Fatty Acid Composition of Fish and Commonly Consumed Food in a Cree Community in Northern Quebec

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Contents

Abbreviations

CHD – Coronary Heart Disease

DHA – Docosahexaenoic acid (omega-3 fatty acid)

2 DM – Type 2 Diabetes Mellitus

EPA – Environmental Protection Agency

FAME – Fatty Acid Methyl Ester

FAO – Food and Agriculture Organization of the United Nations

FDA – US Federal and Drug Administration

GC – Gas Chromatography

GDM – Gestational Diabetes Mellitus

$HDL_{cholesterol}$ – High Density Lipoprotein Cholesterol

Hg - Mercury

$LDL_{cholesterol}$ – Low Density Lipoprotein Cholesterol

LC-PUFA – Long chain Poly-Unsaturated Fatty acid

MeHg - Methylmercury

MUFA – Mono-Unsaturated Fatty Acid

P:S ratio – Polyunsaturated:Saturated ratio

PUFA – Poly-Unsaturated Fatty Acid

RfD – Reference dose

SFA – Saturated Fatty Acid

TFA – *Trans* Fatty Acid

Wet wt – Wet weight

WHO – World Health Organization of the United Nations

ω-3 – Omega-3 fatty acid

ω-6 – Omega-6 fatty acid

1. Summary

While the omega-3 fatty acid content of fish is known to vary from species to species, relatively little work has characterized the effect of cooking procedures on the fatty acid content of fish. As non-fatty fish is usually cooked with added oils, differences in the types of fats present, and the associated health benefits of eating fish may vary substantially according to the cooking method used. As well, fish, whether lean or fatty, can provide health benefits when replacing other popular food items such as market and fast foods in the diet, known to contain high amounts of saturated and *trans* fatty acids. Fish risk and benefit statements in communities suffering from a high prevalence of diabetes and its complications need to consider the broader view of dietary choices, cooking methods and their health implications. We, therefore, evaluated the fatty acid content of fish and other commonly consumed food items cooked in a variety of ways in a Cree community. Food items included chicken, eggs, fries, and fish. Baked goods have been studied elsewhere and were therefore not included in the current study.

Fatty acid content of foods was examined by gas chromatography using a 100 m capillary column. The omega-3 to omega-6 (ω-3 : ω-6) ratio was high for boiled or smoked trout, walleye and whitefish ($\geq$ 2.3 : 1.0) and low for fish that were fried (Pike: 0.7 : 1; Trout 0.8 : 1; and Walleye 0.2 : 1). Cooked fish, whether boiled, baked, smoked or fried had an overall mean *trans* fatty acid content of only 0.06% of total fatty acids, and the saturated fat content of fish ranged from a low of 0.4 g/100 g wet wt for boiled fish, to an average of 1.8 g/100 g wet wt for fried fish. In contrast, high levels of saturated and *trans* fats were found in fast food. Deep-fried and battered or roasted chicken skin had saturated and *trans* fat contents of 8.52 and 1.68 g/100 g wet wt and 15.4 and 0.59 g/100 g wet wt respectively, but the chicken meat with skin removed contained very little saturated and *trans* fat. A high *trans* fat content was found in other commonly consumed fast food such as French fries, chicken nuggets, poutine (fries with cheese

and gravy) and chicken wings with mean values of 11.8%, 6.2%, 5.6% and 2.6% by weight of total fatty acids, respectively.

Promoting traditional food including fatty fish, and supporting local community initiatives that encourage healthy eating and lifestyle, is a positive approach to creating a healthy community. The aim of this study was to evaluate and in turn raise awareness of the amount of *trans* and saturated fats found in some commonly consumed fast foods in order to help reduce chronic disease morbidity and mortality in Cree communities. The results of this study will provide sufficient information in order to protect the health of consumers, especially the younger generations who are becoming major users of these food products. As well as provide an opportunity to encourage community members to maintain their traditional diet which is rich in omega-3 fatty acids.

2. Introduction

One of the most important lifestyle changes that have occurred in the last two to three decades among the Cree in Québec is the abandonment of a traditional diet in favor of lower quality, highly processed market and fast food, especially among the younger generations (Dewailly et al, 2002; Delormier et al, 1999; Belinsky et al, 1996). The introduction of lard, vegetable shortening, and more recently vegetable oils in cooking of traditional and market food will influence the fat composition and health implications of traditional and market food consumption. Traditionally an important part of the Cree diet, fish consumption has decreased significantly, especially among the inland communities, due mainly to public health advisories related to methyl mercury (MeHg) contamination in fish. The Santé Québec Health Survey conducted in 1991 among the James Bay Cree reported that traditional foods contributed only to 12% of energy intake (Santé Québec 1998).

In order to provide more appropriate fish consumption risk/benefit statements of the Eastern James Bay Iiyiyiuch, we explored the fatty acid composition of fish and commonly consumed fast food items, cooked in a variety of ways with different fats and oils.

3. Materials and Methods

Approval for the research proposal was obtained from McGill University's Human Ethics Review Committee, and a research agreement was signed between the community's Band Chief and Council, the Cree Board of Health and Social Services of the James Bay, and CINE researchers. Following the recommendations of community elders, the study concentrated on the most commonly consumed food within the community which included fast food, chicken, eggs (cooked with a variety of cooking fats), and fish. The fish reported in this study were prepared by community members in traditional camps, traditional gatherings or at home during the autumn of 2003 and summer of 2004.

3.1 Chemicals and Standards

All solvents used in this study were obtained from Fisher Scientific (Montreal, QC) and were reagent grade or better. The analytical standard of fatty acid methyl esters, GLC-629 (99% purity) was purchased from Nu-Chek Prep. (Elysian, MN), and C18:2 cis/*trans* isomers were purchased from Supelco (Oakville, ON). Standard reference materials, SRM 1544 and 1946 were purchased from NIST (USA).

3.2 Samples

Cooked samples of chicken, eggs, poutine, French fries, chicken nuggets, and chicken wings were collected from restaurants and the local supermarket. Samples of cooked fish were collected from local homes, traditional camps and during the summer traditional gathering. Fast foods were collected in the community in October-November 2003 and in July 2004. Food items were stored in a -18°C freezer while in the community, and placed in -80°C freezer upon arrival at the CINE laboratory in Montreal.

3.3 Fat Extraction

Fat was extracted following modification of a procedure originally outlined by Folch et al, 1957. Individual food items were homogenized and one to two grams of the homogenized sample was extracted with 18 ml $CHCl_3$:MeOH (2:1 v/v) containing 0.02% BHT. A recovery standard, tridecanoic fatty acid [5 mg/mL], was added to each sample. Samples were extracted for 1 h, then filtered through Na_2SO_4, washed with a saline solution, (0.73% (w/v) sodium chloride in nanopure water), and finally centrifuged to separate it into two distinct phases. The top aqueous layer (H_2O and methanol) was discarded and the lower chloroform layer was evaporated under a constant stream of nitrogen.

3.4 Determination of Fatty Acids

Samples of the lipid extract (10-80 mg lipid) were methylated (Morrison & Smith, 1964), and the fatty acids were converted to their respective fatty acid methyl esters (FAMEs) through the addition of BF_3/benzene/methanol solution in the proportion of 1 mL reagent to 4-16 mg lipid. Samples were placed in a water bath for 45 minutes at 100°C. Hexane and 0.73% sodium chloride solution were added to cooled samples and vortexed. The tubes were centrifuged and the upper hexane layer was removed and stored in vials at -20°C until GC analysis. One milliliter of methyl heptadecanoic acid was added to the extract as an internal standard for quantification.

3.5 Chromatographic conditions

One microlitre of sample was injected by the Varian 8200 CX auto-sampler in split mode (1:50 split ratio) into the gas chromatograph (GC), a Varian Star 3400 CX equipped with a WCOT fused silica (100 m x 0.25 mm x 0.25 μm film thickness, CP7420 capillary column), CP-Select CB for FAME, from Varian (USA). The fatty acids were quantified with the Varian Chromatographic Star Work Station Software (Vs 5.52), and identified by comparing their retention times using appropriate pure standards purchased from Nu Chek Prep and Supelco. Fatty acids were analyzed according to the following temperature program: oven temperature was 80ºC, raised to 185ºC at rate of 30ºC/min, and held at 185ºC for 25 minutes. The final oven temperature was 225ºC, raised at a rate of 2ºC/min for 20 minutes, and held at 225ºC for 7 minutes. The detector and the injector temperature were set at 250ºC. Helium was used as a carrier gas with a flow rate of 2 mL/min at pressure of 43 psi. An entire fatty acid profile including the major *cis*/*trans* isomers of 18:1 and 18:2 fatty acids was generated for each sample. Samples were analyzed in duplicate.

Thirty-eight FAMEs were identified by comparing their equivalent chain lengths to those of standard FAMEs. All identified and quantified fatty acids are listed in Table 1. *Trans* isomers of octadecenoic acid, C18:1 *t*6, C18:1 *t*9 (elaidic), and C18:1 *t*11 (*trans*-vaccenic), have been quantified as a group due to peak overlap. Also, the following two omega-6 fatty acids have been quantified together, C20:4 and C20:3 ω-6 fatty acids due to co-elution.

Fatty acids were classified into five groups: saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs), omega-3 (ω-3) and omega-6 (ω-6) polyunsaturated fatty acids, and *trans*-fatty acids (TFAs). Individual fatty acids within each group are reported in Tables 2a-2e, and are expressed in grams (g) per 100g wet weight. A summary of fatty acids is provided in Table 3.

3.6 Quality Assurance/Quality Control

The recovery of certified fatty acids for the standard reference materials, SRM 1544 – Fatty Acids and Cholesterol in a Frozen Diet Composite, and SRM 1946 – Lake Superior Fish Tissue, were 94 and 95% respectively.

4. Results

The highest ω-3:ω-6 ratios were found in fish, specifically in samples that were smoked, boiled, baked and in fish broth, with mean values of 2.9, 2.3, 1.9 and 1.2 g/100g, respectively (Fig. 1). Fried fish flesh and skin had low ω-3:ω-6 ratios, a mean of only 0.8 and 0.2, respectively. All other foods analyzed in the study had low ω-3:ω-6 ratios, ranging from 0.04 to 0.6. Absolute values for omega-3 and omega-6 polyunsaturated fatty acids (PUFA) are presented in Figure 2. Omega-3 long-chain polyunsaturated fatty acids predominated in all fish samples except for fish that were fried. Omega-6 fatty acids were the main component of PUFA in fast food and eggs.

A European prospective investigation of Cancer Norfolk study, showed that an increased dietary polyunsaturated:saturated (P:S) fat ratio was associated with a reduced risk of diabetes, independent of age, sex, family history of diabetes, and other lifestyle factors (Harding et al, 2004). A P:S ratio of around 1.0 was found to be most favorable. In this study, the foods with a P:S ratio of 1.0 or close to 1.0 were fish that were boiled, baked or smoked (range 0.8-1.5), and eggs fried in margarine (mean 0.85). In comparison, fish that were fried and fast foods had high P:S ratios, ranging from 2.0 to 2.5, and from 0.5 to 3.1 respectively (Table 3).

The TFA composition for eggs, fish and fast food is presented in Figures 3a to 3c. Most fast food items showed a greater amount of saturated and *trans* fats relative to concentrations of mono- and polyunsaturated fats, whereas the reverse was found in all fish examined. The overall mean TFA content for fish, eggs and fast food was 0.03, 0.26 and 0.71g/100 g food, respectively. Fried fish had the highest TFA content (0.06 g/100g wet wt), compared to baked

(0.03), smoked (0.02), or boiled (0.01). Fast food items with high *trans* fat content were deep-fried & battered chicken skin (1.7 g/100g wet wt), chicken nuggets (1.0), roasted chicken skin (0.6), poutine – collected from source 1 (0.4), chicken wings (0.4), and breakfast fries (0.3). Very low levels of *trans* fat however, were present in chicken meat once the skin was removed, regardless of whether the chicken was deep-fried (0.08) or roasted (0.04 g/100g wet wt). Interestingly, French fries collected from two separate commercial establishments in the community had noticeably different *trans* fat content of 0.9 g/100g wet wt for source 1 and 2.4 g/100g wet wt for source 2. There was also a large difference observed in the amount of saturated fat in the French fries, with source 1 having a saturated fat content of 0.85 g/100g wet wt, compared to 3.9 g/100g wet wt for fries collected from source 2 (Fig. 4). According to Romero et al (2000), these differences are attributed to the type of oil being used by each establishment, and the frequency with which it is replenished with fresh oil. Eggs fried with vegetable shortening had a relatively high amount of *trans* fat (0.99 g/100g wet wt), followed by eggs fried with a partially hydrogenated margarine (0.3), butter (0.2) and lard (0.14). Very little *trans* fat was present in hard-boiled eggs (0.03 g/100g wet wt), and eggs fried with Canola oil spray (0.06) or non-hydrogenated margarine (0.10).

The overall level of SFAs was highest in samples of fried eggs and fast foods with mean values of 5.4 and 4.0 g/100 g wet wt respectively, compared to the overall mean value for samples of fish of only 0.97 g/100g (Fig. 4). As expected, the most prominent SFA in all foods analyzed was palmitic acid (C16:0), with mean values of 0.7 for fish, 2.9 for fast food, and 3.8 g/100g for eggs, followed by stearic acid (C18:0), with mean values for fish, fast food and eggs of 0.2, 0.9 and 1.4 respectively (Table 2a). High amounts of C16:0 was found in roasted chicken skin (12.0 g/100g wet wt), and deep fried & battered chicken skin (6.4 g/100g), whereas for fish, the highest amounts were found in fried fish (mean = 1.1 g/100g). Eggs fried with vegetable shortening and lard had the highest level of C16:0 (mean $\geq$ 5.0 g/100g). Myristic (tetradecanoic), arachidic (eicosanoic), behenic (docosanoic), lauric (dodecanoic) and lignoceric (tetracosanoic) acids were present in smaller amounts.

MUFAs predominated in all the foods analyzed, with an overall mean for eggs of 7.2 g/100g wet wt (range 4.8 - 9.7), for fast food, a mean of 7.0 g/100g (range 0.8 - 24.5), and for fish, 2.0 g/100g (range 0.4 - 4.6) (Table 3). Among fish samples prepared by different cooking methods, the highest amount of MUFA was found in fish samples that were fried, 3.9 g/100g wet wt, followed by baked (2.3), smoked (1.4) and boiled (0.7). In fast food the highest amount of MUFA were found in roasted and deep fried & battered chicken skin, 24.5 and 14.7 g/100g food respectively. Eggs fried with vegetable shortening and with a non-hydrogenated margarine contained the greatest amount of MUFAs, 9.8 and 9.7 g/100 g, respectively.

5. Discussion

While differences in the omega-3 fatty acid content of fish species has long been recognized, the impact of cooking procedures on altering the fatty acid composition of fish has not been extensively documented. A striking difference was observed in the ω-3 to ω-6 ratio between fish that was fried and fish that was boiled, smoked, or baked. Fried fish had an ω-3 to ω-6 ratio in the range of 0.2 to 0.8 g/100 g wet weight, compared to boiled, smoked or baked fish which had a ratio in the range of 1.5 to 2.9 g/100 g wet weight, with the higher range representing fatty fish such as Lake Trout and Walleye.

Of the food analyzed in the study, fish samples had low levels of saturated and *trans* fats, and high amounts of omega-3 polyunsaturated fat. In contrast, most fast foods had high levels of saturated and *trans* fats, and were low in omega-3 fat but high in omega-6 polyunsaturated fat. Interestingly, a strong difference in the amount of saturated and *trans* fats were observed between French fries collected from two separate commercial establishments within the community. French fries from source 1 had TFA and SFA content of 0.9 and 0.85 g/100 g wet wt. compared to source 2 with 2.4 and 3.9 g/100 g wet wt., respectively. A study done by Romero et al. (2000), show that most *trans* fatty acids found in food come from the oil used and not from the process itself, and their data suggested that frequent addition of fresh oil through the frying process minimizes the amount of TFAs present in fried foods. It is therefore advantageous for a local establishment to use non-hydrogenated oils whenever possible, and to change their oil more frequently when using a deep fryer. Other fast foods found to contain high amounts of TFAs were deep-fried & battered chicken skin (mean = 1.7 g/100g wet wt). Fried chicken is often consumed with the skin and is among the most favorite food items in the community. Our results found low levels of TFAs in chicken meat (0.08 g/100 g wet wt) once the skin was removed.

Due to the introduction of market food within the community, and an increase use of market-bought fats and oils, it was advantageous to look at the variability in the amount of *trans* and saturated fat present in foods fried with different cooking fats. With recommendations from community members, the study examined the differences in the amount of saturated and *trans* fats found in eggs fried with the most commonly bought cooking fats in the community. Interestingly, the highest amount of *trans* fat was found in eggs fried with vegetable shortening (0.99 g/100g wet wt), followed by eggs fried with partially hydrogenated margarine (0.31 g/100g wet wt). The lowest amount of *trans* fat was found in eggs fried with Canola oil spray (0.06 g/100g wet wt), and non-hydrogenated margarine (0.1 g/100g wet wt). A small amount of *trans* fat was found in butter (0.2 g/100g wet wt), but this was not unexpected since TFAs occur naturally in milk and butter as a result of the fatty acids synthesized by the bacteria in the rumen of animals.

5.1 Health Implications

Animal and human observational and intervention studies indicate that the quality of dietary fat influences insulin sensitivity (Summers et al, 2002; Vessby 2001; Rivellese et al, 2002; Rivellese et al, 2003; Enriquez et al, 2004; Hu 2001; Storlien et al, 1991; Borkman et al, 1993; Clore et al, 1998; Baur et al, 1999). Animal studies have shown that saturated fat worsens insulin sensitivity, whereas ω-3 poly-unsaturated fatty acids in muscle cell membrane phospholipids are strongly and positively correlated with insulin sensitivity (Storlien et al, 1991). Omega-3 fatty acids also improve insulin action and counteract the negative effects of saturated fat (Storlien et al, 1991). In humans, skeletal muscle membrane phospholipids composition is correlated with serum insulin action, with unsaturated fatty acids improving insulin sensitivity, particularly so for the omega-6 series (Borkman et al, 1993; Clore et al, 1998; Baur et al, 1999). The results of studies exploring the role of long-chain omega-3 fatty acids in insulin sensitivity in humans are not as consistent as that of animal studies (Pan et al, 1995; Borkman et al, 1993; Fasching et al, 1991; Toft et al, 1995). Limited prospective epidemiological evidence suggest beneficial effects of fish consumption in reducing the risk of developing type 2 diabetes mellitus (DM) (Hu et al, 2003; Salmeron et al, 2001; Feskens et al, 1995; Parillo et al, 1992), while other studies have found no effect (Vessby et al, 1994; Marshall et al, 1997).

In a four-year prospective trial, the cumulative incidence of abnormal glucose tolerance in 175 elderly normoglycemic 64-87 year olds was higher in non-fish consumers (45%) when compared to habitual fish consumers (25%) (Feskens et al, 1991). In a 20-year prospective trial of Finnish and Dutch Cohorts of the Seven Countries Study of men, baseline and recent fish consumption were inversely related to 2-hour glucose level ($p < .05$) and a high intake of total fat and saturated fat increased risk of type 2 DM and glucose tolerance (Feskens et al, 1995). In the Nurses' Health Study, 5,103 female nurses with type 2 diabetes mellitus, but free of cardiovascular disease or cancer at baseline, were followed over time: fish intake $\geq$ 5 times/week was associated with a 64% reduction in mortality (RR 0.36; 95% CI=0.2-0.66), and fish intake 1-3 times or 2-4 times per week was associated with a 26% to 30% reduction in mortality (RR =0.64; 95% CI=0.42-0.99) compared to those who didn't consume fish (Hu et al, 2003). The same investigators found that specific market food items, including French-fried potatoes, potato chips, white bread, cola and noncarbonated beverages were found to predict type 2 diabetes mellitus (Willet et al, 2002). The consumption of most of these food items has increased in Canada since 1992 (Canada's Food Supply 2003) and are thought to be popular food items in Cree communities as well.

The role of monounsaturated fatty acids (MUFA) and polyunsaturated fats in chronic disease prevention is not as clear, with studies finding either beneficial or no effects of diets high in monounsaturated and polyunsaturated fats (Garg et al, 1992; Parillo et al, 1992; Houtsmuller et al, 1980; Salmeron et al, 2001; Harding et al, 2004). However, in patients with type 2 DM, diets high in MUFA have been positively related to decreased postprandial insulin levels (Parillo et al, 1992), and meal induced insulin levels were inversely related to oleic acid levels in RBC phospholipids (Enriquez et al, 2004). In a population-based study, olive oil was shown to have beneficial effects on fasting plasma glucose (Trevisan et al, 1990), but the role of MUFA intake in diabetes prevention is not consistent in the literature (Garg et al, 1992; Parillo et al, 1992; Houtsmuller et al, 1980; Salmeron et al, 2001; Harding et al, 2004). Human intervention studies have shown that replacement of saturated fat by unsaturated fatty acids leads to improved glucose tolerance (Vessby et al, 1980; Uusitupa et al, 1994), and enhanced insulin sensitivity (Vessby 2001).

5.2 Trans Fatty Acids

Concerns about the health effects of *trans* fatty acids (TFAs) and their adverse effects on lipid risk factors for heart disease and metabolism of ω-3 and ω-6 fatty acids (essential fatty acids), have been a major focus of nutritional debates. Their deleterious effects are believed to play such an important role in human health that recently the House of Commons passed a motion to limit processed *trans* fats from food sold in Canada. TFAs are mainly generated by industrial hardening of edible oils into margarines and shortenings, and are found naturally through the process of bacterial hydrogenation of polyunsaturated fatty acids in the rumen of animals.

The industrial process results in the formation of predominantly TFAs, of which *trans* elaidic acid (C18:1 *t*9) is a major component. The oils most often used by restaurants to cook French fries and other fast food, are usually partially hydrogenated oils, and are known to contain *trans* fats. The difference observed in the amount of *trans* fat present in French fries collected from two establishments within the community using the deep-frying process, is mainly attributed to the type of fats and oils used by each establishment, and not from the process itself (Romero et al, 2000; Satchithanandam et al, 2004). The study by Romero et al (2000) also show that frequent addition of fresh oil throughout the frying process lower the amount of *trans* fats found in fried foods. Frying of foods has shown that the percentage of elaidic acid increases during potato frying in olive oil or high oleic acid sunflower oil (Romero et al, 2000). Major sources of TFAs are bakery items (33% of *trans* fatty acid intake), fast foods (12%), breads (10%), snacks (10%), and margarines/shortenings (8%) (Elias & Innis, 2002). Food products such as deep-fried food that include fried chicken, French-fried potatoes, and snack chips contain up to 36% TFAs when high *trans* oils are used in the frying process (Enig 1993).

The hydrogenation of unsaturated vegetable oils in the industry not only results in the formation of *trans*-unsaturated fatty acids but also in the loss of the *cis* ω-6 and ω-3 polyunsaturated fatty acids, linoleic acid (C18:2), and alpha-linolenic acid (C18:3). Linoleic and alpha-linolenic acids, both essential fatty acids, appear to reduce the risk of coronary heart disease (CHD) (Ascherio 2002; Hu et al, 1997).

TFAs are well absorbed by the body, and long-term intake is reflected in the fatty acid composition of adipose tissue (Ascherio 2002; Seppanen-Laakso et al, 1996). Metabolic studies have shown that t*rans* fats have adverse effects on blood lipid levels by elevating levels of serum low-density lipoprotein ($LDL_{cholesterol}$) (bad cholesterol), and at the same time lowering high-density lipoprotein ($HDL_{cholesterol}$) (good cholesterol) (Mutanen et al, 1997; Mensink et al, 1990). TFAs have also been associated with an increased risk of CHD (Ascherio 2002; Hu et al, 2003; Oomen et al, 2001; van de Vijver et al, 2000; Willett et al, 1993), and there is now evidence that *trans* fats can cross the placenta. TFAs have been reported in newborn umbilical cord plasma (Elias & Innis 2002; Desci et al, 2001; Innis & King, 1999), but the health implications of early fetal exposures have not been examined.

In recent years, *trans*-fats have been studied extensively for their potential influence on insulin sensitivity and diabetes risk. *Trans*-monounsaturated fat given as 20% of energy, was associated with a higher postprandial insulin response than a cis-monounsaturated fat diet in 16 obese type 2 diabetic patients followed for 6 weeks (Christiansen et al, 1997), but no effect was observed in a 4 week study of 14 healthy women given a lower dose of *trans*-fat (Louheranta et al, 1999). In the U.S. Nurses Health Study of 84,204 women, a 14-year follow-up found that *trans* fatty acid consumption at baseline (derived from food frequency questionnaires) was associated with increased risk of type 2 DM, and the highest quintile of ω-3 intake was associated with a 20% lower risk of developing type 2 DM (RR= 0.8 (95% CI=0.67-0.95)

(Salmeron et al, 2001). Given the incomplete documentation, and considerable variability of *trans*-fat content within food items (Innis et al, 1999; Ratnayake et al, 1993), findings should be interpreted with caution.

5.3 Fish and Pregnancy

During pregnancy, saturated fat intake may increase the likelihood of gestational diabetes mellitus (GDM). In an Australian study following women that had GDM, those that consumed high amounts of saturated fat were more likely to develop GDM in a subsequent pregnancy than women consuming lower amounts of saturated fat (Moses et al, 1997). Risk management of GDM during pregnancy includes advice to limit saturated fat intake (Gillen & Tapsell, 2004). GDM increases offspring's risk of obesity and type 2 DM (Catalano et al, 2003), developmental delays (Hod et al, 1999), and elevates the risk of daughters developing GDM in their own pregnancy (Egeland et al, 2000). Research suggests that neurodevelopment is adversely affected by factors related to diabetes during pregnancy (Ornoy et al 1998; Hod et al 1999). The data suggest that the developing brain may be sensitive to altered metabolism associated with diabetes and that the poorer the glycemic control the greater the effects on scores related to mental development and the psychomotor development index.

Randomized clinical trials involving preterm infants have shown a clear requirement for the long-chain polyunsaturated fatty acid (LC-PUFA), DHA (C22:6 ω-3), for full visual and neural development (Gibson & Makrides, 2001). The study showed that infants fed human milk with LC-PUFA had higher percentages of these fatty acids in their muscle membranes than infants fed formulas without LC-PUFA. A recent study found that women who consumed fish 1-3 times per week showed a strong relation between fish intake and improved neurodevelopment of offspring (Daniels et al, 2004). A study in Japan has shown a positive correlation of methyl mercury and docosahexaenoic acid (DHA), which originated from fish consumption, being transferred from mother to her fetus (Sakamoto et al, 2004). DHA (C22:6 ω-3) derived mostly from fish, is one of the most important fatty acids for normal brain development and function. Their results confirmed that pregnant women should not give up fish consumption because of the important health benefits that fish brings. Authors state that women could lessen their exposure to mercury by consuming smaller or non-predatory fish, thereby balancing the risks and benefits of fish consumption (Sakamoto et al, 2004).

Quality market food is expensive in many remote communities and affordable market food is often of poorer quality compared to that of traditional food. As a high intake of saturated fat is likely to increase the risk of diabetes during pregnancy (Moses et al, 1997), and given the emerging literature on the adverse effects of diabetes during pregnancy on the offspring's future risk for cognitive effects, obesity, and type 2 DM, fish consumption advisories may inadvertently increase risk to offspring. Nutritional advice needs to consider a broader range of issues to protect fetal development and community health. In this regard, it is worthwhile to note that the EPA methylmercury reference dose (RfD) (0.1 μg/kg body weight/day) incorporates a margin of safety (EPA RfD exposure level of 0.1 μg/kg corresponds to Hg levels of 1 ppm in hair). Thus, exposures above the reference dose are not necessarily hazardous. Also noteworthy is that the Joint FAO/WHO Expert Committee on Food Additives considered the same studies as that of the US EPA but developed a somewhat higher RfD, partly attributed to different safety margins: their new provisional tolerable weekly intake (PTWI) is 1.6 μg/kg body weight/week (i.e. 0.23 μg/kg body weight/day) (Joint FAO/WHO Expert Committee on Food Additives (JECFA, 2003). For example, if an adult weighing 70 kg consumed 2 meals of fish per week (170g per meal) containing 0.3 μg/g MeHg, would result in about 1.46 μg MeHg/kg body weight/week, and therefore the individual would still be within the FAO/WHO weekly recommended guideline of 1.6 μg/kg body weight/week. These guidelines are based on developmental effects of MeHg.

Recent studies suggest a possible role for MeHg in promoting heart disease, but the evidence is not consistent and requires further evaluation (Chan & Egeland, 2004).

Recent Hg monitoring in hair of women of reproductive age in two Cree communities found very low levels of Hg in hair (50%ile was 0.7 ppm in Ouje-Bougoumou and 0.2 ppm in Nemaska) in 2002 (Dewailly & Nieboer, 2003), suggesting that a considerable proportion of Cree women could benefit from increased fish consumption. The American Heart Association promotes the consumption of fish by recommending that at least two servings of fish, preferably fatty fish, be consumed per week (Krauss et al, 2000). The Québec public health authorities also recommend eating two meals per week of low-mercury fish such as Whitefish, Speckled Trout and Sturgeon in the James Bay region, due to benefits they may bring to the fetus.

6. Conclusion

CINE supports the consumption of fish and other traditional foods for the nutrients and health benefits they provide. Given the competing risks of alternative food choices and the benefits of fish consumption, strict adherence to the EPA reference dose may not be advisable (Egeland & Middaugh, 2000). Consistent messages should be provided to communities to avoid confusion. Fish, caribou, and many lean traditional protein sources can, and should be routinely promoted for <u>all</u> community members as they are nutritionally superior to other food choices, and would reduce harmful levels of saturated and *trans* fatty acids. For women of child-bearing age, an emphasis on choosing more often small and non-predatory fish species such as whitefish, speckled trout, or sturgeon, over large predatory fish such as lake trout, walleye, or pike, can provide a simple message that will remain relevant over time. The monitoring of dietary habits prospectively in Cree communities will be helpful to determine the success of traditional food promotion programs. Finding culturally acceptable ways to decrease saturated and *trans* fat exposures, and to increase traditional food consumption especially among the younger generations will provide long-lasting benefits to community health.

7. Summary

There is an urgent need to gather data on the *trans* fatty acid content of various fast-foods, in order to protect the health of consumers, especially the younger generations who are becoming major users of such food products. The purpose of this study was to compare the quality of fat, especially saturated and *trans* fats, found in fish and in some commonly consumed fast foods, as well as to help raise awareness of competing risks associated with common food choices, and cooking procedures, and the types of oils and fats used.

Fish and the omega-3 fatty acids they contain, have been shown to play an important role in the prevention of coronary heart disease. This study showed that traditional food such as fish, whether it be boiled, smoked, baked or fried, had much lower levels of saturated and *trans* fats compared to fast foods. Fish was also found to have much higher levels of polyunsaturated fatty acids, predominantly as omega-3 fat.

Measures can be taken to reduce the consumption of saturated and *trans* fats by reducing the intake of commercially prepared baked goods, snack foods, and fast fried food, and by removing the skin from deep-fried and battered chicken. There is also a need to work with specific food establishments to change procedures to reduce *trans* fat in fried food by switching to non-hydrogenated oils, and by replacing oils more frequently. An increase in the consumption of traditional food protein sources, including fish, and in particular fatty fish, will provide health benefits to the entire population, including pregnant women and their offspring.

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