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Dietary contaminants and oxidative stress in Inuit of Nunavik

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Abstract

The aim of the present study was to investigate the potential deleterious effects of dietary contaminants such as polychlorinated biphenyls (PCBs) and methylmercury (MeHg) on different molecules sensitive to oxidative stress, namely, plasma oxidized low-density lipoproteins (OxLDLs), plasma homocysteine (Hcy), blood glutathione peroxidase (GPx), glutathione reductase (GR), and glutathione (GSH). We also planned to assess the potential beneficial effects of long-chain ω-3 polyunsaturated fatty acids (n-3 PUFAs) and selenium (Se) that are also present in the traditional Inuit diet. A total of 99 participants were studied. Plasma levels of PCBs, blood levels of Se and MeHg, plasma lipids (triacylglycerols, total, LDL-, and high-density lipoprotein cholesterol [LDL-C and HDL-C, respectively], apolipoprotein B–LDL), erythrocyte n-3 PUFAs, OxLDL, Hcy, blood GPx, GSH, and GR have been determined. Mean concentrations of MeHg, Se, and PCBs were respectively 10- to 14-fold, 8- to 15-fold, and 16- to 18-fold higher than reported in white population consuming little or no fish. Multivariate analyses show that variance in plasma OxLDL concentrations was predicted by LDL-C (P = .007), HDL-C (P = .005), and PCBs (P = .006). The level of LDL oxidation, represented as the ratio OxLDL/apolipoprotein B–LDL, was predicted by LDL-C (P = .0002), HDL-C (P = .002), and GSH (P = .005). Concentration of plasma Hcy was positively predicted by age (P = .02) but negatively by body mass index (P = .04) and Se (P = .005). Glutathione was predicted by the smoking status (P = .004) and the level of LDL oxidation (P = .005), whereas GR was only predicted by the smoking status (P = .0009). The variance of GPx was not predicted by any contaminant or other physiological parameter. Dietary MeHg showed no association with the examined oxidative biomarkers, whereas PCB level was a predictor of the plasma concentration of OxLDL, although this concentration remained very low. The level of GPx activity in Inuit was higher than levels previously reported to be protective in whites. Homocysteine was negatively predicted by Se, suggesting a possible beneficial effect of Se. Moreover, n-3 PUFAs were highly correlated with dietary contaminants, but had no relationships with oxidative biomarkers. This study suggests that, in adult Inuit, contaminated traditional diet seems to have no direct oxidative effects on molecules involved in oxidative stress.

1. Introduction

After recent reports showing that methylmercury (MeHg) could be associated with increased risk of cardiovascular disease and acute myocardial infarction in the European populations, potential deleterious effects of mercury (Hg) on cardiovascular health have been the focus of vigorous debates [1-4]. Production of reactive oxygen species, peroxidized lipids, and oxidized low-density lipoproteins (OxLDLs) has been proposed as major mechanisms involved in the induction of atherosclerosis by Hg [5-8]. Finnish studies have reported an increased risk of cardiovascular diseases associated with exposure to Hg after consumption of contaminated fishes, probably due to the induction of lipid peroxidation by Hg [3,4] and to interference with mitochondrial electron transport chain, resulting into the oxidation of sulfhydryl groups of many proteins and the depletion of cellular glutathione (GSH) [9]. Recently, it has been demonstrated that plasma homocysteine (Hcy) could activate pathogenic mechanisms leading to oxidative stress [10]. Indeed, hyperhomocysteinemia has been shown to decrease vascular reactivity and was associated with cardiovascular morbidity and mortality [11].

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Table 1
General characteristics of study participants

Characteristics	
n (F/M)	71/28
Age (y)	43 ± 1
BMI (kg/m^2)	29.1 ± 0.7*
Type 2 diabetes (% of subjects)	5.0
Hypertension (% of subjects)	19.1
Smokers (% of subjects)	72.3
Lipids	
Plasma triacylglycerols (mmol/L)	1.23 ± 0.06
Plasma cholesterol (mmol/L)	
Total	5.52 ± 0.11
LDL	3.16 ± 0.10
HDL	1.42 ± 0.04
Total/HDL	4.09 ± 0.13
Plasma LDL apoB (g/L)	0.79 ± 0.03
Erythrocyte n-3 PUFAs (%)	11.2 ± 0.3
Molecules involved in oxidative stress	
OxLDL (U/L)	44.4 ± 1.7
OxLDL/apoB-LDL	57.9 ± 2.7
Homocysteine (μmol/L)	7.4 ± 0.3
GPx (U/g Hb)	77.5 ± 1.2
GSH (μmol/g Hb)	4.1 ± 0.2
GR (U/g Hb)	12.7 ± 0.3

Values are shown as mean ± SEM. F indicates female; M, male.
* n = 91 (66 F/25 M)

The traditional Inuit diet consists primarily of marine mammals, white whales and seals, and fishes reported to be highly contaminated by MeHg [12] and other potentially pro-oxidant contaminants such as polychlorinated biphenyls (PCBs) [13,14]. It has been also demonstrated that this traditional diet was an important source of nutrients, including selenium (Se) [15]. Polychlorinated biphenyls constitute a family of 209 possible congeners that were extensively used in industrial and commercial products [16]. Polychlorinated biphenyls have been dispersed widely in the environment and they resist to degradation. Because of their lipophilicity, PCBs accumulate in fatty tissues and are biomagnified through the food chain, producing relatively high concentrations in fat of predator species [17]. Because fish and marine mammals represent an important part of Inuit diet, exposure to PCBs is of particular interest for public health authorities. The most prevalent PCB congeners found in human in Northern Quebec were IUPAC 28, 52, 99, 101, 105, 118, 128, 138, 153, 156, 170, 180, 183, and 187 [14,18].

Selenium, a nutrient found in high amount in traditional Inuit diet, is a component of glutathione peroxidases (GPxs) which are a family of enzymes that contain a selenocystein at the active site, which is successively oxidized and then reduced during catalytic cycles with the help of glutathione reductase (GR). Glutathione peroxidase uses GSH to reduce hydrogen peroxide to water and lipid peroxides to their respective alcohol [19].

Recently, a study in Inuit of Nunavik showed that consumption of marine products, the main source of eicosapentaenoic and docosahexaenoic acids, appeared to beneficially affect some cardiovascular risk factors. The authors concluded that the traditional Inuit diet was probably responsible for the low mortality rate from ischemic heart disease in this population [20]. The relative contributions of deleterious conditions, such as obesity and smoking, toxic contaminants, such as Hg and PCBs, and potentially protective effects of dietary ω-3 polyunsaturated fatty acids (n-3 PUFAs) and Se on cardiovascular disease risk factors and oxidative stress are currently unclear [2,4,12,20,21]. The aim of the present study was to investigate the potential deleterious effects of dietary contaminants PCBs and MeHg on different molecules sensitive to oxidative stress (OxLDL, Hcy, GPx, GR, and GSH). On the other hand, we also aimed at assessing the potential protective effects of selenium and n-3 PUFAs that are also elevated in the traditional Inuit diet.

2. Methods

2.1. Subjects

This study was carried out in the Canadian Northern Inuit village of Salluit (Nunavik, Northern Quebec). Inuit adult participants (n = 99) were randomly selected from the municipal list. They signed an informed consent approved by the Université du Québec à Montréal Ethic Committee, the Nunavik Nutrition and Health Committee, and the Medical Board of the Povungnituk Hospital. Data related to participant health status, current health problems, and use of medication were obtained. Blood samples were collected after an overnight fast. Subjects taking medication affecting lipid metabolism and/or oxidative stress markers, such as female hormones, statins, fibrates, angiotensin-converting enzyme inhibitors, anti-inflammatory drugs, and antioxidants, were excluded from the study.

Table 2
Levels of contaminants in study participants

	Number of individuals	Measures above detection limit	Average concentrations (mean ± SEM)
Se (μg/L blood)	98	98	635.5 ± 38.7
MeHg (nmol/L blood)	98	98	106.2 ± 9.8
PCBs (μg/L plasma)			
28	97	10	0.05 ± 0.002
52	97	82	0.11 ± 0.013
99	97	97	0.54 ± 0.04
101	97	87	0.13 ± 0.01
105	97	77	0.16 ± 0.02
118	97	97	0.57 ± 0.06
128	97	50	0.04 ± 0.002
138	97	97	1.97 ± 0.17
153	97	97	3.17 ± 0.28
156	97	97	0.21 ± 0.02
170	97	97	0.50 ± 0.05
180	97	97	1.49 ± 0.15
183	97	96	0.19 ± 0.02
187	97	97	0.75 ± 0.07
Total PCBs	97	97	8.78 ± 0.79

2.2. Laboratory analyses

Analyses of contaminants (Hg, Se, PCBs) were performed at the Quebec Toxicology Laboratory using previously described methods. Blood Hg was analyzed by cold vapor atomic absorption technique [22]. Blood Se was analyzed by inductively coupled plasma–mass spectrometry after nitric acid digestion [23]. Polychlorinated biphenyls were quantified in plasma samples by high-resolution gas chromatography with electron-capture detection [24].

Lipoproteins were separated by sequential ultracentrifugation [25]. Cholesterol and triacylglycerol concentrations were measured enzymatically using an RA-500 analyzer (Technicon, Tarry Town, NY). Lipids from erythrocyte membranes were extracted with chloroform/methanol (2:1 by volume), and fatty acids were methylated using acetyl chloride as previously published [26,27]. Fatty acid profiles were obtained by gas chromatography (HP 5890, Hewlett Packard, Toronto, Canada) using an Innowax capillary column (30 m × 0.25 mm × 0.25 μm, Agilent Technologies, Mississauga, Canada) and were expressed as percent of total fatty acids. Plasma OxLDL was measured by enzyme-linked immunosorbent assay using the monoclonal antibody mAb-4E6 (Mercodia, Uppsala, Sweden) (intravariability <7.3% and intervariability <6.2%). Glutathione peroxidase and GR activities were determined in whole blood using commercial enzymatic assays (Randox Laboratories, Mississauga, Canada) (intra- and intervariability <5%). Glutathione was enzymatically measured in total blood according to the GSH cyclic reductase assay (intra- and interassay variability <5%) [16]. Total plasma Hcy was quantitatively measured by fluorescence polarization immunoassay with reagents provided by the manufacturer and using the AxSym system (Abbott Laboratories; intra-assay variability <5%) [28].

2.3. Statistical analyses

Statistical analyses were carried out using JMP 4.0 software (SAS Institute, Cary, NC). Statistical tests were performed with log transformed data when variables were not normally distributed as testing using the Shapiro-Wilk *W* test. Pairwise correlations were performed between molecules susceptible to undergo oxidation, namely, OxLDL, OxLDL/apolipoprotein B (apoB)–LDL, Hcy, GPx, GR, biological factors such as age, body mass index (BMI), erythrocyte n-3 PUFAs, LDL-C, apoB-LDL, and high-density lipoprotein cholesterol (HDL-C), and dietary contaminants PCBs and MeHg and nutrient Se. Student *t* tests were performed to compare data between smokers and nonsmokers and to compare individuals having low and high OxLDL levels. Multivariate analyses using stepwise models for each dependent variables, namely, OxLDL, OxLDL/apoB-LDL ratio, Hcy, GPx, GR, and GSH, were built using variables that already correlated with the dependent variables. Because of the nature of the dependent variables and their possible physiological interactions, dependent variables could be used as another independent model. For the OxLDL stepwise model, OxLDL was correlated with plasma cholesterol and triglycerides and with LDL-C. To avoid colinearity effects, we chose to include LDL-C into the model because it was the strongest correlate of OxLDL.

3. Results

Participants taking lipid-lowering drugs, hypotensive, anti-inflammatory, or other drugs that could have an impact

Table 3
Pearson correlations (*r* values) between variables influencing oxidative/antioxidant status

	LDL-C	OxLDL	ApoB-LDL	OxLDL/apoB-LDL	HDL-C	n-3 PUFAs	MeHg	PCBs	Se	Hcy	GPx	GSH	GR	BMI
LDL-C	1													
OxLDL	0.23*	1												
ApoB-LDL	0.89§	0.30**	1											
OxLDL/apoB-LDL	−0.38§	0.77§	−0.38§	1										
HDL-C	0.20*	−0.26**	−0.01	−0.19*	1									
n-3 PUFAs	0.09	0.19	0.15	0.06	0.16	1								
MeHg	−0.01	0.07	0.12	0.01	0.13	0.76§	1							
PCBs	0.06	0.24**	0.17	0.12	0.21*	0.79§	0.70§	1						
Se	−0.11	0.20*	−0.16	0.11	−0.16	0.59§	0.76§	0.58§	1					
Hcy	−0.08	−0.13	−0.13	−0.04	0.07	−0.11	−0.16	0.03	−0.28**	1				
GPx	0.02	0.03	−0.07	0.09	0.05	0.19	0.11	0.12	0.08	−0.18	1			
GSH	0.04	0.17	−0.15	0.29**	0.11	0.07	−0.02	0.02	−0.05	0.06	0.06	1		
GR	0.01	−0.13	0.01	−0.07	−0.13	−0.08	−0.02	0.01	0.02	0.12	−0.01	−0.13	1	
BMI	0.04	0.09	0.24*	−0.09	−0.35§	0.23*	0.27**	0.10	0.39§	−0.27**	−0.08	−0.16	0.16	1
Age	0.01	0.08	0.08	0.02	0.29**	0.73§	0.59§	0.78§	0.40§	0.24*	0.07	0.01	0.07	0.25*

Correlations were made on log-transformed variables.

* $P < .05$.

** $P < .01$.

§ $P < .0005$.

Table 4
Comparisons of environmental contaminants, oxidative stress, and antioxidant markers between subjects with low and high plasma OxLDL concentrations

	Low OxLDL* (≤43.5 U/L)	High OxLDL* (>43.5 U/L)	*P*
n	49	50	
Age (y)	40.8 ± 1.8	45.6 ± 1.9	NS
BMI (kg/m^2)	28.5 ± 0.9	29.5 ± 1.0	NS
Plasma cholesterol (mmol/L)	5.35 ± 0.16	5.69 ± 0.16	NS
Plasma triacylglycerols (mmol/L)	1.14 ± 0.07	1.33 ± 0.10	NS
ApoB-LDL (g/L plasma)	0.74 ± 0.04	0.85 ± 0.03	.02
n-3 PUFAs (%)	10.5 ± 0.3	11.9 ± 0.44	.02
Environmental contaminants			
MeHg (nmol/L blood)	88.1 ± 11.4	123.1 ± 15.9	NS
Se (μg/L blood)	547.6 ± 46.0	718.2 ± 60.1	.015
PCBs (μg/L plasma)	6.48 ± 0.89	11.1 ± 1.2	.01
Molecules involved in oxidative stress			
OxLDL (U/L)	31.5 ± 1.1	56.8 ± 2.1	–
Hcy (μmol/L)	7.4 ± 0.5	7.3 ± 0.4	NS
GPx (U/g Hb)	76.7 ± 1.7	77.8 ± 1.8	NS
GR (U/g Hb)	12.8 ± 0.4	12.7 ± 0.4	NS
GSH (μmol/g Hb)	3.8 ± 0.2	4.5 ± 0.2	.01

Values are shown as mean ± SEM. NS indicates not significant.
* Subjects were subgrouped into low and high levels of OxLDL, based on the OxLDL median value of 43.5 U/L. *t* Tests were made on log-transformed variables.

on the oxidative status were excluded. Table 1 shows the general characteristics of study participants (n = 99). Five percent of these participants had untreated type 2 diabetes mellitus, 19% had untreated hypertension, whereas the majority of them (72.3%) were smokers. Table 1 also indicates the plasma level of OxLDL, an LDL molecule susceptible to undergo oxidative stress, the level of oxidation per LDL particle, represented by the OxLDL/apoB-LDL ratio, the level of plasma Hcy, and elements of the GSH redox cycle, namely, GPx, GR, and GSH. Table 2 shows blood levels of MeHg and Se and plasma levels of the 14 most prevalent PCB congeners found in Inuit participants of Northern Quebec. Polychlorinated biphenyls were determined in 97 of the 99 subjects.

Table 3 shows that OxLDL levels correlated with PCBs ($P < .01$), Se ($P < .05$), LDL-C ($P < .05$), and apoB-LDL ($P < .005$), and negatively with HDL-C ($P < .005$). The level of LDL oxidation, represented by the OxLDL/apoB-LDL ratio, correlated positively with GSH ($P < .01$) and negatively with LDL-C ($P < .005$), HDL-C ($P < .01$), and apoB-LDL ($P < .005$). Plasma Hcy correlated negatively with Se ($P < .01$) and BMI ($P < .01$) but positively with age ($P < .05$). n-3 PUFAs correlated with MeHg ($P < .005$), PCBs ($P < .05$), Se ($P < .005$), BMI ($P < .05$), and age ($P < .005$). Body mass index correlated negatively with HDL-C ($P < .0005$) but positively with MeHg ($P < .01$). Methylmercury, PCBs, and Se were highly correlated between themselves ($P < .005$) and also with n-3 PUFAs ($P < .005$). Age correlated with BMI ($P < .05$), HDL-C ($P < .05$), and the levels of Se, MeHg, PCBs, and n-3 PUFAs ($P < .005$). In addition, comparisons between smokers and nonsmokers, using Student *t* tests, revealed that there was no significant difference in the levels of cholesterol, triglyceride, LDL-C, apoB-LDL, HDL-C, OxLDL, Hcy, GPx, GR, and GSH between these 2 subgroups. However, BMI was significantly higher in the nonsmoker group (31.8 ± 1.3 vs 28.0 ± 0.8 kg/m^2 in nonsmokers).

Participants were then subgrouped into low or high levels of plasma OxLDL, using the median value of the overall group, OxLDL 43.5 U/L (Table 4). Although both groups had similar age and BMI, Se and PCBs were significantly higher in subjects with high OxLDL. However, differences between blood MeHg concentrations in the low and high OxLDL subgroups did not reach statistical significance.

Multivariate analyses presented in Table 5 show that variance in plasma OxLDL concentrations was significantly predicted by LDL-C ($P = .007$), HDL-C ($P = .005$), and PCBs ($P = .006$). The level of LDL oxidation, represented by the ratio of OxLDL/apoB-LDL, was predicted by LDL-C ($P = .0002$), HDL-C ($P = .002$), and GSH ($P = .005$). Concentration of plasma Hcy was predicted by age ($P = .02$), BMI ($P = .04$), and Se ($P = .005$). Glutathione was predicted by the smoking status ($P = .04$) and the oxidation level of the LDL particle, the OxLDL/apoB-LDL ratio

Table 5
Regression coefficients (β) from multiple linear regression analyses preceded by stepwise analyses using OxLDL, OxLDL/apoB-LDL, Hcy, GSH, GPX, and GR as dependent variables and various biological parameters as predictor variables

	OxLDL	OxLDL/apoB-LDL	Hcy	GSH	GPx	GR
Age	–*	–	0.22 (.02)**	–	–	–
BMI	–	–	−0.23 (.04)	–	–	–
Smoking status	–	–	–	0.10 (.04)	–	−0.07 (.0009)
n-3 PUFAs	–	–	–	–	–	–
LDL-C	0.42 (.007)	−0.72 (.0002)	–	–	–	–
OxLDL	–	–	–	–	–	–
OxLDL/apoB-LDL	–	–	–	0.21 (.005)	–	–
HDL-C	−0.32 (.005)	−0.21 (.002)	–	–	–	–
PCBs	0.11 (.006)	–	–	–	–	–
MeHg	–	–	–	–	–	–
Se	–	–	−0.19 (.005)	–	–	–

* Values not statistically significant are not included.
** P values within parentheses.

(P = .005), whereas GPx was not predicted by any of the contaminants nor other physiological parameters, and GR was only predicted by the smoking status (P = .0009).

4. Discussion

We had the unique opportunity to investigate the effects of potential pro-oxidant dietary contaminants found in the traditional Inuit diet, namely, MeHg and PCBs, on different molecules sensitive to oxidative stress (OxLDL, Hcy, GPx, GR, and GSH). Furthermore, we investigated the potential beneficial effects of n-3 PUFAs and Se, also present in the traditional Inuit diet. Table 1 shows that this population had concentrations of erythrocyte n-3 PUFAs more than 3-fold higher than previously reported in white subjects [29]. Lipid values were comparable to those previously found in Inuit [20]. Table 2 confirms that Inuit participants were more exposed to MeHg and PCBs (8- to 18-fold) than the general white population [30,31]. Despite these high levels of contaminants, OxLDL concentrations were comparable to, and sometimes lower than, those reported in healthy whites [32-36]. Erythrocyte GPx and GR activities were elevated compared to a healthy Canadian population [37], whereas plasma levels of Hcy were similar to those observed in the general white population [38]. In multivariate analyses (Table 5), only the levels of PCBs were found to be associated to OxLDL; these results are in contrast with the expected deleterious effects of dietary contaminants. It is of interest to note that n-3 PUFAs were not related to any of the dependent variables.

Blood Se was 2-fold higher than reported in the Southern Québec population (Eric Dewailly, personal communication). Selenium negatively covariates with Hcy, suggesting that Se could have potential beneficial effect on the Hcy status.

Oxidized low-density lipoprotein has been shown to play an important role in the pathogenesis of atherosclerosis [8]. Indeed, it has been shown that LDL particles can undergo oxidative modifications through disturbances of their redox status via several mechanisms, including the production of reactive oxygen species by contaminants, such as MeHg [3,4]. However, to date, there is no study on the potential interactions between PCBs and OxLDL. Although plasma concentrations of OxLDL were lower than accounted for in healthy white populations (Table 1) [32-36], we now report concentrations of OxLDL significantly correlating with PCBs (Table 3). Furthermore, Table 4 reveals higher PCB levels in the high-OxLDL group, and multivariate modeling (Table 5) suggests that PCBs were positive predictors of plasma OxLDL concentrations. These results thus suggest that PCBs participate to LDL oxidation by yet unknown mechanisms. This interpretation is supported by several reports indicating that PCBs can promote oxidative stress, as reviewed by Slim et al [39].

The plasma concentration of OxLDL and the level of LDL oxidation, as represented by the ratio of OxLDL/apoB-LDL, were negatively correlated with concentrations of HDL-C. Multivariate analyses (Table 5) also reported that HDL-C was a negative predictor of OxLDL concentration and oxidation. It is plausible that elevated paraoxonase activity, an antioxidant enzymatic activity associated with HDL-C particles [40], could favor lower levels of OxLDL. However, this hypothesis remains to be further investigated. It is of interest to note that higher GSH in the high OxLDL subgroup was unrelated to GPx or GR activities nor to n-3 PUFAs. The level of LDL oxidation correlated with GSH level and, in the multivariate model, was also predicted by GSH (Table 5). These findings, as well as the higher levels of GSH in the high-OxLDL subgroup (Table 4), suggest that the presence of OxLDL particles could trigger the synthesis of GSH. Recent literature also indicates that OxLDL particles are able to induce a coordinated upregulation of GSH in macrophages [41]. Such increase in macrophage production of GSH could partly explain the present higher concentrations of GSH found in Inuit blood.

Recently, it has been reported that the risk of cardiovascular events was inversely associated with the activity of blood GPx when this activity was higher than 56.3 U/g Hb [42]. We report, in Inuit, a mean GPx activity of 77.5 ± 1.2 U/g Hb (Table 1), ranging from 53.4 to 111.4 U/g Hb. Although it has been reported that GPx synthesis and activity depend on dietary Se intake [43], GPx and Se did not correlate (Table 3) and Se was not a predictor for GPx levels as shown in Table 5. This suggests that GPx activity in Inuit could have reached a maximal enzymatic activity. This finding is concordant with report indicating that, at low Se intake, Se level is well correlated with GPx activity, whereas at high intake, GPx activity effectively reached a plateau [44]. The American Recommended Dietary Allowance prescribed Se intake of 55 μg/d [45], which is much lower than the already reported intake of 140 μg/d for a similar Inuit population from Nunavik [15]. Despite an elevated GR enzymatic activity compared to healthy controls [46], smoking status negatively correlated (P < .0009) with GR. A previous report showed that smokers had similar erythrocyte GSH than nonsmokers, whereas a tendency toward lower GR activity compared to nonsmokers was observed [47].

Nunavik Inuit had normal Hcy level similar to that of Greenland Inuit and whites [48,49]. Plasma Hcy correlated negatively with Se, BMI, and positively with age (Table 3), whereas multivariate analyses (Table 5) showed that Hcy was predicted by the same variables. This is in contrast with studies in white subjects showing that BMI or Se, at low level, had no effect on Hcy levels [50,51]. However, Se has also been considered as a potential factor lowering Hcy in the elderly [52]. Mechanisms linking the levels of Se and Hcy are yet unknown, but the present report, as well as a study in Greenland Inuit [49], does not support the notion of an Hcy-lowering effect of n-3PUFAs in healthy individuals, as previously reported in hyperlipemic men [53].

In concordance with a previous report in Inuit of Nunavik [15], correlations between age and n-3 PUFA, Se MeHg, and

PCBs (Table 3) confirm that older Inuit consume higher amounts of traditional food. The levels of contaminants were highly correlated with n-3 PUFAs and between themselves, suggesting that they originated from the same dietary source. However, no relationship between the levels of n-3 PUFAs and LDL oxidation (OxLDL/apoB-LDL) could be detected, suggesting that despite the elevated unsaturated bonds present in n-3 PUFAs, LDL particles were well protected against the oxidative activity of environmental contaminants. We can thus speculate that the high amounts of n-3 PUFAs present in Inuit could enhance the GSH antioxidant defense as previously reported in diabetes [54].

In summary, erythrocyte n-3 PUFAs were highly correlated with dietary contaminants. Whereas n-3 PUFAs and MeHg were not correlated with biomarkers of oxidation, the level of plasma PCBs was a good predictor of the concentration of plasma OxLDL even if this concentration remained very low in Inuit. Level of Hcy was negatively predicted by blood Se, suggesting a possible beneficial effect of Se. The activity of GPx was higher in Inuit than activities already known to be protective in whites [42]. This study suggests that, in adult Inuit, contaminants present in the traditional diet seem to have no direct oxidative effect on the studied biomarkers of oxidation known to be involved in the pathogenesis of atherosclerosis.

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