

# **Maternal fish and shellfish intake and pregnancy outcomes. A prospective cohort study in Brittany, France.**

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# **ABSTRACT**

## **Background**

Recommendations about risks and benefits of seafood intake during pregnancy have been published in the last decade, but specific health effects of the different categories of seafood remain unknown. Fish and shellfish may differ according to their fatty acids (FA) content and their concentration of chemical pollutants and toxins. Not taking into account these specificities may lead to underestimation of both positive and negative impacts of seafood on birth outcomes and partly explain inconsistent results on the subject.

## **Methods**

In the PELAGIE cohort study, including 2398 pregnant from Brittany, we examined associations between fish or shellfish intake, and length of gestation, birthweight, risk of preterm births (PB), low birthweight (LBW) or small for gestational age (SGA) babies, fitting multiple linear and logistic regression models.

## **Results**

When fish and shellfish consumptions were considered simultaneously, we observed opposite trends in the risk of SGA births for fish (negative trend  $p=0.07$ ) and shellfish consumption (positive trend  $p=0.02$ ) with an OR= 2.14 (95%CI: 1.13 to 4.07) for the group with highest shellfish consumption compared with the lowest one. Each additional monthly fish meal was significantly related ( $p=0.03$ ) to a 0.14-day increase in gestational length. No other association was observed with birthweight, or length of gestation.

## **Conclusions**

These results suggest that different categories of seafood may be differently associated with birth outcomes, fish consumption with increased length of gestation and shellfish consumption with decreased fetal growth.

## Background

Seafood is a major source of long chain polyunsaturated fatty acids (PUFA). Reviews of the health benefits of n-3 FA on pregnancy outcome by Allen in 2001 [1] and Facchinetti in 2005 [2] suggest they have a beneficial effect on gestational length and fetal growth. Some observational studies [3, 4] and clinical trials in the general population [5] and in women with high-risk pregnancies [6] show an association between fish oil or seafood intake and prolonged length of gestation or decreased preterm-birth (PB) rates, as well as an influence on birthweight and on reduction of small-for-gestational age (SGA) births [3, 5, 7-9]. Results are nonetheless inconsistent: some clinical trials and studies find seafood consumption is not associated with fetal growth [6, 10, 11] or length of gestation [7, 9-12], while others suggest it has a negative effect on birthweight [12, 13]. This inconsistency has been widely discussed and explained in part by the possibility that the beneficial effects of eating seafood during pregnancy may be balanced by the potential adverse effects of seafood contaminants such as polychlorinated biphenyls (PCBs), dioxins, or other polychlorinated compounds and metals [14-16].

Despite the many studies on this topic in populations in Denmark, the Faroe Islands, England and the US, this association has never been studied in France. Brittany is an interesting site for such a study: seafood consumption is high, due to the proximity of the sea, and consumption of shellfish is sufficiently high to allow for a separate analysis of the effects of fish and shellfish. The studies mentioned above analyzed relations between pregnancy outcome and fish consumption alone or global seafood consumption, without distinguishing between fish and shellfish intake. Because the levels of contaminants and fatty acids in these two categories may differ, their health effects may differ as well, and specific profiles of seafood consumers may be at higher risk for adverse pregnancy outcome.

Accordingly we investigated the relation of seafood -that is fish and shellfish- intake during pregnancy to length of gestation, birthweight and decreased fetal growth in a cohort of 2398 pregnant women in Brittany.

## **Methods**

### **Population and study design**

The aim of the PELAGIE cohort was to study the role of environmental pollutants on pregnancy course and outcome and on children's health and development. Women in two districts (Ille et Vilaine and Finistere) of Brittany (France) were enrolled from April 2002 to February 2005 during the first trimester of their pregnancy, when they saw participating gynecologists or ultrasonographers for antenatal care. They were then followed through delivery. Informed consent for data collection was obtained from the participants and this procedure was approved by the appropriate ethical committees. At inclusion, women completed a questionnaire that asked about family social and demographic characteristics, obstetrical history, occupational activity, nutrition and lifestyle. Medical information about pregnancy, delivery, and the newborn's health was obtained from midwives, pediatricians and hospital medical records.

In all, 2398 women returned the inclusion questionnaire (for an estimated participation rate of 80%), and delivery information was available for 2353 (98%). This analysis excludes the stillbirths (n=28) and multiple pregnancies (n=24).

### **Dietary assessment**

The inclusion questionnaire included food frequency questions that inquired about the usual prevalence of consumption, before pregnancy, of 18 specific categories of food, originally selected because of their contribution to polychlorinated dibenzo-dioxins/furans (PCDD/PCDF) intake in the French population [17]. Seafood consumption was examined by 4

items about intake of salt-water fish (including salmon), mollusks, large crustaceans (for example, crabs) and small crustaceans (for example, shrimp). Women with data missing for any of these 4 items (n=23) were excluded. The 5 categories of frequency ranged from “never or less than once a month” to “every day” and were translated into 0.5, 3, 10, 20 and 30 meals of the specific food each month. Because of small cell sizes, the initial five categories of frequency for fish consumption were recoded as three, that is “never or less than once a month”, “1-4 a month” and “2 or more a week”. The total number of shellfish meals (that is, mollusks and crustaceans) was computed and then categorized as “once a month or less”, “2 to 4 times a month” and “2 times a week and more”.

### **Outcome assessment**

Birthweight (in g) and length of gestation (in weeks) were abstracted from hospital records. Preterm birth (PB) was defined as length of gestation < 37 weeks and low birthweight (LBW) as birthweight < 2500 g. Infants classified as small-for-gestational age (SGA) were defined by a birthweight lower than the 10th percentile of birthweight distribution for a given gestational age and sex, according to French reference curves [18].

### **Covariates and potential confounders**

Smoking habits at inclusion were used to define smoking status and level of consumption at the end of the first trimester. Maternal height and pre-pregnancy weight were used to compute maternal body mass index (BMI, kg/m<sup>2</sup>) before pregnancy. The list of covariates for the multivariate models included maternal age (<25, 25-29, 30-34, ≥35), marital status (single, couple), educational level (≤ baccalaureate examination, 2 years and 3 years or more of education after high school), primiparous (yes, no), maternal height (<160 cm, 160-<165, 165-<170, ≥170), maternal BMI (<18.5, 18.5-<25, 25-<30, ≥30), level of smoking at inclusion (non-smoker, <10 cigarettes per day, ≥10 per day), alcohol consumption (< or ≥ 1

drink per week), sex of the child and diabetes (prior to pregnancy or induced by gestation).

Length of gestation was also included for birthweight and LBW analyses.

### **Statistical analysis**

Statistical significance was assessed with the chi-square statistic and trend tests for all categorical variables and with analysis of variance for continuous variables. The relation between fish or shellfish consumption and birth outcomes was assessed with multiple linear regression for length of gestation or birthweight, and with multiple logistic regression for categorical variables (PB, LBW and SGA). Covariates for regression analyses included those mentioned above. For the LBW analysis, length of gestation was categorized as <35, 35-36, 37, 38, 39 and  $\geq 40$  weeks. Tests for trend in ORs for fish and shellfish intake were performed by including these 2 variables in multivariate models coded as 0, 1, 2 for the three levels of intake frequency. Statistical analyses were performed with SAS software version 9.1 (SAS Institute, Inc., Cary, North Carolina).

### **Results**

Mean maternal age at inclusion was 30.2 (standard deviation SD=4.1) years; 65% of the women had 2 years or more of education after high school and 46% were primiparous (table 1). Mean BMI was 22.2 kg/m<sup>2</sup> (SD=3.6): 11.8% of the women were overweight (between 25 and 30 kg/m<sup>2</sup>), and 4.1% were considered obese (30 kg/m<sup>2</sup> or more). Of the 11.3% (n=256) who reported smoking at inclusion, only 58 smoked 10 cigarettes/day or more. Mean birthweight was 3324 g (SD=484) for girls and 3448 (SD=498) for boys, and mean length of gestation was 39.4 weeks (SD=1.6). In our population sample, 4.2% of births were classified as PB, 3.1% as LBW and 5.3% as SGA. Risk of preterm birth was higher among primiparous women; it also increased when the mother had diabetes. The rates of LBW and SGA babies tended to be higher among primiparous women, and to increase with smoking. LBW risk increased among women drinking one drink or more per week during pregnancy. SGA risk

decreased with increasing maternal height or BMI and women who had not passed the baccalaureate examination had a higher risk of SGA babies than their better-educated peers. The total number of seafood meals per month averaged 7.6, including 4.6 meals of fish, and 3.0 of shellfish (table 2). About one quarter of the women (26.6%, n=606) reported eating fish at least twice a week. Most women reported eating shellfish (mollusks, large and small crustaceans) less than once a month (respectively 81%, 91% and 74%). Fish and shellfish intake were significantly correlated (correlation coefficient=0.25  $p<10^{-4}$ ). Individual factors associated with increased seafood consumption, such as increasing maternal age and educational level, were similar for fish and shellfish. Heavy smokers ate fish less frequently than the other subjects, but not less shellfish.

Table 3 reports the frequency of adverse pregnancy outcomes and the odds ratios (OR) and 95% confidence intervals (CI) for PB and LBW and SGA infants according to frequency of fish and shellfish intake, both when these were included separately (models 1 for fish and 2 for shellfish) or simultaneously (model 3) in regression models. The results for models 1 and 2 show non significant inverse associations between fish intake and risks of PB, LBW and SGA, between shellfish intake and PB risk, and a non significant positive association between shellfish intake and risk of LBW or SGA infants. After mutual adjustment for both categories of seafood intake (model 3), associations between fish and shellfish intake and risk of SGA infants were stronger and the positive association between risk of SGA babies and shellfish intake was significant ( $p=0.02$ ).

When we studied continuous outcome variables, there was a trend toward increasing length of gestation with increasing fish consumption, with a statistically significant increase ( $p=0.03$ ) of 0.02 week (SD=0.008) in the duration of gestation for each additional fish meal per month (table 4). No other association was observed between fish or shellfish consumption and either duration of gestation or birthweight.

## Discussion

We investigated the role of seafood intake during pregnancy and analyzed the influence of the two principal categories of seafood on pregnancy outcome. This study showed a significant increase in length of gestation with increasing fish intake and a significantly increased risk of SGA births with increasing shellfish intake. An analysis of subcategories of shellfish intake (i.e. mollusks, small and large crustaceans) showed that the latter association was mostly explained by intake of large crustaceans: the risk of SGA babies was twice as high among women who ate large crustaceans more than once a month ( $p=0.03$ ) compared to those eating this type of seafood once a month or less.

When we fit models with continuous outcome, we found no evidence of a relation between seafood intake and birthweight. Because it has been suggested that smoking might act as a modifying factor [7], we also stratified our analyses by smoking status, but this did not change our results.

The rates of adverse outcomes in our population (4.2% for PB, 3.1% for LBW and 5.3% for SGA infants) were relatively low compared with national data. In 2003, the national perinatal survey [19] estimated French rates of PB and LBW among singleton live births at 5.0% and 5.8%, respectively. The high rate of ascertainment of pregnancy outcomes (98%) and the good quality of medical data obtained lead us to consider that these rates are not underestimated in our study population and reflect regional specificity. SGA was defined according to standard national reference curves for birthweight, published in 1996. The SGA birth rate was lower than 10%, however, as it has been observed in other populations using recently the same reference curves [20]. Length of gestation was assessed according to information in the medical files, and all women began antenatal care during the first trimester. We thus assume that this information is accurate. Measuring pregnancy duration in days

instead of weeks would, however, have provided more sensitive and precise information about the increase observed.

Most determinants of birthweight and gestational length were taken into account, except weight gain during pregnancy. This variable was measured in a subgroup of our sample and did not appear to add information in the models. Our population had a particularly high educational level and a particularly low smoking rate but major known risk factors significantly affected gestational age, birthweight and other outcomes.

Our conclusions can only be suggestive, however, because of some limitations in dietary assessment and lack of biomarkers. Because we had no detailed information about different types of fish consumed (including oily vs. white fish), we could not estimate either FA or contaminant intake. Food frequency was assessed by a single questionnaire, administered during the first trimester and asking about habitual fish intake just before pregnancy. We therefore could not take into account possible changes during pregnancy. However, a recent study conducted among Danish women [4] showed similar decreases in duration of gestation among women never consuming fish compared to those consuming fish at least once a week, when fish intake was assessed either during the first or the second trimester of pregnancy. Seafood consumption was high in our population, especially shellfish, compared to national data, with mean intake estimated at about 20.4 g/day of fish and 19.7 g/day of shellfish. A national diet survey conducted in 1998-1999 estimated intake for these foods among women at 28 g/day for fish and 4 g/day for shellfish [21], that is, of the same order of magnitude for fish, but much lower for shellfish than in our population, due to regional characteristics.

## **Comparison with other studies**

### Length of gestation

Our results are concordant with several observational studies and clinical trials that show positive associations between prolonged length of gestation (or decreased risk of preterm

birth) and fish intake levels [3, 4], n-3 fatty acid concentration in cord serum phospholipids or maternal erythrocytes as biomarkers of marine n-3 FA intake [13, 22], or fish oil supplementation [5, 6]. In our study, the association between gestational length and fish intake corresponded to a mean decrease of 0.52 day (95%CI : 0.05 to 0.99) among woman eating less than one fish meal per month when compared to those eating fish 4 times a month, and 1.03 day (95%CI : 0.10 to 1.97) when compared to women eating fish 2 times per week. These estimates are small compared to recent results published by Olsen and colleagues [4]. In this latter study, mean gestation length was 3.91 day (95%CI : 2.24-5.58) shorter among women never consuming fish compared to those consuming fish at least once a week, as assessed during the first trimester of pregnancy. This difference may be partly explained by the inclusion of women eating fish less than once a month in our non consumer category.

#### Birthweight, Small for Gestational Age:

Studies suggesting that fish intake has a positive effect on birthweight or fetal growth include one clinical trial [5] and observational studies of fish intake, either alone [3, 7, 8] or including shellfish consumption [9]. This positive relation exists even when no association is observed with length of gestation [7-9]. In contrast, one clinical trial [6] and two cohort studies [10, 11] reported finding no relation between fish or fish oil intake and SGA or birthweight. A recent study [12] showed a negative relation between n-3 polyunsaturated FA intake and fetal growth, but it did not present risk estimates according to different categories of seafood. An inverse association between eicosapentaenoic acid (EPA) cord serum concentration and birthweight adjusted for gestational age was also evidenced among Faroese women [13] but shellfish intake was not investigated in this study.

In our data, the trend we saw in the crude analyses between increasing fish intake and both decreased risk of LBW ( $p=0.008$ ) and SGA ( $p=0.04$ ) was considerably attenuated when we

adjusted for confounders, particularly length of gestation for LBW and tobacco consumption for both outcomes.

When we looked at total seafood consumption, we found no association with risk of SGA births; the ORs for the intermediate and highest categories of total seafood intake were respectively 0.97 (0.54-1.76) and 1.02 (0.65-1.58),  $p=0.9$ , compared with the lowest category. The trend towards a positive association between risk of SGA birth and fish intake may then have been balanced by the negative trend for shellfish intake. This justifies separate analyses and mutual adjustment for these two categories of seafood.

Our observations are consistent with the hypothesis of that n-3 FA (higher in fish than shellfish) may have a positive impact that would be counterbalanced in part by the deleterious impact of some contaminants such as metals and organochlorines (often high in shellfish due to their filter feeding characteristics). French national data about fish contents in n-3 PUFA, and concentration in trace elements and pollutants were published in 2006 by the French Agency of Food Safety [23]. Based on these data, we selected the 5 types of fish and the 3 types of large crustaceans the most frequently consumed among women of childbearing age (18-44 years) in Lorient (south Brittany) to compare mean lipid compositions and mean contaminations by pollutants of these two categories of seafood (table 5). These results show that if mean levels of n-3 PUFA in fishes (including cod, salmon, saithe or coalfish, hake and whiting) were quite similar to what was found in large crustaceans (including crab, spider crab and lobster), large crustaceans contained more EPA but less DHA than fishes. Concentrations of most seafood pollutants were higher in large crustaceans than in fish : almost 3 times higher for lead, 10 times for arsenic, PCDD/ PCDF or PCBs “dioxin like” and other PCBs, and more than 100 times for cadmium.

## **Conclusions**

In a population with low background rates of adverse pregnancy outcomes and high seafood consumption, we observed that different categories of seafood are differently associated with birth outcomes. Our findings confirm that increased fish consumption is associated with increased length of gestation and suggest that high shellfish intake is associated with an increased risk of SGA births. Further investigation should elucidate the respective effects of the different categories of seafood based upon measurements of toxics and beneficial nutrients. Levels of contaminants in some categories of seafood (especially shellfish) should be monitored because heavy consumers may be at particular risk.

## **Competing interest**

The authors declare that they have no competing interests.

## **Authors' contributions**

LG was involved in statistical analysis, interpretation of the results, and drafted the manuscript. CM assisted in the planning of the study, data collection, data management and analysis. FR was the paediatrician coordinator and was involved in study planning and medical data collection. RG was in charge of data quality control, data coding and collection of medical data. SC conceived and designed the study, supervised the overall project and was involved in the interpretation of the results and revision of the paper. All authors read and approved the final manuscript.

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**Table 1 Description of study population and variations of adverse pregnancy outcome rates**

	Overall (N=2278)		PB n=94 (4.2%)		LBW n=71 (3.1%)		SGA n=120 (5.3%)	
	N	(%)	%	P	%	p	%	P
<b>Maternal age</b>								
<25	214	9.4	6.5	0.3	3.7	0.6	5.6	0.9
25-29	945	41.5	3.8		2.9		5.0	
30-34	808	35.5	4.0		3.6		5.2	
≥35	310	13.6	3.9		2.3		6.2	
<b>Marital = single</b>	50	2.1	4.1	1.0	4.0	0.7	10.0	0.1
<b>Education level = Less than baccalaureate</b>	376	16.6	4.9	0.8	4.3	0.6	7.5	0.2
<b>Primiparous</b>	1045	46.0	5.2	0.02	4.2	0.004	7.4	<10 <sup>-4</sup>
<b>Maternal height (cm)</b>								
<160	421	18.5	5.5	0.3	4.5	0.3	9.3	0.0003
160 - <165	793	35.0	4.1		3.2		4.9	
165 - <170	617	27.2	4.3		2.4		4.7	
≥170	437	19.3	3.0		2.8		3.0	
<b>Pre-pregnancy BMI (kg/m<sup>2</sup>)</b>								
<18.5	180	7.9	5.6	0.3	3.3	0.8	3.9	0.04
18.5- <25	1725	76.2	3.7		3.3		6.0	
25- <30	267	11.8	5.7		2.3		1.9	
≥30	93	4.1	5.4		2.2		5.4	
<b>Nb of cig/day smoked at inclusion</b>								
0	2022	88.8	4.3	0.7	2.9	0.006	4.9	0.02
<10	198	8.7	3.1		3.0		7.6	
≥10	58	2.5	3.5		10.3		12.1	

<b>Alcohol drinking = 1 drink per week and more</b>	39	1.7	7.7	0.3	10.3	0.009	10.3	0.2
<b>Diabetes</b>	78	3.4	10.3	0.006	3.9	0.7	6.4	0.6

p: degree of significance; PB: premature births; LBW: low birthweight; SGA: small-for-gestational age; BMI : Body Mass Index

**Table 2 Frequency of seafood consumption according to category**

<b>Frequency of consumption n (%)</b>	<b>Fish</b>	<b>Mollusks</b>	<b>Large crustaceans</b>	<b>Small crustaceans</b>
Never or less than once a month	406 (17.8)	1846 (81.0)	2068 (90.8)	1683 (73.9)
1 to 4 a month	1266 (55.6)	415 (18.2)	203 (8.9)	572 (25.1)
2 or 3 times a week	555 (24.4)	17 (0.8)	7 (0.3)	21 (0.9)
4 to 6 times a week	49 (2.1)	0	0	1 (0.05)
Every day	2 (0.1)	0	0	1 (0.05)
Mean number of meals a month (sd)	4.6 (4.1)	1.0 (1.2)	0.8 (0.9)	1.2 (1.6)

**Table 3 Odds ratios of preterm birth, low birthweight, and small for gestational age birth, according to frequency of seafood (fish and shellfish) intake**

	Frequency of adverse outcomes n(%)			Models 1 and 2 <sup>a,c</sup> OR (95% CI)			Model 3 <sup>b,c</sup> OR (95% CI)		
	PB	LBW	SGA	PB	LBW <sup>d</sup>	SGA	PB	LBW <sup>d</sup>	SGA
<b>Frequency of fish intake</b>				<i>Model 1</i>					
<1 time a month <i>n=406</i>	18 (4.5)	18 (4.4)	29 (7.1)	1	1	1	1	1	1
1-4 times a month <i>n=1266</i>	58 (4.6)	42 (3.3)	64 (5.1)	1.01 (0.58-1.78)	0.62 (0.24-1.61)	0.79 (0.48-1.29)	1.06 (0.60-1.87)	0.59 (0.23-1.55)	0.72 (0.44-1.19)
≥2 times a week <i>n=606</i>	18 (3.0)	11 (1.8)	27 (4.5)	0.65 (0.32-1.32)	0.65 (0.21-2.09)	0.68 (0.37-1.22)	0.71 (0.35-1.46)	0.59 (0.18-1.91)	0.57 (0.31-1.05)
p (linear trend)	0.1	0.008	0.04	0.2	0.5	0.2	0.3	0.4	0.07
<b>Frequency of shellfish intake</b>				<i>Model 2</i>					
≤1 time a month <i>n=1548</i>	71 (4.6)	52 (3.4)	75 (4.8)	1	1	1	1	1	1
2-4 times a month <i>n=548</i>	18 (3.3)	13 (2.4)	31 (5.7)	0.77 (0.45-1.32)	1.06 (0.44-2.52)	1.21 (0.77-1.91)	0.81 (0.47-1.39)	1.09 (0.45-2.62)	1.33 (0.83-2.11)
≥2 times a week <i>n=182</i>	5 (2.8)	6 (3.3)	14 (7.7)	0.62 (0.24-1.57)	2.10 (0.67-6.59)	1.89 (1.01-3.52)	0.66 (0.26-1.70)	2.24 (0.70-7.15)	2.14 (1.13-4.07)
P (linear trend)	0.06	0.3	0.05	0.2	0.3	0.05	0.3	0.2	0.02

PB: Preterm Birth; LBW: Low Birthweight; SGA: Small for Gestational Age; BMI: Body Mass Index; p: degree of significance

<sup>a</sup> adjusted models including either fish (model 1) OR shellfish (model 2) consumption

<sup>b</sup> adjusted model including both fish AND shellfish consumption

<sup>c</sup> adjusted for maternal age, marital status, education level, parity, bmi, height, smoking status, alcohol consumption, diabetes and sex of the child.

<sup>d</sup> adjusted for duration of gestation

**Table 4 Results of multiple linear regression for length of gestation and birthweight according to seafood (fish and shellfish) intake**

	Length of gestation (weeks)				Birthweight (grams)			
	Simple linear regression		Multiple linear regression <sup>b</sup>		Simple linear regression <sup>c</sup>		Multiple linear regression <sup>b,c</sup>	
	Coefficient (SD)	P	Coefficient (SD)	p	Coefficient (SD)	p	Coefficient (st.dev)	p
<b>Frequency of fish intake<sup>a</sup></b>	0.02 (0.008)	0.01	0.02 (0.008)	0.03	0.78 (2.2)	0.7	-0.48 (2.2)	0.8
<b>Frequency of shellfish intake<sup>a</sup></b>	-0.01 (0.01)	0.2	-0.02 (0.01)	0.1	1.00 (3.0)	0.7	0.08 (2.9)	1.0

<sup>a</sup> models included both fish and shellfish for mutual adjustment

<sup>b</sup> adjusted for maternal age, marital status, education level, parity, bmi, height, smoking status, alcohol consumption, diabetes and sex of the child.

<sup>c</sup> adjusted for duration of gestation

**Table 5 Mean lipid composition and mean contamination by trace elements or persistent organic pollutants of fish and large crustaceans\***

	Lipids				Trace elements (µg/g FW)				Persistent organic pollutants	
	Total lipids (g/100g)	LC-PUFA n-3 (mg/100g)	EPA (mg/100g)	DHA (mg/100g)	Total arsenic	Total mercury	Cadmium	Lead	Total PCDD/F & PCB-DL (pg TEQ <sub>OMS</sub> /g FW)	PCBi (ng/g FW)
<b>FISH<sup>a</sup></b>	3.13	1023.80	250.80	520.80	3.29	0.11	0.01	0.01	0.53	4.88
<b>LARGE CRUSTACEANS<sup>b</sup></b>	4.19	1186.33	574.67	395.33	20.36	0.09	1.66	0.03	4.54	27.33

\*Source AFSSA : CALIPSO. Fish and seafood consumption study and biomarker of exposure to trace elements, pollutants and omega 3. Women of childbearing age (18-44y), Lorient, France, 2006.

LC-PUFA n-3 : Long-chain polyunsaturated fatty acids of n-3 series, EPA : Eicosapentaenoic acid, DHA : Docosahexaenoic acid, PCDD/Fs : polychlorinated dibenzo-dioxins/furans, PCB-DL dioxin like polychlorobiphenyls, PCBi : Indicator polychlorobiphenyls (28, 52, 101, 118, 138, 153 and 180 congeners), FW : fresh weight

<sup>a</sup> cod, salmon, saithe/coalfish, hake and whiting

<sup>b</sup> crab, spider crab and lobster