Original Article

Intake ratio and major food sources of n-3 and n-6 fatty acids in Korea: a study based on the sixth Korea national health and nutrition examination survey (2013–2014)

Ae Wha Ha PhD[1], Woo Kyoung Kim PhD[2]

[1]*Department of Food Science and Nutrition & Natural Nutraceuticals Industrization Research Center, Dankook University, Chungnam, Korea*
[2]*Department of Food Science and Nutrition, Dankook University, Chungnam, Korea*

Background and Objectives: In addition to the intake ratio of omega 6 (n-6) to omega 3 (n-3) fatty acids, their intake amount has an effect on health. This study evaluated the n-6:n-3 intake ratio as well as the food sources and association of these fatty acids with demographic characteristics based on sixth Korea National Health and Nutrition Examination Survey data. **Methods and Study Design:** This study included 13,937 participants from the survey. The weighted mean intake and major food groups of n-3 and n-6 fatty acids were determined. The 10 chief food sources of n-3 and n-6 fatty acid were expressed as percent contribution to total intake. **Results:** α-Linolenic acid constituted approximately 80% of total n-3 intake, followed by docosahexaenoic acid (10.5%) and eicosapentaenoic acid (6.1%). Linoleic acid constituted 97% of total n-6 intake. After adjustment for cofactors (age, sex, and energy intake), education level ($p<0.01$), alcohol consumption frequency ($p<0.05$) and monthly income ($p<0.01$) were significant variables determining n-3 and n-6 FA intake by Korean people. The average n-6:n-3 intake ratio was 7.49:1. The major source of α-linolenic acid and linoleic acid was soybean oil, whereas that of docosahexaenoic acid and eicosapentaenoic acid was mackerel. Pork (70.0%) and egg (38.7%) were the major food sources of arachidonic acid and dihomo-γ-linolenic acid, respectively. **Conclusion:** Monthly income, alcohol consumption frequency, and education level significantly affected n-3 FA intake. The dietary n-6: n-3 intake ratio in Korea is 7.49:1; however, eicosapentaenoic acid and docosahexaenoic acid intake remains inadequate (0.27 g/day).

Key Words: n-3 fatty acid, α-Linolenic acid, linoleic acid, docosahexaenoic acid, n-6 fatty acid

INTRODUCTION

Polyunsaturated fatty acids (PUFAs) are fatty acids (FAs) containing two or more double bonds along their carbon backbones comprising 18 or more carbon atoms. PUFAs can be classified into two biologically important omega FAs, namely omega 6 (n-6) FAs and omega 3 (n-3) FAs. These FAs differ in the location of the last double bond in the terminal methyl end, with that for n-3 being located at the third carbon from the end, and that for n-6 being located at the sixth carbon from the end.[1] n-3 FAs include α-linolenic acid (ALA), stearidonic acid (SDA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA), whereas n-6 FAs include linoleic acid (LA), γ-linolenic acid (GLA), eicosadienoic acid, dihomo-γ-linolenic acid (DGLA), arachidonic acid (AA) and docosadienoic acid.[2]

n-3 and n-6 FAs are precursors of eicosanoids, which consist of prostaglandins (PGs), thromboxanes and leukotrienes.[2] PGs have various roles in inflammation: PGs synthesized from n-6 FAs induce inflammation, whereas some PGs synthesized from n-3 FAs inhibit inflammation. Thus, consuming food with excessively high n-6 and insufficient n-3 FA content may increase inflammation and contribute to chronic diseases.[3,4]

The n-6:n-3 ratio as well as the n-6 and n-3 FA types are critical for health maintenance. A study reported that n-3 FAs, including ALA, EPA, and DHA, have specific and potentially independent effects on cancer, insulin resistance, and cardiovascular disease.[5] Increased DHA and EPA intake (1–2 g/day) can significantly alleviate the risk of cardiovascular disease, because these FAs improve vascular contraction and relaxation and reduce inflammation and plasma triglyceride levels.[6]

An accurate nationwide assessment of FA intake is required for establishing the association between FA intake and health status. The Korea National Health and Nutrition Examination Survey (KNHANES) is a national surveillance system used for assessing health and nutritional status in Korea. FA composition data were not collected in the KNHANES until 2013.[7,8] Since 2013, data regarding the mean intake of saturated, monounsaturated, total

Corresponding Author: Dr Woo Kyoung Kim, Department of Food Science and Nutrition, Dankook University, 119, Dandae-ro, Dongnam-gu, Cheonan-si, Chungnam 31116, Korea.
Tel: +82-41-550-3471; Fax: +82-41-550-3471
Email: wkkim@dankook.ac.kr; wooend118@gmail.com
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n-3 and total n-6 FAs have been reported in the newly constructed 2013 KNHANES FA composition table;[9] however, these data do not individually elaborate the intake or food sources of various n-3 and n-6 FAs.

Therefore, this study investigated the mean daily intake of various n-3 and n-6 FAs and their relationship with demographic characteristics. In addition, the major food groups and sources of n-3 and n-6 FAs were identified using data from the sixth KNHANES (KNHANES VI; 2013–2014).

PARTICIPANTS AND METHODS

Study population

This study analysed data from the KNHANES VI (2013–2014), a cross-sectional and nationally representative survey conducted between 2007 and 2014 by the Korea Centers for Disease Control and Prevention (KCDC). This study complied with the provision of the Helsinki declaration and was approved by KCDC (Institutional Review Board numbers: 2013–07CON-03-4Cand 2013-12EXP-03-5C). Signed Informed consent was obtained from all individual participants included in this study. Participants who completed 24-h dietary recall interviews were included; of them, individuals with daily energy intake of <500 or >5,000 kcal were excluded.

Demographic characteristics

The participants were grouped according to their general characteristics, namely age (<19, 19–29, 30–49,50–64 and >65 years), current smoking status (currently smoking or currently not smoking),education (middle school graduate or lower, high school graduate and college graduate or higher), alcohol consumption frequency (once per month, once per week and two or more times per week) and monthly income (low, middle-low, middle-high and high income, based on mean income of participant age groups). We applied the following cut-off values for obesity, given by the Western Pacific Regional Office:[10] BMI ≤18.5 kg/m^2, underweight; BMI between 18.5–24.9 kg/m^2, normal or overweight; and BMI ≥25.0 kg/m^2, obese.

Food groups and nutrient intake

Major food groups and nutrient intake were estimated on the basis of the 24-h dietary recall interviews, which were conducted by trained dietitians. To estimate the intake of each food group among the participants, a secondary food code for 24-h recall data was used. The KNHANES applies 18 food group classifications, based on the Rural Development Administration food ingredient tables.[11] In brief, 5,000 food codes are used to code the intake of adult respondents, and these individual KNHANES food codes are combined into 144 food items and finally divided into 18 food groups—16 general food groups, 1 processed (instant) food group, and 1 other food group, under the secondary food code of the 24-h recall data.

Statistical analysis

To make valid inferences, accounting for the complex multistage sampling design of the KNHANES VI (2013–2014), this study incorporated sampling weights to produce population estimates by using SAS software (version 9.2; SAS Institute, Cary, NC, USA). The survey sample weights were calculated considering the sampling rate, response rate and proportion of the reference population. The data were reported as the weighted mean and standard errors (SE).

To identify major food groups of n-6 and n-3 FAs, the weighted contribution (%) of n-6 or n-3 FAs from each food group was calculated by multiplying the amount of individual n-3 or n-6 FA in foods by the sample weight of the individual consuming that food, using proc survey frequency in SAS. The food sources of n-6 and n-3 FAs were calculated and expressed as percent contribution to total intake.

Significant differences among continuous variables were verified using a generalized linear model through proc survey regression. After adjustment for age, sex and energy intake, significance testing was conducted for *p* for trend by using proc survey regression. $p<0.05$ was considered to be statistically significant.

RESULTS

This study included a total of 13,797 participants, comprising 6,038 men (49.7%) and 7,759 women, with a mean age of 39.5±0.32 years. Of them, 22.0%, 9.0%, 26.0%, 20.0% and 19.0% were <19 (10.2±0.11), 19–29 (24.1±0.10), 30–49 (39.7±0.14), 50–64 (56.2±0.10) and ≥65 (73.4±0.14) years old, respectively. Table 1 presents the observed intake of major n-3 FAs stratified by demographic characteristics, after adjustment for age, sex and energy intake. The average total n-3 FA intake was 1.59 g/day. ALA accounted for 80% of the total n-3 FAs, whereas DHA and EPA accounted for 10.5% and 6.1%, respectively. Participants aged 19–29 years consumed the highest amount of ALA, whereas those aged 50–64 years consumed the highest amount of DHA and EPA; this trend was similar in both men and women. Only ALA consumption was significantly associated with education level. The consumption of all n-3 FAs was significantly associated with monthly income levels. Obesity was not associated with ALA intake alone.

Table 2 presents the determined intake of major n-6 FAs stratified by demographic characteristics after adjustment for age, sex and energy intake. The average total n-6 FA intake was 10.1 g/day. Furthermore, LA accounted for 97% of total n-6 FA intake, followed by AA and DGLA. Individuals aged 19–29 years consumed the highest amount of all n-6 FAs. Compared with women, men consumed higher amounts of all n-6 FAs.

Participants in the high-income group consumed higher amounts of all n-6 FAs than did those in the low-income groups. Total n-6 FA intake was significantly associated with alcohol consumption frequency. Obesity was not associated with the intake of n-6 FAs, except for LA.

Figure 1A illustrates the distribution of the n-6:n-3 ratio in the entire study population (n=13,705). The mean±standard deviation of the n-6:n-3 ratio was 7.49±4.3. The curve of n6:n3 ratio was skewed to the right. Thus a natural logarithm transformation of n6:n3ratio were undertaken for regression analysis. Figure 1B shows boxplots for the pooled n-6:n-3 ratio in the age subgroup. In the boxplots, horizontal bars inside the boxes indicate median values, and the upper and lower boundaries of the boxes represent the third quartile (Q3)

Table 1. Dietary intake of n-3 fatty acids stratified by demographic characteristics†

Variables	n	ALA (g) Mean±SE‡	EPA (mg) Mean±SE	DHA (mg) Mean±SE	Total n-3 (g) Mean±SE
Age					
<19	3280	1.16±0.03	52.8±3.06***§	95.5±5.81***	1.33±0.03*
19–29	1237	1.52±0.05***	72.8±5.86***	123±10.7***	1.74±0.05
30–49	3830	1.36±0.03	116±4.51	200±9.54	1.75±0.04
50–64	2885	1.29±0.04*	140±7.13***	244±14.7***	1.76±0.05***
65 or older (reference)	2811	0.89±32.6	76.7±3.45	129±6.19	1.14±0.04
Sex					
Men	6712	1.41±0.03***	116±4.01	203±8.28	1.79±0.03***
Women (reference)	7871	1.13±0.02	78.5±2.62	134±4.73	1.39±0.02
Current smoking status					
No	7725	1.27±0.02**	99.9±3.33	171±6.26	1.60 ±0.03
Yes(reference)	1679	1.37±0.04	133±9.36	232±20.4	1.81±0.06.
Education level					
<High school	6673	1.18±0.02**	97.7±3.87	170±7.81	1.50±0.03***
High school	3250	1.46±0.03*	104±4.71	176±8.01	1.80±0.04*
≥college(reference)	349	1.77±0.12	164±25.8	303±60.3	2.35±0.19
Drinking habit					
< 1/month	4788	1.28±0.03***	92.0±3.52**	160±7.02**	1.58±0.03*
1–4/month	3017	1.39±0.03**	110±5.51	187±10.5	1.75±0.04*
≥ 2–4/weeks (reference)	1915	1.37±0.04	143±9.41	252±20.2	1.84±0.06
Monthly income					
Low	2514	0.99±0.04**	71.6±4.17**	121±6.83**	1.21±0.04***
Middle-low	3673	1.16±0.03**	89.7±4.45 *	158±8.38*	1.46±0.03**
Middle-high	3983	1.33±0.04*	98.1±4.24*	165±8.11*	1.64±0.04*
High (reference)	3788	1.47±0.04	117±5.93	207±12.7	1.86±0.05
Obesity status					
Underweight	432	1.06±0.04	73.5±4.73*	118±7.82*	1.48±0.04**
Normal/overweight	6411	1.03±0.03	105±3.84	181±7.41	1.61±0.03
Obese (reference)	3328	1.29±0.07	118±14.4	200±29.5	1.67±0.04

ALA: α-linolenic acid; EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid.
†All estimates were weighted and calculated by considering the complex survey design.
‡Mean±SE; mean intake (mg/day) and standard error.
§*p* for trend obtained by proc survey regression after adjusting for age, sex, and energy intakes.
****p*<0.001, ***p*<0.01, **p*<0.05.

or 75th percentile and the first quartile (Q1) or 25th percentile, respectively. The median n-6:n-3 ratio of the age groups 50–64 (6.63) and ≥65 (6.44) years were slightly lower than those of other age groups (<19 years, 7.64; 19–29 years, 8.19; 30–49 years, 8.25).

Tables 3 and 4 present the major food groups of n-3 and n-6 FAs, respectively. Among the 18 food groups defined by the KNHANES, the oil group was the major contributor of ALA, (>41%; Table 3), followed by the seasoning, grain, legume and nut groups. The seafood group was the major contributor of EPA and DHA. The oil group was also the major contributor of LA (major n-6 FA; Table 4), followed by the grain, seasoning, meat and legume groups. The meat was the highest contributors of AA while the egg group was the primary contributor of DGLA.

The 10 chief food sources of each n-3 and n-6 FA are listed in Tables 5 and 6. The major food source of ALA was soybean oil, followed by perilla seed oil and mayonnaise (Table 5). Mackerel was the major food source of EPA and DHA. Other seafood, such as eel, hairtail, anchovy, oyster, and yellow croaker, were sources of n-3 FAs. Similar to ALA, soybean oil was the primary source of LA (Table 6), followed by mayonnaise, sesame oil, tofu and pork. Pork was also the major food source of AA, whereas egg was the primary food source of DGLA.

DISCUSSION

By using the data from the KNHANES VI (2013–2014), this study analyzed the daily intake of various n-3 and n-6 FAs and determined its association with demographic characteristics. In addition, this study identified the major food groups and food sources of these n-3 and n-6 FAs.

As shown in Table 1 and 2, among individuals aged 19–29 years, LA (major n-6 FA) intake was the highest, whereas DHA and EPA intake was lowest, indicating that young adults in Korea consume less fish and more fatty foods. In Japan, fish consumption was reported to be positively correlated with cardiovascular disease alleviation.[12] A study also reported that changes in food consumption (i.e., decreased fish consumption and increased fatty food consumption) were associated with increased metabolic syndrome risk among young adults.[13] Thus, to reduce the risk of cardiovascular disease among young adults, we recommend increasing the consumption of fish or DHA- or EPA-rich foods.

Even after adjustment for cofactors (i.e., age, sex and energy intake), monthly income remained significant negative factors affecting n-3 FA intake among Korean people; this is probably because food sources of n-3 FAs (e.g., seafood and fish oil) are expensive and thus less accessible to the population with lower income.[14] The current study also revealed that n-3 or n-6 FA intake was

Table 2. Dietary intake of n-6 fatty acids stratified by demographic characteristics†

Variables	n	LA (g)	DGLA (mg)	AA (mg)	Total n-6 (g)
		Mean±SE‡	Mean±SE	Mean±SE	Mean±SE
Age					
<19	3280	9.59±0.25***§	75.2±1.52***	88.7±3.11***	9.85±0.23***
19–29	1237	12.3±0.30***	81.8±3.31***	127±5.81***	13.3±0.43***
30–49	3830	11.0±0.19***	69.8±1.31***	105±3.07***	11.3±0.21***
50–64	2885	8.80 ±0.18	50.6±1.82***	77.2±3.17***	8.91±0.25***
65 or higher(reference)	2811	5.27±0.14	27.0±1.02	44.5±2.41	5.39±0.23
Sex					
Men	6712	11.4±0.16***	73.5±1.42	115±2.91	11.7±0.14***
Women(reference)	7871	8.32±0.12	53.0±0.91	68.8±1.62.	8.52±0.16
Current smoking status					
No	7725	9.43±0.14	56.9±1.02	83.9±2.23	9.66±0.16
Yes(reference)	1679	11.3±0.27	71.1±2.44	123±5.56	11.6±0.32
Education level					
<high school	6673	8.60±0.13***	52.0±1.12	81.1±2.25	8.80±0.18**
High school	3250	11.2±0.22*	75.0±1.72	114±3.55	12.2±0.27*
≥college (reference)	349	13.8±0.91	77.4±6.14	119±17.6	14.2±0.91
Drinking habit					
<1/month	4788	9.60±0.15***	59.3±1.45	84.9±3.13	9.83±0.23**
1–4/month	3017	11.9±0.22***	68.0±1.77	103±3.43	11.5±0.22***
≥2–4/weeks(reference)	1915	10.7±0.29	66.6±2.33	115±4.61	11.0±0.35
Monthly income					
Low	2514	7.10±0.27***	46.5±2.41	63.6±4.44	7.28±0.36**
Middle-low	3673	9.12±0.17***	59.7±1.63**	89.6±3.21**	9.38±0.27*
Middle-high	3983	10.4±0.20**	64.8±1.48**	99.0±3.12	10.7±0.23*
High(reference)	3788	11.3±0.24	73.2±1.79	102±3.67	11.5±0.23
Obesity status					
Underweight	432	9.15±0.22**	57.9±1.81	85.9±4.96	9.81±0.25
Normal/overweight	6411	9.87±0.18	59.1±1.36	89.9±2.55	10.2±0.29
Obese(reference)	3328	9.91±0.46	60.6±3.44	98.2±7.51	10.4±0.25

LA: linoleic acid; DGLA: dihomo-γ-linolenic acid; AA: arachidonic acid.
†All estimates were weighted and calculated by considering the complex survey design.
‡Mean ±SE: Mean intake (mg/day) and standard error.
§*p* for trend obtained through proc survey regression after adjustment for age, sex, and energy intake.
****p*<0.001, ***p*<0.01, **p*<0.05.

Table 3. The weighted contribution (%) of n-3 FAs from each food group†

Group	ALA		EPA		DHA	
	%‡	SE (%)	%	SE (%)	%	SE (%)
Grains	9.13	0.36	0.18	0.02	0.18	0.01
Potatoes	0.21	0.02	-§	-	-	-
Sugars	0.09	0.01	-	-	-	-
Legumes	10.5	0.27	-	-	-	-
Nuts	6.23	0.39	-	-	-	-
Vegetables	5.37	0.10	-	-	-	-
Mushrooms	-	-	-	-	-	-
Fruits	1.26	0.07	-	-	-	-
Meats	5.54	0.14	0.38	0.03	0.30	0.02
Eggs	2.69	0.09	-	-	0.30	0.03
Seafood	1.81	0.07	94.1	0.29	98.5	0.15
Seaweed	0.11	-	4.34	0.18	0.03	-
Milk	1.11	0.04	0.10	0.03	0.03	0.01
Oils	40.8	0.66	-	-	-	-
Drinks	0.39	0.04	-	-	-	-
Seasonings	14.6	0.45	0.01	-	0.03	-
Instant foods	0.02	0.01	0.02	-	0.01	-
Others	0.02	-	0.85	0.21	0.58	0.15

ALA: α-linolenic acid; EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid.
†All estimates were weighted and calculated by considering the complex survey design.
‡Percent (%) and standard error (SE): fractions of the individual n-3 FA intake falling into each category of food group, calculated by new-weight variable of individual n-3 FA.
§Percent n-3 FA intake in each group was less than 0.01.

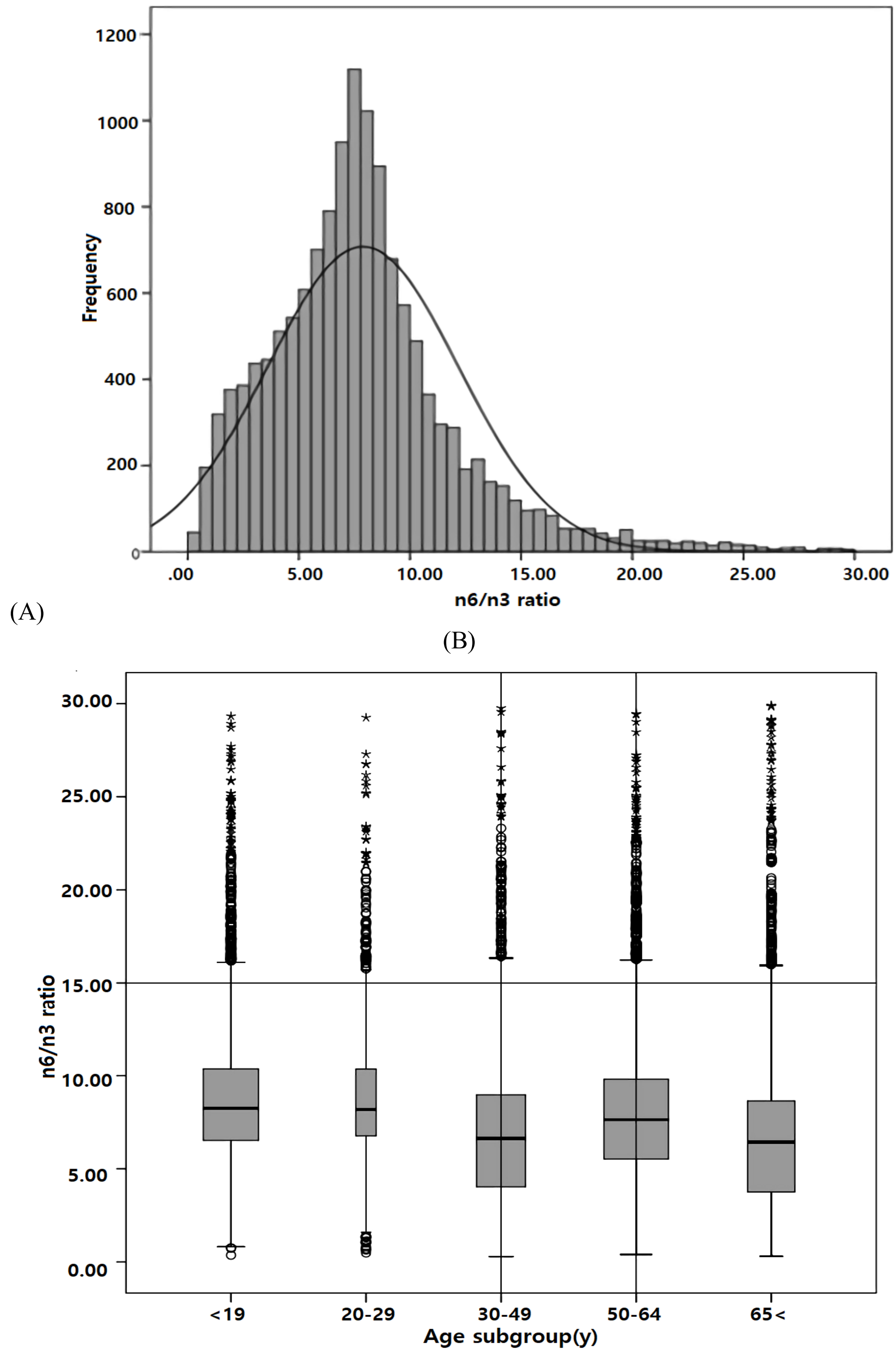

Figure 1. (A) Distribution of the n-6:n-3 ratio of all participants (n=13,705, age=1–84 years) and (B) Boxplots for age subgroups and the n-6:n-3 ratio. The n-6:n-3 ratio was calculated as the sum of total n-6 fatty acid intake divided by the sum of total n-3 fatty acid intake..

high among individuals with high alcohol consumption frequency, and this is probably because alcohol consumers often tend to eat more fatty foods, such as fried foods, snacks or side dishes.[15,16]

Appropriate DHA and EPA intake and n-6:n-3 ratio are crucial for health maintenance. The results of the current study indicate that the average n-6:n-3 intake ratio in Korea is 7.49:1, which is lower than that in Western countries.[17-19] The average intake of DHA and EPA in Korea is 0.27g/day, which is similar to that in Western countries, with approximately 0.1–0.5 g/day and 0.1–0.2 g/day being consumed in Europe and the United States, respectively.[16-19]

DHA and EPA intake of at least 0.5 g/day can reduce cardiovascular disease risk, whereas DHA and EPA intake of 1–2 g/day is recommended for treating existing cardiovascular disease.[20-23] In Korea, the current DHA and EPA intake (0.27 g/day) must be increased to capitalize on their health benefits. The recommended DHA and EPA intake level can be achieved through the consumption of DHA-rich fish and fish products. Oily fish consumption at least two times a week is recommended for achieving 0.5 g/day DHA intake.[17] According to our results, Korean people obtain DHA and EPA mainly from mackerel; thus, consuming various DHA-rich fish species, such as salmon and tuna, may aid in achieving the

Table 4. The weighted contribution (%) of n-6 FAs from each food group[†]

Food group	LA[‡]		DGLA		AA	
	%[§]	SE (%)	%	SE (%)	%	SE (%)
Grains	15.8	0.37	0.15	0.05	2.94	0.26
Potatoes	0.47	0.04	-[¶]	-	0.01	-
Sugars	0.31	0.03	0.01	-	-	-
Legumes	10.5	0.27	-	-	-	-
Nuts	5.90	0.24			0.04	0.01
Vegetables	1.56	0.03	-	-	0.74	0.06
Mushrooms	0.02	-	-	-	-	-
Fruits	0.32	0.01	0.08	0.01	0.08	0.01
Meats	12.7	0.30	26.1	0.63	79.4	0.60
Eggs	4.06	0.10	52.7	0.70	-	-
Seafood	1.44	0.06	3.84	0.21	13.1	0.43
Seaweed	0.84	0.03	-	-	2.07	0.11
Milk	1.19	0.04	15.7	0.41	0.57	0.13
Oils	31.0	0.43	1.09	0.07	0.02	-
Drinks	0.34	0.01	0.07	0.01	0.05	0.01
Seasonings	13.3	0.40	0.15	0.02	0.48	0.07
Instant foods	0.02	0.01	0.01	-	-	-
Others	0.02	-	-	-	0.51	0.13

[†]All estimates were weighted and calculated by considering the complex survey design.
[‡]Linoleic acid (LA), dihomo-γ-linolenic acid (DGLA), arachidonic acid (AA).
[§]Percent (%) and standard error (SE): fractions of the individual n-6 intake falling into each category of food group, calculated by new-weight variable of individual n-6 FA.
[¶]Percent n-6 intake in each group was less than 0.01.

Table 5. Major food sources of n-3 fatty acids in Korean population

Rank	ALA		EPA		DHA	
	Foods	%[†]	Foods	%	Foods	%
1	Soybean oil	24.5	Mackerel	16.2	Mackerel	13.1
2	Perilla seed oil	14.0	Anchovy(Small)	7.1	Mackerel (Salted)	6.8
3	Mayonnaise	10.2	Oyster	4.9	Eel	6.8
4	Perilla seed	4.9	Yellow croaker	4.4	Hairtail	5.6
5	Tofu	4.5	Eel	4.2	Anchovy(Large)	5.5
6	Black soybean	3.2	Anchovy(Large)	4.1	Yellow croaker	5.5
7	Rapeseed oil	2.4	Hairtail	3.8	Squid	3.9
8	Fried egg	2.3	Squid	2.5	Anchovy(Small)	3.3
9	Doenjang	1.9	Yellow croaker(Dried)	2.4	Yellow croaker(Dried)	3.2
10	Walnut	1.5	Pacific saury	2.3	Pacific saury	2.8

ALA: α-Linolenic acid; EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid.
[†]Percent total intake.

Table 6. Major food sources of n-6 fatty acids in the Korean population

Rank	LA		DGLA		AA	
	Foods	%[†]	Foods	%	Foods	%
1	Soybean oil	22.5	Hen's egg (Raw)	38.7	Pork (Loin)	35.6
2	Mayonnaise	10.6	Fried egg	12.0	Chicken	6.2
3	Sesame oil	7.3	Pork (Loin)	8.6	Pork (Rib)	3.8
4	Tofu	5.5	Butter	6.0	Beef	2.9
5	Pork meat loin	3.2	Milk	5.6	Mackerel	2.8
6	Black soybean	3.0	Beef	5.5	Pork (Belly)	2.4
7	Fried egg	2.5	Ice cream	4.0	Pork product (Ham, Sausage)	2.3
8	Pork meat belly	2.1	Quail's egg	1.5	Wheat products	2.2
9	Hen's egg	1.7	Pacific saury	1.1	Duck	2.0
10	Sesame seed	1.6	Cheese	1.0	Pacific saury	1.8

LA: linoleic acid; DGLA: dihomo-γ-linolenic acid; AA: arachidonic acid.
[†]percent total intake.

recommended DHA and EPA intake amount; however, the mercury content of canned salmon or tuna must be carefully monitored.

Consuming more ALA-rich food can aid in achieving the recommended DHA and EPA intake, particularly in people who cannot consume fish. The human body can synthesize DHA and EPA from ALA, but at a slow conversion rate. According to our results, the major food source of ALA in Korea is soybean oil (24.5%), followed by perilla oil (14%). Soybean oil contains 8-10% of ALA while perilla oil contains 60%–65% of ALA; therefore, the use of perilla oil for cooking, rather than soybean oil, may enhance DHA and EPA synthesis in the body.[24]

Stearidonic acid (SDA) can effectively increase EPA and DHA levels in humans, and it is a suggested alternative to fish oil; this is because SDA is more readily and efficiently converted to EPA than ALA in the body.[25] According to the results of this study, Korean people consume trace amounts of SDA (8.4 mg/day), with the major contributing food group being seafood (98%), mainly mackerel (data were not shown). Seed oils, such as echium oil (3.5%–9.0% SDA) and blackcurrant seed oil (2%–6% SDA), are the existing plant sources of SDA.[26,27] Therefore, adding SDA-enriched plant oils to foods may increase SDA intake, thus increasing EPA levels in the body.

In addition, some n-6 FAs have roles in inflammation and antiallergic pathways.[28] Dihomo-γ-linolenic acid (DGLA) is a nutritionally important n-6 FA; it has 20 carbons and 4 double bonds and is synthesized from LA by delta-6-desaturase. DGLA is also converted to PG1 by cyclooxygenase enzymes, which have anti-inflammatory effects.[29] The results of this study reveal that the mean DGLA intake in Korea is 63.3 mg/day (6.3% of total n-6 FA intake), with eggs (38.7%) being its primary source, followed by pork, milk and butter. Because these food sources of DGLA also contain a considerable amount of saturated FAs, the consumption of plant sources of DGLA, such as evening primrose oil, must be considered.[30]

In conclusion, Monthly income, alcohol consumption frequency and education level remained significantly important factors affecting n-3 FA intake, even after adjustment for the cofactors (i.e., age, sex and energy intake). Although Korean people consume foods with an n-6:n-3 ratio of 7.49:1, their EPA and DHA intake remains inadequate. The suitable alternatives for achieving the recommended DHA and EPA intake amount include consuming DHA- and EPA-rich seafood, using cooking oil rich in n-3 FAs, or DGLA-enriched foods.

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AUTHOR DISCLOSURES
No conflict of interests to declare.

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