Very high concentrations of n-3 fatty acids in peri- and postmenopausal Inuit women from Greenland

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ABSTRACT
Objectives. The objectives of this study were to examine the profile of relative concentrations in plasma phospholipids of n-3 fatty acids among peri- and postmenopausal Inuit women living in Greenland and to verify their relationships with ischemic heart disease risk factors and more particularly, with concentrations of plasma triacylglycerols. Study Design. This study was part of a survey conducted in 2000, which aimed to assess the prevalence of osteoporosis and the associated risk factors among peri- and postmenopausal Greenland Inuit women. Methods. The study population consisted of 153 women aged 49–69 years (mean ± SD: 55.3 ± 4.4 y) randomly selected. Data were obtained through an interview (questionnaire on lifestyle habits, medical history etc) and a clinical session (physiologic and anthropologic measurements). Plasma samples were used to measure the fatty acid composition of plasma phospholipids. Results. The mean body mass index of women was 27.9 ± 6.1. Seventy-five percent were smokers and 9% were currently on hormone replacement therapy. Relative concentrations of total n-3 fatty acids were very high (13.8%, 95% CI: 13.1-14.6), with docosahexaenoic and eicosapentaenoic acids accounting for 4.7% and 7.2%, respectively. The ratio of n-3:n-6 fatty acids was 0.67. n-3 fatty acids were inversely correlated to triacylglycerols. Conclusion. These data show that peri- and postmenopausal Greenland Inuit women have very high plasma concentrations of n-3 fatty acids that protect them from ischemic heart disease.

Keywords: n-3 fatty acids; cardiovascular disease; Inuit; peri- and postmenopausal women; triacylglycerol; fish intake.

INTRODUCTION
Many studies have shown low mortality rates from ischemic heart disease (IHD) among the Inuit of Greenland, whereas IHD is a major cause of death in industrialized countries (1-3). In the last few decades, numerous studies have reported that the Inuit diet, which is rich in fish and marine mammals, could protect individuals against IHD. This beneficial effect is attributed to the high n-3 fatty acid content of marine foods. Dietary fish and marine mammal oils are particularly high in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are polyunsaturated fatty acids of the n-3 series.

MATERIAL AND METHODS
This study was part of a survey conducted among peri- and postmenopausal Inuit women from Nuuk, capital of Greenland, which aimed to assess risks factors of osteoporosis and their association with environmental factors (such as polychlorinated biphenyls, chlorinated pesticides
Recruitment was randomly achieved at the Primary Health Care Clinic in Nuuk. Women were considered to be menopausal if they had had no menses for at least one year before recruitment. Data on lifestyle habits and ischemic heart disease (IHD) risk factors were obtained from an interview and a clinical visit. Weight, height and waist, abdominal and hip girth were measured using a standardized technique. Blood was collected for evaluation of plasma phospholipid concentrations of fatty acids. These were determined from plasma samples by capillary gas-liquid chromatography. The fatty acid composition of plasma phospholipids was expressed as a percentage of the total area of all fatty acid peaks from 14:0 to 24:0. In this study, plasma phospholipids of fatty acids correspond to relative percentages of total fatty acids by weight.

RESULTS

The study population consisted of 153 peri- and postmenopausal women aged 49 to 65 years (mean ± SD: 55.3 ± 4.4 y). Seventy five percent (75%) of Inuit women were smokers, 51% had a body mass index (BMI) higher than 27, and 74% were sedentary. Nearly 40% of women were non-alcohol drinkers, 31% consumed between 1 and 6 alcohol drinks weekly, and 29% consumed 7 drinks or more per week. Only 9% of the Inuit women were currently on hormone replacement therapy. Thirty percent (30%) of the women reported that they consumed fish less than once a week, 53% consumed it once or twice a week, and 17% reported consuming fish more than three times a week.

Mean concentrations of total n-3 fatty acids in plasma phospholipids were very high among peri- and postmenopausal Greenland Inuit women (13.8%, 95% CI: 13.1-14.6), with EPA and DHA accounting for 4.7% and 7.2%, respectively (Table I). EPA+DHA accounted for 86% of total n-3 fatty acids, and 25% of the women had EPA+DHA concentrations as high as 15.0% and over. Concentrations of n-3 fatty acids increased significantly with the frequency of fish and marine mammal consumption (p=0.008). The mean concentration of total n-6 fatty acids was 22.8%, and arachidonic acid (AA) accounted for 25% of n-6 fatty acids. Concentrations of total n-3 and n-6 fatty acids were inversely correlated (r= -0.84, p< 0.0001).

Table I. Relative concentrations of fatty acids in plasma phospholipids among Inuit peri- and postmenopausal women from Greenland, aged between 49 and 65 years, and women from Québec (Canada)1.

| Fatty acids | Greenland women (n=153) | Québec women (n=93)2 |
|-------------|-------------------------|---------------------|
|             | Arithmetic (95% CI)     | Range               |
|             | mean                    |                     |
| Eicosapentaenoic: |                     |                     |
| EPA (C20:5 n-3)  | 4.7 (4.3-5.2)          | 0.6-12.4            |
| DHA (C22:6 n-3)  | 7.2 (6.9-7.5)          | 2.3-13.1            |
| EPA + DHA      | 12.0 (11.3-12.7)       | 3.3-24.7            |
| PUFA, n-3 series | 13.8 (13.1-14.6)      | 4.4-27.6            |
| PUFA, n-6 series | 22.8 (22.1-23.5)      | 10.9-31.5           |
| EPA / AA ratio | 0.90 (0.82-0.99)       | 0.13-2.69           |
| n-3 / n-6 ratio | 0.67 (0.61-0.74)       | 0.14-2.32           |
| MUFA, n-9 series | 18.0 (17.6-18.4)      | 13.0-31.0           |
| SATURATED     | 45.0 (44.8-45.2)       | 39.5-50.7           |

1 Relative concentrations are expressed as the percentage of total fatty acids in plasma phospholipids.

2 This number represents all women who were within the same group of age. Data for Québec women taken from a previous study (4).

*** P < 0.001
The ratios of EPA to AA and of n-3 to n-6 fatty acids were 0.90 and 0.67, respectively, and 39% of the women had an EPA/AA higher than 1.0. Monounsaturated and saturated fatty acids in plasma phospholipids were 18.0% and 45.0% of total fatty acids, respectively. Table II shows that concentrations of n-3 fatty acids in plasma phospholipids of Inuit women are much higher than those observed among Quebec women that we assessed in 1990, the concentrations of James Bay Cree women being in between those of Inuit and Quebec women (4-6).

Concentrations of n-3 fatty acids and triacylglycerols were inversely correlated (r = -0.22, p < 0.007). Triacylglycerols are composed of one molecule of glycerol and three fatty acid molecules. Different triacylglycerols can be formed, depending on the length and degree of unsaturation of their fatty acid components.

The association between the prevalence of high triacylglycerol concentrations and quintiles of total n-3 fatty acids was examined by using conditional odds ratio and comparing subjects in quintiles 2 to 5 with those in quintile 1. Results showed that, when modeling the probability that plasma triacylglycerols are higher than or equal 2.3 mmol/L, and controlling for age, BMI, smoking, alcohol intake and hormone replacement therapy, the odds ratios (OR) for the highest n-3 fatty acid groups (e.g. the fourth and fifth quintiles) were 0.17 (95% CI: 0.04-0.71) and 0.15 (95% CI, 0.03-0.63), respectively, as compared with the lowest group (Table III).

**DISCUSSION**

Our study results showed that peri- and postmenopausal Inuit women of Greenland had very high concentrations of n-3 fatty acids, reflecting their high consumption of marine foods. Numerous reports have shown that n-3 fatty acids in phospholipids do reflect fish intake (3,8). Moreover, older Inuit (including menopausal women) generally show higher concentrations of n-3 fatty acids than do younger Inuit, older Inuit being likely to eat more traditional foods than younger Inuit (2,5,7). This last observation is consistent with previous studies conducted in northern native populations (2,5,9,10,11). Furthermore, it was observed that in comparison with the Greenlanders, baseline Canadian women had 73% and 46% less EPA (20:n-3) and DHA (22:6n-3), respectively (7). Moreover, another study shows that the Inuit women of West Greenland aged 35 years old and more had triacylglycerol concentrations at 1.0 mmol/l, while the concentration was at 1.3 in the population of Copenhagen in Denmark (2).

Our results also showed a protective effect of n-3 fatty acids on plasma triacylglycerol concentrations. The inverse relation noted between n-3 fatty acids and circulating triacylglycerol concentrations is well documented (8). High triacylglycerol concentrations are a key risk factor for IHD. The lower IHD mortality rate observed in the Inuit population as compared with westernized populations suggests that the Inuit diet may contribute substantial benefits regarding ischemic heart risk factors (12). Thus, the promo-
tion of safe nutritional habits among Inuit should include maintaining or increasing traditional food consumption combined with the use of healthy market foods.

In conclusion, these results show that peri- and postmenopausal Inuit women from Greenland had very high plasma concentrations of n-3 fatty acids. Moreover, the inverse association between plasma concentrations of n-3 fatty acids and triacylglycerols supports the hypothesis that the Inuit diet, which is rich in fish and marine mammals, has beneficial effects on ischemic heart disease risk factors. The intake of n-3 polyunsaturated fatty acids from fish may have substantial implications for public health and health economy.

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