

CHAPTER 2

DIET PROFILE OF CIRCUMPOLAR INUIT

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Abstract: Nutrition surveys conducted in the Arctic indicate major variations in nutrient intake among Inuit from different regions. However, no studies have been undertaken to evaluate the importance of these differences or similarities in terms of nutrient intakes. In order to provide a basis for comparison of the different Arctic regions, a profile of food consumption and nutritional patterns for each circumpolar region is required. The main objective of this chapter was to describe Inuit diet and estimate nutritional values for each region (Canada, Alaska, Greenland, Siberia), and to study trends over time. To do this, an inventory was taken of all nutritional surveys conducted on Inuit populations in the circumpolar Arctic, as well as a review the different survey methods used, and standardized data compiled. For interregional comparisons, only the most recent and most complete surveys were considered. However, the more dated surveys served to establish temporal trends. Mean consumption levels, energy and nutrient intakes were measured according to gender and age. The contribution of traditional and market foods to energy and nutrient intakes were also assessed. Finally, the principal diet changes occurring in Inuit populations in the last decades were put in perspective to identify the ideal conditions in which an optimal diet can be secured.

1. INTRODUCTION

For Inuit, food is at the juncture of values, economic practices, health-related behaviors and knowledge systems that reflect the relationship between Inuit and their environment. For thousands of years, the Inuit lived of the land, rivers, lakes, and the sea. Inuit have also known periods of starvation. Through experience and the teaching of their elders, Inuit learned to select foods in proper amounts to supply the body with the required nutrients. Inuit appear to have succeeded in avoiding nutritional deficiencies by using all parts of wildlife (Labbé 1987). Meat from big and small game, marine mammals, and fish supplied protein. Animal liver, fish and marine mammal fat supplied vitamins A and D, and animal products provided large amounts of iron and zinc. The consumption of raw meat, of the stomach contents (lichen and moss) of caribou and of plants and berries in summer provided vitamin C.

In addition to providing significant amounts of essential nutrients for the living body and its functions, the Inuit diet, rich in fish and marine mammals, has also been linked to a lower incidence of thrombotic disease in Greenland and Japan (Bang & Dyerberg 1972, 1976; Dyerberg *et al.* 1975; Yamori *et al.* 1985). Death owing to ischemic illnesses is a rare event in Nunavik, whereas these illnesses are a major cause of mortality in industrialized countries (Hodgins 1996). Omega-3 type

fatty acids may also offer protection against other illnesses seldom encountered in Nunavik, such as high blood pressure, diabetes, and certain types of cancers (breast, colon, prostate) (Dewailly *et al.* 2001, Beilin *et al.* 1993, Frolich *et al.* 1992, Kremer *et al.* 1987, Nielsen *et al.* 1996).

Numerous nutritional surveys have been conducted in different regions of the circumpolar Arctic. They indicate major regional variations in nutrient intakes among Inuit. Effectively, even though there is no doubt that traditional food is a major source of many nutrients in the Inuit diet, recent studies show that market food is also important for the nutritional status of Inuit populations, and particularly young individuals. However, no studies evaluating the importance of regional differences and similarities with respect to nutrient intakes have been conducted to date. To provide the basis for comparisons between the different regions of the Arctic, a prerequisite is to draw a profile of food consumption and nutritional patterns for each circumpolar region. The main objective of this chapter is to review and compile recent international data concerning Inuit food and to assess the importance of regional variations or similarities regarding nutrient intakes and food quality, considering country food and market food consumption. Whenever possible, temporal comparisons of food intake will also be presented by region.

The comparisons will help formulate interpretations of the health consequences and assess the different factors that should ideally be integrated at a regional scale to attain an optimal diet from a public health perspective. This will also make it possible to define some health limitations, which may hinder the development of the economic base underlying the production and consumption of country foods.

2. METHODOLOGY

Four countries were included in this circumpolar study: Alaska, the northernmost state among the United States, Canada, Greenland and Siberia. We first conducted an inventory of the existing studies on food consumption and nutritional intake among Inuit populations. Approximately forty-two studies conducted after 1950 were identified and included. More recent (between 1982 and 2000), completed and available studies were selected for comparison between regions.

2.1 Selection of Studies

2.1.1 Alaska

For Alaska, three studies were included:

- 1-*Dietary Intake of Alaska Native Adults 1987-1988* (Nobmann *et al.* 1989, 1992);
- 2-*Diet Among Siberian Yup'iks of Alaska and the Implications for Cardiovascular Disease* (Nobmann 1996);
- 3-*Dietary intake among Alaska Native women resident of Anchorage, Alaska* (Nobmann & Lanier 2001).

2.1.1.1 *Dietary Intake of Alaska Native Adults 1987-1988* (Nobmann 1989, 1992)

This study was conducted in 1987-1988. Subjects were selected in eleven communities: Anchorage, Sitka, Kake, Mt. Village, Kwigillingok, Bethel, Pedro Bay, Pilot Point, Dillingham, Kotzebue, and Selawik. Three hundred and fifty one Alaska native men and women (53% Eskimos, of whom 21% were Inuit and 32% Yupik, 34% Indians, and 13% Aleuts) between 21 and 60 years of age were interviewed using a 24-hour dietary recall. To determine seasonal differences in food intakes, each participant was asked to recall all foods consumed in the previous 24-hour period during five seasons over an 18-month period. Each participant completed between one and five recalls.

2.1.1.2 *Diet Among Siberian Yup'iks of Alaska and the Implications for Cardiovascular Disease* (Nobmann 1996)

This study was conducted in 1992 among 65 Siberian Yup'ik between 40 and 89 years of age. Inuit were

interviewed using a 24-hour dietary recall and a food frequency questionnaire. Subjects were selected from a community on St. Lawrence Island.

2.1.1.3 *Dietary intake among Alaska Native women resident of Anchorage, Alaska* (Nobmann & Lanier 2001).

This study was conducted in 1996-1998 among 74 women between the ages of 18 to 45, living in and around Anchorage and who were not pregnant. Women were interviewed using up to four 24-hour dietary recalls. Blood samples were analyzed for hematocrit, red blood cell folate, plasma vitamin A, vitamin C, and vitamin E.

2.1.2 Canada

For Canada, six studies were selected:

- 1-*A Health Profile of the Inuit of Nunavik*. (Santé Québec 1994, 1995a);
- 2-*Assessment of dietary benefit/risk in Inuit communities* (Kuhnlein *et al.* 2000);
- 3-*Air Stage Subsidy Monitoring Program: Food consumption patterns of Inuit women of childbearing age* (Lawn and Langner 1994);
- 4-*Nutritional and Toxicological Components of Inuit Diets in Broughton Island, Northwest Territories* (Kuhnlein *et al.* 1989);
- 5-*Sanikiluaq Traditional Food Study Report* (Wein *et al.* 1995);
- 6-*Inuvialuit Food Use and Food Preferences in Aklavik, Northwest Territories, Canada* (Wein and Freeman 1992).

2.1.2.1 *A Health Profile of the Inuit of Nunavik* (Santé Québec 1994, 1995a)

This study was conducted in Nunavik in 1992 among 433 Inuit. Subjects were selected from the communities of Akulivik, Aupaluk, Inukjuak, Ivujivik, Kangiqsualujuaq, Kangiqsujaq, Kangirsuk, Kuujuaq, Kuujuaqik, Povungnituk, Quaqtaq, Salluit, Tasiujaq, and Umiujaq. A 24-hour dietary recall was administered to 197 men and 236 women between 18 and 74 years of age. A food frequency questionnaire was administered to 228 women who were neither pregnant nor breastfeeding and who had completed the 24-hour recall.

2.1.2.2 *Assessment of dietary benefit/risk in Inuit communities* (Kuhnlein *et al.* 2000)

This extensive dietary survey was conducted from 1997 to 2000 in five Canadian arctic regions: Inuvialuit, Kitikmeot, Kivalliq, Qikiqtaaluk (Baffin) and Labrador (Kuhnlein, 2000). Eighteen communities were selected to represent approximately 50 Inuit communities in

these regions. Inuit residents of communities were interviewed using a food frequency questionnaire of traditional foods and 24-hour dietary recalls, 7-day food records, socio-cultural interviews and food perception interviews.

2.1.2.3 Air Stage Subsidy Monitoring Program: Food consumption patterns of Inuit women of childbearing age (Lawn & Langner 1994)

This study was conducted in 1992 among 397 Inuit women and in 1993 among 396 Inuit women. Women were between 15 and 44 years of age; pregnant and breastfeeding women were included in the study. Women were selected from communities in the Northwest Territories—Pond Inlet and Arctic Bay (Baffin Island), Repulse Bay and Coral Harbour (Keewatin region), Gjoa Haven (Kitikmeot region)—and from Labrador (Nain). Two Indian communities were also selected for this study but were not used in this report. Women were interviewed using a 24-hour dietary recall and a food frequency questionnaire. Data on nutrient intakes are presently under review.

2.1.2.4 Nutritional and Toxicological Components of Inuit Diets in Broughton Island, Northwest Territories (Kuhnlein 1989)

This study was conducted between 1987 and 1988. Three hundred and sixty-six Inuit between 3 and 85 years of age were interviewed using a 24-hour dietary recall and a food frequency questionnaire. Pregnant or breast-feeding women were included in the study. Subjects were selected in the community from Broughton Island (Qikiqtarjuaq) on Baffin Island. Each participant was asked to recall all foods consumed in the previous 24-hour period for six seasons over a 12 month period to determine seasonal differences in food intakes. Participants completed between one and six recalls.

2.1.2.5 Sanikiluaq Traditional Food Study Report (Wein 1995)

This study was conducted between 1992 and 1993. Subjects were selected from the community of Sanikiluaq in the Belcher Islands and 102 Inuit households were interviewed using a traditional food frequency questionnaire. Respondents were asked to estimate their consumption for each season of the preceding year (December 1992–November 1993). In addition, 48 adults completed two 24-hour dietary recalls, one in the winter (February–March 1993) and the other in the fall (October–November 1993).

2.1.2.6 Inuvialuit Food Use and Food Preferences in Aklavik, Northwest Territories, Canada (Wein & Freeman 1992)

This study was conducted between 1990 and 1991. Subjects were selected from the community of Aklavik (Inuvik). Thirty-six Inuit households were interviewed using a traditional food frequency questionnaire. Respondents were asked to estimate their consumption for each season of the preceding year (Fall 1990–Summer 1991).

2.1.3 Greenland

For Greenland, one study was selected:

2.1.3.1 Greenland Health Interview Survey (Pars 2001; Bjerregaard and Young 1998; Bjerregaard *et al.* 1997, 2000)

This population-based survey was conducted between 1993 and 1994. The population surveyed was comprised of 1728 Greenland residents (1580 Inuit) over 18 years of age. Subjects were selected from all 17 towns and 21 villages and were interviewed using a short food frequency questionnaire (17 food items). Danish, as well as East and North Greenlanders were excluded from the study. A food frequency questionnaire survey was used to gather information on the consumption of traditional and market food items during the last three months before the survey. Information on food preferences was also gathered from a list of 12 traditional and 12 market food items.

2.1.4 Siberia

For Siberia, three studies were selected:

1-*Comparison of Diets in Two Native Chukotka Populations and Prevalence of Ischemic Heart Disease Risk Factors* (Nikitin *et al.* 1991);

2-*Dietary Fat and Disease Patterns in Chukotka Native Adults* (Mamleeva *et al.* 1996);

3-*Nutrition of Chukotka Native Children* (Beresovikova *et al.* 1996).

2.1.4.1 Comparison of Diets in Two Native Chukotka Populations and Prevalence of Ischemic Heart Disease Risk Factors (Nikitin *et al.* 1991)

This study was conducted in 1982–1983 among 277 native males between 30 and 59 years of age. The subjects were selected from coastal and tundra regions of Chukotka. They were interviewed using a 24-hour dietary recall.

2.1.4.2 Dietary Fat and Disease Patterns in Chukotka Native Adults (Mamleeva *et al.* 1996)

This study was conducted in 1992–1993 in four villages of Chukotka coast. The population surveyed comprised

362 men and women between 25 and 64 years of age. Respondents were interviewed using a 24-hour dietary recall.

2.1.4.3 *Nutrition of Chukotka Native Children* (Beresovikova *et al.* 1996)

This study was conducted among 317 students (162 natives and 155 non-natives). Students were between 14 and 17 years of age and were from the coastal and tundra Chukotka regions. Students were asked to complete a 24-hour dietary recall.

2.2 Limits of Data

All methods used to survey food consumption have their limitations. The 24-hour dietary recall is a method often used to quantify the food intake of an individual or household during a specific day just prior to the interview (Willett 1998). The method is simple and rapid and its value in assessing the average intake of groups is well established. However, since dietary intake from day to day is highly variable, a single 24-hour recall is rarely representative of an individual's average intake. Multiple 24-hour recalls improve the accuracy of individual intake estimates. The frequency questionnaire is used to measure long-term intakes, thus providing a more representative idea of usual intakes (Gibson 1990, Willett 1998). This questionnaire is useful in epidemiological studies for ranking subjects into broad consumption categories. The major limitation of the food frequency questionnaire is its list of foods. Often, the food list may be extensive enough to enable estimates of total food intake. In general, longer food frequency lists overestimate individual's intake, whereas shorter lists underestimate individual's intake (Thompson & Byers 1994, Gibson 1990). Both methods were used in studies included in this report since each study had its own research objectives. Thus, results presented are descriptive and should be considered with some caution.

In addition to methodological differences, there are differences in the nutrient databases used. This can create differences in results. Differences in interviewers and their skill level also influence results.

3. RESULTS

The results focus on the consumption of traditional and market foods by Inuit populations. Traditional food is highlighted in an attempt to determine their importance in the Inuit diet. Whenever possible, the contribution of traditional and market foods to energy and nutrient intakes are discussed according to gender and age.

Results are restricted primarily to nutrients of particular interest in the public health literature. Mean and/or median intakes of energy and nutrients were compared to USA recommendations (1989), and to recommended nutrient intakes (RNI) in Canada (1990).

3.1 Results from Alaska

3.1.1 Results from eleven Alaskan Native communities (Nobmann 1989, 1992)

Food intakes, particularly protein sources, varied by season. For example, fish were consumed more frequently in the summer and fall and game meat was eaten more often in the winter. Traditional food was still eaten in 1987-1988. This study revealed that traditional foods most frequently consumed by Alaskan Inuit were: salmon and other fish, crustaceans, caribou, reindeer, berries, duck, and moose. For men and women, intakes in traditional food increased with age, and intakes varied with seasons. The kind of traditional foods also varied by region. Market foods most frequently consumed were coffee, sugar, white bread, tea, soft drinks, butte, and margarine.

Energy, protein, and fat intakes were significantly lower in the spring than in other seasons among both men and women. Average intakes calculated from the 24-hour recall data were compared to Canadian Recommended Nutrient Intakes (RNI), since most studies were conducted in Canada (Santé et Bien-être social Canada/Health and Welfare Canada 1990). Data indicated that calcium intakes were low for women of all age groups and for men 40 years of age and over. Men 21-40 years of age in Kotzebue and Selawik had mean intakes that were higher than older men and higher than women. Intakes in cholesterol were relatively high (>300 mg/day) for men of all age groups. Among men and women, contribution of total lipids to energy intake was approximately 37%. Contribution of carbohydrates was lower than recommended.

3.1.2 Results from St. Lawrence Island (Nobmann 1996)

This study revealed that the most popular traditional foods consumed by Alaskan Inuit were seal meat, walrus meat and liver, seal fat, skin, and fat of whale (*mallu*), fish and seafood, whale (*mallu*) meat, and berries. No significant differences were observed between Inuit 40 and 60 years of age and those of 60 years and over regarding traditional food consumption.

Nutrient intakes measured by the 24-hour recall appear to be lower than those measured using the food frequency questionnaire. This is especially the situation

for vitamin C and folic acid intakes. When compared to nutrient recommendations, folic acid intake was low and vitamin B6 intake was close to RNI for women 40 years of age and over. Cholesterol intake was also high among men of 40 years and over, based on intakes from the food frequency questionnaire, but <300 mg/d based on those from the 24 hour recalls. For men and women of all age groups, contribution of total lipids to energy intake was greater than the recommended level, while contribution of carbohydrate was lower than the RNI level.

Contribution of traditional food to total energy intake was approximately 25%. Over 50% of the intake in protein and approximately 31% of the lipid intake were derived from traditional foods. Moreover, traditional food supplied more monounsaturated (34%) and polyunsaturated (30%) fatty acids than saturated fatty acids (23%). For iron and vitamin B12, traditional foods accounted for as much as 60% of the total intakes. However, market food contributed more than traditional food to total carbohydrate, fiber, sodium, selenium, vitamins B-6, C and E, folic acid and β -carotene intakes.

3.1.3 Results from Anchorage (Nobmann & Lanier 2001)

Only 27% of women reported eating Native foods and, among those, the number of times consumed was infrequent. The most frequent item mentioned was salmon. When wild game was mentioned, it was often used in mixed dishes (some commercially packaged). According to Nobmann and Lanier, the fact that these women were young (< 46 y) and urban residents may provide a potential explanation for the low consumption of country foods.

The mean daily energy intake was 1804 kilocalories, which fell within the recommended intake. Mean and median intakes met dietary recommendations for protein, cholesterol, phosphorus, potassium, vitamin C, thiamine, riboflavin, niacin, vitamin B-6 and vitamin B-12. Mean but not median intake of vitamin A met the recommendation. Mean and median intakes of fiber, calcium, magnesium, iron, zinc, copper, folacin and vitamin E did not meet the dietary recommendation. In contrast, mean intakes of sweets, sodium and energy from fat and saturated fatty acids exceeding recommendations.

3.2 Results from Canada

3.2.1 Results from Nunavik. (Santé Québec 1995)

According to the Santé Québec Health Survey conducted in 1992 among the Inuit of Nunavik, market food consumption was greater than that of traditional food among all age and gender groups. However, traditional food intakes increased with age among both men and women, whereas the contribution of market food to the total diet decreased. Geographical differences in food and nutritional intakes were also reported. Residents of the Ungava coast depend more on market food than on traditional food when compared with residents of the Hudson coast. According to data collected from the 24-hour dietary recall, traditional foods most frequently consumed were: caribou, red char (arctic char), *misirak*, white whale blubber, seal, and lake whitefish. According to data collected from the food frequency questionnaire, similar results were observed but consumption of wildfowl was higher from the food frequency questionnaire than from the 24-hour recall. As well, traditional food consumption varied seasonally.

The most popular market foods were sugar and sweets, pasta and rice, tea and coffee, bannock, sweetened beverages, butter, shortening and white bread. Intakes of perishable market foods, such as milk and dairy milk products, appeared to be related to the availability of these foods in the Nunavik communities. Further data analysis showed a greater consumption of milk, dairy products, and white bread, and a lower consumption of bannock in Kuujuaq where availability of market food is greater compared to other remote communities in the region.

For all age groups and both sexes, intakes of calcium, vitamin A, and folic acid were low and, for men 40 years of age and over, vitamin C intake was insufficient. These low intakes could be explained by low levels of consumption of dairy products, fruits, and vegetables (Santé Québec 1995). Intakes of iron were quite high (except for women under the age of 35), related to a high consumption of meat. Magnesium and vitamin B6 intakes were close to RNI levels and men between 18 and 40 years showed low vitamin E intake. Cholesterol intake was high among men of all age groups. For men and women, contribution of total lipids to total energy intake was greater than the recommended intake level and higher than for the total Québec population, while that of carbohydrate was lower. This difference can be explained by a diet rich in meat, poultry, and fish (including game) and rather low in fruits and vegetables (Santé Québec 1995). Vitamin D

intake estimated by the 24-hour recall was low among men and women. However, when analyzed with the food frequency questionnaire, and using additional data covering vitamin D content in traditional foods, vitamin D intakes of Inuit women met and exceeded the daily requirements through the consumption of traditional food (Blanchet 2000, Dewailly 1996). Intake in omega-3 fatty acids (EPA and DHA), found in fish and marine mammals, were higher among the Inuit compared to the total Quebec population (Dewailly *et al.* 2001).

The mean contribution of traditional food to energy and nutrients increased with age in both men and women. According to the 24-hour recall, traditional food supplied less than 20% of the energy in young people between the ages of 18 and 34, whereas they supplied up to 35% of the energy among men between 50 and 74 years of age (Santé Québec 1995). Bannock was the primary source of energy, carbohydrates, dietary fibre, saturated fats, and polyunsaturated fatty acids (Santé Québec 1995). Among men and women over the age of 50, about a third of the energy and lipids came from bannock. Traditional food contributed 39% to 65% of total protein intake and 22% to 40% of total lipid intake. Traditional foods supplied more monounsaturated and polyunsaturated fatty acids than saturated fatty acids. However, traditional food supplied only 1% of carbohydrate intakes. More than 40% of intakes in iron, niacin, riboflavin, zinc, vitamin B12 and pantothenic acid were derived from traditional foods. Finally, contribution of traditional food to fiber, calcium, sodium, vitamin C, and folic acid intake was low among the population surveyed.

3.2.2 Results from the five Canadian Arctic regions (Kuhnlein *et al.* 2000)

The survey revealed that in fall, the contribution of country foods to total energy varied from 18 to 32% in Inuvialuit region, from 20 to 24% in Kitikmeot region, from 22 to 32% in Kivalliq region, from 16 to 39% in Baffin region and from 8 to 24% in Labrador. In winter, the contribution of country foods varied from 8 to 21% in Inuvialuit region, from 10 to 29% in Kitikmeot region, from 17 to 26% in Kivalliq region, from 16 to 42% in Baffin region and from 17 to 23% in Labrador. In all regions, country foods were consumed less by younger Inuit (between 15 to 40) than older Inuit. Many individuals, including more than 30% of elders in three regions, reported eating less country foods than they did five years ago. The amount of country foods consumed by Inuit and the type and overall variety of species consumed were substantial. Moreover, there were differences by region in the total country food quantity

and the number of species used. In Inuvialuit region, country foods most frequently consumed in summer were caribou, beluga, whitefish, geese and swans, herring (particularly in Aklavik) and char (particularly in Paulatuk). In winter, caribou was generally consumed more than once a week. In Kitikmeot region, caribou, arctic char, ringed seal and muskox (particularly in Holman), trout and whitefish (especially in Cambridge Bay) were most frequently consumed (generally more than once a week) in summer whereas in winter, caribou and arctic char were the main country foods consumed (generally consumed 2-4 times per month). In Kivallik region, caribou was consumed more than once a week in summer and winter. Arctic char and beluga were also frequently consumed in summer (especially in Chesterfield Inlet and Rankin Inlet). The most frequently consumed country foods in Baffin region during summer were ringed seal, caribou, arctic char and narwhal. Caribou, ringed seal and arctic char were also moderately to highly consumed in winter in this region. Finally, caribou, trout (especially in Makkovik and Rigolet), arctic char (in Nain) were country foods most frequently consumed in Labrador during summer. In winter, caribou was the most frequently consumed country food in Labrador. Results revealed also that in the five regions, market food consumption was higher among younger age groups (< 40 y) than among Inuit of older age groups. Market foods most frequently consumed were tea, coffee, soft drinks, powdered drinks with vitamin C, unfortified powdered drinks, white bread and sugar. Furthermore, the most favorite market foods reported were various meats and mixed food preparations (pizzas, spaghetti, etc). Results revealed also that intakes of vitamins A and E, folic acid, fibre, calcium, and magnesium do not meet the recommended levels. It was observed that more nutrients were present in the diet when country foods were consumed. Moreover, when country foods were consumed, intakes in total fat, saturated fatty acids, sucrose and carbohydrate were lower than when only market foods were consumed.

3.2.3 Results from Northwest Territories and Labrador (Lawn & Langner 1994)

Consumption of market food was higher than that for traditional foods among women for all regions and age groups. Some regional variations in traditional food consumption were observed. Seal was eaten more often in Keewatin and Baffin regions and caribou was more often consumed in Labrador and Baffin regions. These regional differences could be explained, in part, by availability of these species in each territory. According

to the food frequency questionnaire, the most frequently consumed traditional foods were caribou, arctic char, *muktuk*, and seal. The most popular market foods were sweetened beverages, fruit juices, milk, and white bread. Similar results were obtained among pregnant women.

Lawn and Langner reported a number of serious nutritional concerns for women of child-bearing age, and in particular for those who were pregnant or lactating. They noted that low intakes in calcium, vitamin A and folacin placed many of these women at risk. The low consumption of organ meats, vegetables, fruits, and dairy products makes it difficult for many women to meet their nutrient requirements.

3.2.4 Results from Qikiqtarjuaq (Broughton Island) (Kuhnlein 1989)

The use of traditional food during different periods of the year changed with their availability. The overall contribution of traditional food was significantly higher during September and lower during the winter period (November to January). Traditional food intakes increased with age, this was particularly true for seal intake. Market food intakes decreased with age. According to data collected from the food frequency questionnaire, traditional foods most frequently consumed were: seal (meat, fat, and liver), caribou (meat and fat), red char (flesh and skin), walrus (fat, skin, and meat), seaweed, berries, duck and other wildfowl, crustaceans, and wild eggs. Data collected from the 24-hour dietary recall showed similar results. Market foods most frequently consumed were tea, sugar, bannock, cookies, fruit drinks, crackers, evaporated milk, and white bread. Sucrose intake in the younger age groups was high as well as tea and coffee consumption in all age and gender categories.

Using data from 24-hour recalls, mean intakes were compared to recommended nutrient intake levels. More than 80% of the population exceeded two thirds of the recommended dietary allowances for energy, protein, iron, and zinc. Calcium intake among Broughton Island Inuit was especially low and vitamin A intake was close to the RNI among men. Pregnant and breastfeeding women and children had very low vitamin A intake. The mean contribution of total lipids to energy intake appeared to be greater than the recommended intake level.

Most nutrient intakes were significantly different depending the food source. The contribution of traditional food to total energy intake increased with age and varied from 27% among women to 50% among older men. Sea mammal foods were the greatest contributors of traditional food energy. Contribution of

traditional food to nutritional intakes also increased with age and was associated with the season. Traditional food supplied from 62% to 83% of the total protein intake. In individuals over 40 years of age, traditional food contributed more than 60% of the total lipid intake. Market foods contributed 99% of the total carbohydrate intake. Among men and women of all age groups (except vitamin A intake in pregnant women), traditional food supplied more than 40% of the intake in iron, magnesium, phosphorus, zinc, and vitamin A. However, for calcium and sodium intakes, contribution from traditional foods was low. According to Receveur and Kuhnlein (1996), dietary surveys may underestimate intakes in vitamin A and calcium. Effectively, dietary questionnaires tend to miss traditional food—items rarely consumed but rich in nutrients (particularly vitamin A), and food composition databases may be biased downwards for calcium in important recipes such as stews and soups made with bones.

3.2.5 Results from Sanikiluaq (Belcher Islands, Northwest Territories) (Wein 1995)

Traditional food represented an important part of contemporary Sanikiluaq diets in terms of the frequency of consumption, daily portion size, nutrient contribution to daily diets, and people's preference for them. The consumption frequency of main traditional food items was, in order of importance: fish and mollusc, wildfowl and eggs, marine mammals (particularly seal), berries and land mammals. Traditional food consumption varied very little according to season but total consumption was higher from September to November. Wein noted that there may be overestimation of some traditional foods in the food frequency questionnaire such as fish and mollusc intakes. As noted in data collected with the 24-hour dietary recall, market food was more often mentioned than traditional food. However, traditional food was consumed in higher amounts, in particular among men and elders. Traditional food intakes were higher in the winter and the most frequently traditional foods consumed were reindeer and seal. Approximately 85% of individuals had eaten one traditional food the day before the survey. The most frequently consumed market foods were tea, sugar, bannock, evaporated milk, and white bread.

Differences in energy and nutrient intakes varied by season among Sanikiluaq Inuit. Intakes in protein, phosphorus, iron, zinc, thiamin, riboflavin, and niacin were well above the recommended intake levels and levels were higher in winter compared to those in fall, thus confirming the importance of traditional food in winter. Using median intakes calculated from the 24-

hour recall data for comparison with nutrient recommendations, it was observed that median intakes in calcium, vitamins A and C, and folic acid were low and 50% of adults were at risk of inadequate intake of these nutrients. Median intake in vitamin D was close to the RNI level among men and women of all age groups, whereas cholesterol intake exceeded recommended levels. Traditional food supplied, on average, 47% of the total energy, and accounted for as much as 60% among older people compared to 30% among younger ages. Traditional food supplied over 80% of protein, iron, zinc, and niacin intakes and 79% of riboflavin intake among individuals. Finally, traditional food contributed less in calcium and vitamins A and C intakes than market foods.

3.2.6 Results from Aklavik (Northwest Territories) (Wein & Freeman 1992)

Results of the Aklavik dietary survey showed that traditional food comprised a large and very important part of the contemporary Inuvialuit diet. According to the food frequency questionnaire, mammals (in particular caribou and white whale), fish (particularly lake whitefish), wildfowl, berries and other plants were the most popular traditional foods. Traditional food was consumed, on average, 1.85 times per day by each family, and were more often consumed in fall and winter months. Large mammals, particularly caribou and beluga were used throughout the year. Fish were consumed in all seasons and birds were consumed most often in fall and spring. For 31 of 34 traditional food items, there were no differences in children's vs adult's preference ratings. However, children rated 8 of 12 market food items higher than adults did. No nutritional data was analyzed in this project.

3.3 Results from Greenland

3.3.1 Pars *et al.* 2001; Bjerregaard *et al.*, 1997, 2000; Bjerregaard & Young, 1998;

Consumption of Inuit traditional foods was found to be high in Greenland. Results of the 1993-94 Health Survey conducted revealed that average traditional food meals amounted to 29.3 per month (Pars, 2001). The contribution of traditional foods to the daily energy intake was estimated to 22% (Bjerregaard, 2000). Greenlandic men consumed more traditional foods than women and the consumption of traditional foods increased with age with the exception of terrestrial mammal consumption, which was similar among the elders and the younger Inuit (Pars, 2001). The difference between generations was most clear in the towns where the older Inuit consumed

traditional food almost twice as often as the youngest age group. A higher consumption rate was observed in villages or in northern communities than in the larger towns or in the southern part of the country. The regional difference was most pronounced for seal, and the consumption of birds and whale meat was twice as high in the north western villages as in other regions.

The most preferred traditional foods by Greenlandic Inuit were *mattak*, Brunnich's guillemot, dried cod, crowberries and seal meat (Pars, 2001). The survey indicated that seal meat and fish were the most commonly consumed traditional food items, distributed on 100g of seal/d (meat and blubber), 64g/d of fish, 44g/d of whale and 17g/d of sea-birds. Potatoes, fruit juice, fruit syrup, cheese, vegetables and butter were the most popular market foods daily consumed. The youngest Inuit consumed fruit and vegetables, fruit syrup and soft drinks more often than the oldest while there was no difference according to age for dairy products. The consumption of market foods was higher in towns than in villages. Evidence of deficiencies for individual vitamins and/or minerals have not been documented among Greenlandic Inuit.

3.4 Results from Siberia

3.4.1 Nikitin *et al.* 1991

Nikitin *et al.* observed that Inuit living in the tundra mainly consumed caribou meat and organs, bread, sugar, river fish, and butter. Coastal Inuit showed greater intakes of walrus, whale, seal, mutton, bread, and sugar. Berry and root consumption was also important. Authors noted that the consumption of eggs, milk products, fruits, and vegetables was low.

3.4.2 Mamleeva *et al.* 1996

Among the population surveyed, bread and meat supplied the majority of total energy intake followed by animal fat, sugar and other types of sweets. Caribou meat was the most popular traditional food consumed, as stated by more than 90% of respondents in the 24-hour dietary recall. Animal fat (including butter and pan-frying fat), followed by meat fat (caribou, beef, pork, mutton) and seal meat contributed significantly more to fat intake than vegetal fat. Consumption of milk products, fruits and vegetables was low. Among men and women, intakes in total and saturated lipids and cholesterol were higher than the recommended levels.

3.4.3 Beresovikova *et al.* 1996

Among the population surveyed, the contribution of foods to total energy intake was, in decreasing order: bread, fat, sugar and sweets, fruits and vegetables, meat and fish. The most popular meat consumed was caribou followed by beef, marine mammals, chicken and sausage. Caribou consumption was higher in native children than non-natives, whereas the inverse was observed for beef consumption. The most important source of fat among children was butter, and sugar consumption was high among all children. Finally, all children had intakes of total and saturated fat greater than recommended levels.

4. DISCUSSION

4.1 Food and Nutrient Intake Comparisons of Inuit Between Regions

Traditional food consumption varies according to regions. This variation may be attributed to territorial availability of species as populations in more coastal regions consuming more marine mammals and fish than populations in more central regions. Traditional foods such as caribou and red char (arctic char) were frequently consumed in Baffin Island, Kitikmeot and Kivallik regions, Labrador and Nunavik. In Greenland, seal meat and fish (dried cod and Greenland halibut) were the most frequently consumed traditional food items. Compared to Nunavik, Alaska and Greenland, seal, narwhal, and walrus were more frequently consumed among Baffin Island Inuit. Salmon and other fish (except for red char), reindeer and venison intakes were higher in Alaska. Intakes of the most perishable market foods such as milk, fruit juices and fruit also varied according to regions. Alaska appeared to be better supplied in market food than other regions and this last ascertainment could explain, at least in part, why Alaska showed the highest market food intakes among all regions studied.

Comparisons between regions are somewhat difficult as food studies conducted did not evaluate the same nutrients. Thus, in comparing results, a degree of caution is required. Except for Alaska studies conducted before 1996, the main similarities observed are the low intakes in calcium and vitamin A among Inuit populations. It was also observed that intake in total lipids was high and greater than the recommended intake level, and inversely, intake of carbohydrates was lower than recommended level. The contribution of protein to total energy intake was quite high while intake for more southern populations are much lower. The traditional food contribution to total carbohydrate

intake was generally very low as compared to market food. This observation could be explained by the fact that traditional foods are mainly animal sources, which generally contain very low amounts of carbohydrates. Intakes in folic acid and vitamin C were relatively low among all populations, except among Alaskan men and women in 1987-1988 and men in 1992, which mean vitamin C intake exceeded recommendations. Fiber intakes were generally low. In summary, when energy intake was high, nutrient intakes (e.g., calcium intake) were more likely closed to recommended intake level.

The main differences in nutrient intakes were observed for iron, zinc, folic acid and vitamins A and C. According to Receveur and Kuhnlein (1996), dietary surveys may underestimate intakes in vitamin A and calcium since dietary questionnaires and food nutrient databases underestimate nutrient content of these elements in traditional foods. However, for iron, some of the difference observed between studies could be attributed to the use of different nutrient databases. Effectively, Kuhnlein *et al.* used nutritive values from traditional food samples that were analyzed in a laboratory during their survey. When comparing these nutritive values with the Canadian Nutrient File (1989), iron data from the Kuhnlein study were higher. Wein also used the Kuhnlein nutrient database.

Nobmann *et al.* (1989) reported intakes in vitamins A and C eight times greater than reported in other studies. These elevated intakes could be associated to higher intake in fruit and vegetables and also to vitamin and mineral supplementation, which was included in nutritional analysis. Nobmann *et al.* (1989, 1994) also compared the 1987-1988 Alaskan data with that of Siberia (Chukotka) and the Alaskan diet appeared to be « more urbanized » than that of the Chukotka region. The Alaskan population consumed a higher proportion of their calories as carbohydrates and lipids compared to the Chukotka population.

4.2 Temporal Food Intake Comparison According to Regions

4.2.1 Canada

For Canada, results obtained from recent surveys were first compared to the Nutrition Canada Eskimo Survey conducted in 1971. Subjects were selected from Frobisher Bay (Iqaluit), Coppermine, Pelly Bay and Eskimo Point. Results from a 24-hour dietary recall were used for comparisons. In comparing the results of dietary studies, one must be cautious as the sample size of this survey was very small ($n=194$).

In 1971, daily traditional food consumption varied between 191 and 219 g in women and, according to recent studies, quantities consumed in women varied between 164 and 607 g. Among men, daily traditional food consumption varied between 277 and 464 g in 1971, whereas consumption varied between 171 to 811 g in more recent studies. The highest intakes in traditional food were observed by Kuhnlein (1989, 2000) and Wein (1995). In Canada, intakes in traditional food do not seem to have changed significantly in the last 20 years. Changes in diet of Inuit populations are mainly related to market food intake. Inuit have added more market food to their diet, in particular, cereal products, meat, fruits, vegetables, and sugar. Energy intake increased from year to year. Effectively, mean energy intakes of Inuit were lower in 1971 than more recent studies show. Also, the contribution of protein to total energy intake has decreased since 1971, whereas lipid contribution has increased. According to the Santé Québec survey, changes in the contribution of protein and lipid over the past 20 years are attributable to a higher consumption of market meat, prepared meals, and lower consumption of game meat (Santé Québec 1995). The low intakes in vitamins A and C, folic acid and calcium observed in recent studies were observed in 1971.

Schaefer and Steckle (1980) reviewed several dietary studies conducted among Inuit populations and noted regional differences. The more urbanized or less traditional the population surveyed was, the greater the protein intake decreased, whereas carbohydrate and sugar intake increased. The same results were observed in Alaska and Greenland.

4.2.2 Alaska

In 1978, Knapp and Panruk (1978) repeated a dietary survey in five Alaskan villages that were originally evaluated by Heller and Scott between 1956 and 1961. They reported decreasing intakes of protein, lipid and energy and increasing intakes of carbohydrates. They also noted lower intakes of thiamin, riboflavin, niacin, iron, and higher intakes of vitamins A and C and calcium in the 1978 survey. Authors attributed the increase in vitamins A and C to higher consumption of fortified fruit beverages and the increase in calcium intake to milk programs in schools. The decrease of thiamin, riboflavin, and niacin intake was associated with the lower total protein intake.

Recently, Nobmann *et al.* (1992) compared results of their study conducted in 1987-1988 with those of Heller and Scott (1967). According to Nobmann, traditional foods are still popular among the Inuit

population. Nobmann *et al.* (1992) observed that Inuit reached the nutrient recommendations for vitamins A and C, calcium and—specifically among men—for iron more easily. Among men, energy intake was greater in the 1987-1988 survey overall, but lowest in the 1992 study. Among women, energy intake declined from the 1956-1961 study to 1987-1988 and was lowest among women in the 1992 study. These differences were not tested for statistical significance and may be due to differences in interviews, methods, or databases. The higher intakes in vitamins A and C was attributed to a higher consumption of fruit beverages. Intakes of riboflavin were reached less than recommended intake level and women had difficulty reaching recommended iron intake levels in the 1987-1988 study.

Nobmann also compared results of her 1992 dietary study with those of Heller and Scott. Nobmann *et al.* (1992) noted a decrease in traditional food contribution to intakes in energy, protein, lipid, iron, and vitamin C from the previous study. After a review of dietary studies conducted in Alaska, they concluded that the higher carbohydrate intake was associated with increasing market food consumption.

4.2.3 Greenland

Helms compared average food intakes of Angmagssalik Inuit evaluated in 1945 with intakes in 1978. He noted an increase in market food consumption and a decrease in traditional food consumption. In 1945, traditional food contributed 74% of the total energy intake, whereas they contributed only 22% in 1978.

4.2.4 Siberia

Mamleeva *et al.* (1996) compared results of their dietary study conducted in 1991-1992 with those obtained in 1982-1983. Authors noted a decreasing contribution of protein and lipid and an increasing contribution of carbohydrate and sugar contribution to total energy intakes. In 1992, they also observed higher saturated fatty acid and lower polyunsaturated fatty acid intakes. Variations in the types of fatty acid intake could be related to a lower traditional food consumption—such as marine mammals—and higher market food consumption. Finally, a greater proportion of obesity and diabetes cases was observed in 1982 compared to 1992.

In summary, the higher market food consumption observed in Canada in the last 20 years could be associated with a higher total energy intake. For Greenland and Siberia, a lower protein and lipid contribution to total energy intake and a higher carbohydrate and sugar contribution was noted. For

Alaska, the higher contribution of carbohydrates to total energy intake reflected a higher consumption of market foods. From the 1950's to the 1980's, Nobmann observed an increase in calcium and vitamin A and C intakes.

5. CONCLUSION

Modifications that Inuit populations brought to their diet are associated with market food integration. Market food consumption appears to be higher among young people for all circumpolar regions. The introduction of market food to the Inuit diet contributes to a slight decrease in traditional food intake, with this decrease varying by regions. For some isolated regions, traditional food intakes are still high and are comparable to those observed in past studies. Food intakes are different according to the degree of urbanization of Inuit communities as Schaefer and Steckle (1980) observed. The discovery of contaminants in the food chain led to undesirable changes in traditional food consumption. However, as yet it is still unclear whether these changes in eating habits truly came about due to a concern over PCB contamination, or whether they reflect a certain malaise and public reaction to the general state of the environment (Santé Québec 1994).

The replacement of traditional food by market food is not always desirable. In fact, several market foods have low nutritive value (junk foods) and are high in saturated fat and sugars. Lawn and Langner (1994) reported that substitution of traditional foods by market foods such as prepared meals is easier for Inuit, since they require less preparation. In the past, cooking traditional food was simple, and often foods were consumed raw. However, in some regions, in particular Alaska, market food supply appears to be better and the diet is more varied. Thus, the Alaskan Natives consumed more fruits and vegetables compared to other regions. Lawn and Langner noted in their report that the high consumption of sugar, soft drinks and fruit drink crystals without vitamin C found in Inuit communities is a nutritional and health concern. These foods provide very few other essential nutrients, often replace more nutritious foods, and leave less money available for more nutritious diet choices. In addition, the high sugar intake contributes to dental decay. Authors mentioned that if fruits were eaten more frequently as a snack, the diet would contain more fibre and essential vitamins and minerals. Conversely, the high consumption of high-fat snack foods, such as potato chips and chocolate bars, adds saturated fat to the diet. In excess, this can lead to higher blood cholesterol and promote heart disease.

Despite the fact that higher nutrient intakes have been observed in the 20 to 30 years, several recent dietary surveys report low intakes of vitamins A and C, folic acid, and calcium. We cannot assert that Inuit populations show a high risk of nutritional deficiencies. However, they are more likely to develop in these Inuit groups than in southern populations, since the recent availability and accessibility of market foods changed the eating habits of the Inuit.

The challenge now is to apply knowledge gained to educational programs on nutrition. The adoption of safe nutritional habits presents a two-fold challenge: to maintain aspects of the traditional diet, which have afforded the Inuit population a comparative advantage (such as a low prevalence of cardiovascular disease associated with high omega-3 fatty acids intake) and to include a greater variety of healthy market foods in the diet. While contaminants found in traditional foods from the aquatic chain might present a public health risk, these foods constitute a good source of several key nutrients (Kuhnlein 1989, 2000, Blanchet *et al.* 2000, Dewailly *et al.* 1996a). The availability of market foods will certainly increase from year to year. Substitution of traditional foods by market foods, without nutritional education, could lead to disabilities and chronic diseases (Dewailly *et al.* 2001, Kuhnlein 1989, 2000, Bjerregaard and Young 1998, Nobmann 1998, Wein 1986). Quality control in food supply, plus healthy market food choices, must be made available and accessible for Inuit populations. The promotion of health through nutrition among Inuit populations must take into account societal values of the traditional Inuit diet.

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