 ± 47.6	6.7 (1.8-18.0)	15.3 ± 23.5	8.2 (3.3-17.6)	35.9 ± 92.7	5.1 (0.9-26.5)	70.5 ± 152.7	26.1 (9.6-64.2)
9-13 y	1,110	23.5 ± 58.0	8.7 (2.6-23.0)	20.8 ± 32.1	10.8 (4.3-23.8)	40.9 ± 107.3	6.8 (1.1-27.4)	85.3 ± 183.2	32.6 (13.9-75.7)
14-16 y	1,090	28.2 ± 68.9	9.8 (2.7-28.0)	24.9 ± 38.9	12.2 (5-28.7)	49.3 ± 127.0	7.8 (1.5-32.9)	102.5 ± 215.9	36.7 (15.9-94.4)
Sex									
Boys	2,249	23.2 ± 59.6	7.6 (2-21.9)	19.3 ± 32.4	9.0 (3.5-21.5)	40.9 ± 110.8	6.4 (0.9-27.5)	83.5 ± 187.9	29.6 (11.5-75.5)
Girls	2,238	20.4 ± 49.6	6.8 (1.9-18.9)	17.1 ± 26.4	8.7 (3.4-19.4)	37.6 ± 93.8	5.9 (0.9-26.7)	75.0 ± 157.4	27.9 (10.5-69.4)

[a]Total LC (long chain) n-3 PUFA: sum of EPA, DPA, and DHA

Table 1B. Average daily intake of long chain n-3 PUFA for all children by age group and sex, adjusted for energy intake (mg/1000 Kcal/d)

	n	EPA (mg/1000 Kcal/d)		DPA (mg/1000 Kcal/d)		DHA (mg/1000 Kcal/d)		Total LC n-3 PUFA[a] (mg/1000 Kcal/d)	
		Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)
Age									
All ages	4,487	11.7 ± 28.5	3.8 (0.8-10.9)	9.6 ± 14.7	5.0 (1.7-10.9)	21.4 ± 54.8	2.9 (6.3-38.1)	42.7 ± 90.9	15.9 (6.3-37.7)
2-3 y	1,071	11.7 ± 28.9	3.8*[bc] (1.3-9.6)	8.4 ± 13.4	4.2*[bc] (1.7-10.0)	21.8 ± 53.2	2.9 (0.4-16.7)	41.4 ± 89.6	15.1*[bc] (5.0-36.0)
4-8 y	1,216	11.3 ± 26.8	3.8*[e] (1.3-10.9)	8.8 ± 13.4	5.0*[de] (2.1-10.5)	20.9 ± 53.2	2.9 (0.4-15.9)	41.0 ± 86.7	15.5*[e] (5.4-36.4)
9-13 y	1,110	11.7 ± 28.9	4.6*[b] (1.3-11.3)	10.5 ± 15.5	5.9*[bd] (2.1-12.1)	20.1 ± 52.3	3.3 (0.4-14.2)	41.9 ± 90.0	16.7*[b] (7.1-38.1)
14-16 y	1,090	12.6 ± 30.1	4.2*[ce] (1.3-12.6)	11.3 ± 15.9	5.9*[ce] (2.5-13.0)	23.0 ± 60.3	3.8 (0.8-14.7)	46.9 ± 97.6	16.7*[ce] (7.5-43.1)
Sex									
Boys	2,249	11.3 ± 28.5	3.8 (0.8-10.9)	9.6 ± 14.2	4.6 (1.7-10.9)	20.5 ± 53.6	2.9 (0.4-14.2)	41.0 ± 90.0	15.5 (5.9-37.3)
Girls	2,238	12.1 ± 28.5	4.2 (0.8-10.9)	10.0 ± 15.1	5.4 (2.1-11.3)	22.6 ± 56.1	3.3 (0.4-16.3)	44.4 ± 91.7	16.3 (6.3-39.4)

[a]Total LC (long chain) n-3 PUFA = sum of EPA, DPA, and DHA

*[b,c,d,e] If superscript is the same, this shows significant differences (*P*<0.05) between the two age groups

Table 2. Average daily intake of EPA, DPA, DHA and total LC n-3 PUFA for all children by fish eater status[a] , adjusted and unadjusted for energy intake

	Intake (mg/d)				Intake (mg/1000 Kcal/d)			
	Fish eater (*n* 933)		Non-fish eater (*n* 3,554)		Fish eater (*n* 933)		Non-fish eater (*n* 3,554)	
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)
All ages								
EPA	70 ± 104	36 (19-72)	9 ± 13	5 (1-12)	38 ± 54	21 (13-42)	5 ± 6.3	2.5 (0.8-6.7)
DPA	32 ± 48	16 (7-39)	15 ± 21	8 (3-17)	17 ± 21	8.4 (4.2-21)	7.5 ± 11	4.2 (1.7-9.2)
DHA	153 ± 182	87 (40-203)	9 ± 16	3 (0.3-11)	84 ± 96	50 (25-109)	5 ± 8	2.1 (0.2-6.3)
Total LC n-3 PUFA	255 ± 314	150 (76-308)	33 ± 41	21 (8-43)	138 ± 163	84 (46-172)	18 ± 21	12 (14.6-23)

[a] Fish eater, ate fish during at least one of the two survey days; Non fish eater, did not eat fish during the two survey days

Intake of EPA, DPA, DHA and total LC (long chain) n-3 PUFA (mg/1000 Kcal/d) for fish eater and non-fish eater are significantly different between corresponding values for all age groups ($P<0.001$)

[b]Total LC n-3 PUFA: sum of EPA, DPA, and DHA

Table 3. The consumption (g/d) of major food sources of long chain n-3 PUFA (meat, egg and fish) by fish eater status[a] in relation to percentage of children meeting SDT[a]

	n	Percentage of children		Actual consumption (g/d) (mean ± SD)					Percentage of children meeting the SDT[c]	
				Meat		Egg		Fish		
		Non-fish eaters (%)	Fish eaters (%)	Non-fish eater	Fish eaters	Non-fish eaters	Fish eater	Fish eater	Non-fish eaters	Fish eaters
Boys										
2-3 y	550	75	25	65 ± 52	47 ± 38	5.3 ± 14	6.5 ± 18	42 ± 35	0.5	16
4-8 y	613	79	21	101 ± 73	78 ± 58	5.8 ± 16	8.8 ± 20	63 ± 51	0.0	16
3-13 y	525	81	19	129 ± 88	110 ± 98	6.0 ± 16	6.7 ± 17	78 ± 66	0.0	15
14-16 y	561	82	18	186 ± 114	138 ± 109	7.5 ± 19	12.6 ± 22	83 ± 58	0.0	21
Girl										
2-3 y	521	77	23	68 ± 52	50 ± 40	4.8 ± 12	5.4 ± 11	43 ± 33	0.0	22
4-8 y	603	76	24	84 ± 61	63 ± 58	5.2 ± 13	8.4 ± 16	48 ± 39	0.0	20
3-13 y	585	82	18	113 ± 93	90 ± 73	7.6 ± 20	6.8 ± 18	59 ± 46	0.0	16
14-16 y	529	81	19	112 ± 92	92 ± 84	7.5 ± 20	8.8 ± 23	68 ± 42	0.0	18
Total children	4487	79	21	108 ± 30	80 ±76	6.2 ± 16	7.9 ± 18	59 ± 32	0.0*	18

[a]Fish eater, ate fish during at least one of the two survey days; Non fish eater, did not eat fish during the two survey days

[b]SDT, suggested dietary target

[c]SDT for LC (long chain) n-3 PUFA (Meyer & Kolanu, 2011) [22]

total LC n-3 PUFA: sum of EPA, DPA, and DHA

*The actual value = 0.000563

n, number of children

Table 4. Intakes of EPA, DPA, DHA and total LC n-3 PUFA[a] in correlation with the intakes of some food groups (Kendall's tau-b correlation coefficients)

	EPA	DPA	DHA	Total LC n-3 PUFA
EPA		0.525[b]	0.395	0.692
DPA			0.343	0.633
DHA				0.651
Fish and seafood products and dishes	0.463	0.191	0.519	0.486
Meat, poultry and game products and dishes	0.161	0.280	0.114	0.193
Egg products and dishes	0.023	0.110	0.379	0.242
	$P < 0.05$			
Cereal based products and dishes	0.038	0.048	0.023	0.044
			$P < 0.05$	
Fats and oils	0.041	0.043	0.015	0.035
Vegetable products and dishes	0.078	0.072	0.029	0.067
			$P = 0.004$	

[a]Total LC (long chain) n-3 PUFA: sum of EPA, DPA, and DHA

[b]All correlation coefficients are significant for $P < 0.001$, except those for which a P value is indicated

Table 5 Percentage contribution of food groups to EPA, DPA, DHA and total long chain (LC) n-3 PUFA[a] for all children (*n* 4,487) aged 2-16 y

Food group name	EPA	DPA	DHA	Total LC n-3 PUFA
Fish and seafood products and dishes	59.4	23.6	75.9	59.3
Meat, poultry and game products and dishes	24.5	56.1	7.1	23.1
Egg products and dishes	0.3	3.6	12.6	7.1
Cereal-based products and dishes[b]	4.2	5.7	2.2	3.6
Milk products and dishes[c]	2.3	5.6	0.2	2.0
Fats and oils	1.9	1.9	0.0	1.0
Vegetable products and dishes	2.7	0.4	0.0	0.9
Cereal and cereal products	0.6	0.4	1.2	0.8
Soup	0.7	1.3	0.4	0.7
Snack foods	2.2	0.4	0.0	0.7
Savoury sauces and condiments	0.8	0.5	0.4	0.5
Sugar products and dishes	0.2	0.2	0.0	0.1
Miscellaneous	0.1	0.1	0.0	0.0
Fruit products and dishes	0.1	0.1	0.0	0.0
Confectionery and cereal/nut/fruit/seed bars	0.1	0.1	0.0	0.0
Other: infant formulae and foods, non-alcoholic beverages, dairy substitutes, seed and nut products and dishes, legume and pulse products and dishes, alcoholic beverages, special dietary foods	0.0	0.0	0.0	0.0

[a]Total LC (long chain) n-3 PUFA: sum of EPA, DPA, and DHA

[b]Including n-3 enriched bread

[c]Including n-3 enriched milk

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