



## Inuit dietary patterns in modern Greenland

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## ORIGINAL ARTICLE

INUIT DIETARY PATTERNS  
IN MODERN GREENLAND

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## ABSTRACT

**Objectives.** The purpose of the study was to apply two different approaches of dietary pattern definition to data from Greenland and to analyse the contemporary dietary patterns of the Inuit in Greenland in relation to urbanization and socio-economic positions.

**Study design.** Cross-sectional population survey.

**Methods.** A total of 2,247 Inuit aged 18+ from 15 towns and villages in West Greenland (25% of all communities) were interviewed about their diet as part of a general health survey. A 67-item Food Frequency Questionnaire (FFQ) with portion sizes was used as the survey instrument. The analyses were based on 2,026 individuals who reported realistic daily energy intakes. Dietary patterns were determined by two different methods: a factor-cum-cluster analysis, and a normative approach based on adherence to dietary recommendations.

**Results.** The 2 approaches resulted in 6 respective and 5 partly overlapping dietary patterns. The distribution of patterns varied significantly according to age, gender, urbanization and socio-economic position. A healthy diet was most often reported by women aged 35+, who lived in towns and who belonged to the upper social stratum; an unhealthy diet was reported by young men and women irrespective of urbanization or social position; and a traditional diet was reported increasingly with age, among village residents and by hunters/fishermen and their families.

**Conclusions.** The two methodological approaches gave comparable results. The normative approach can be extended to other data sets and its results are directly applicable to dietary intervention, while the data-driven approach can identify novel patterns but is tied to the actual data set.

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**Keywords:** dietary patterns, Inuit, Greenland, factor analysis, cluster analysis, dietary recommendations

## INTRODUCTION

Inuit diet has attracted scientific interest due to its unique composition of meat, fat and organs of marine mammals, especially since an alleged low rate of coronary heart disease among the Inuit was attributed to their diet's high contents of long-chain n-3 fatty acids (1). The theory has given rise to a whole industry of fish oil supplementation, although the effect of n-3 fatty acids on heart disease is still debated (2,3). The Inuit diet in Greenland has changed as a result of the Westernization of the country, and the proportion of traditional food has been steadily decreasing over the past century. In 1901, the contribution of traditional food (seal and fish in particular) to the total energy intake was estimated at 83%, while in 1930 this proportion had decreased to 37% (4). This pronounced decrease over just 30 years is in contrast to the gradual decrease to 35% during the following 25 years (5). Since the 1950s, the relative decrease has again gained momentum: 21 E% in 1995 (6) and ca. 18 E% in 2006 (7,8).

While the change in the consumption of local food has been mostly a decrease in its proportion of the total diet and to some extent a diminished diversification of tissues consumed, there have been significant changes in the composition of the imported food. In 1930, imports were largely limited to grain, flour and sugar (4). In 1955 the situation was not much different (5), whereas today a whole range of farmed meat, fruit, vegetables, dairy products and nutrient-poor, high-calorie junk food is available.

Dietary pattern analysis differs conceptually from the study of the relationship between single nutrients and disease (9), and has recently been put into use in a variety of countries and in the study of different diseases (10–14) among Indig-

enous peoples of the Arctic (15). In the study of the association between Greenlandic diet and disease, focus has thus far been on single nutrients, such as n-3 fatty acids (16), single food items with high contents of n-3 fatty acids such as marine mammals (17) or contaminants present in marine mammals such as mercury (18), thus ignoring the contribution of saturated fatty acids, trans fatty acids, fruits, vegetables and refined sugar, which all make up increasing proportions of the diet in Greenland.

The purpose of the present article is to apply 2 different approaches of dietary pattern definition to an analysis of the contemporary dietary patterns of the Inuit in Greenland, to analyse the dietary patterns in relation to urbanization and socio-economic position and to relate the diet to the recommendations of the Greenland Board of Nutrition.

## MATERIAL AND METHODS

Data were collected as part of a country-wide health survey in Greenland between 2005 and 2007. A total of 2,374 adult inhabitants (aged 18+) were interviewed, made up of 2,247 Inuit and 127 Danes. Ethnicity was determined at enrolment in agreement by the interviewer and the participant. Fifteen towns and villages in West Greenland (25% of all communities) were selected as study areas to represent different community sizes and geographical locations. A random population sample was drawn from the central population register. Pregnant women, persons not born in Greenland or Denmark and persons who had moved out of the study area were excluded from the sample. Participation rate was 68% for Inuit and 39% for Danes; in the present article Danes were excluded.

Questionnaires were developed in Danish, translated into Greenlandic, back translated and revised. The interviews were conducted by native Greenlandic-speaking interviewers who had been trained in the study procedures, in the language of choice for the participant, which was most often Greenlandic. In addition to the interview, clinical testing and sampling of biological media were conducted. A full description of the methods is available (19).

We define traditional foods as meat, fat and organs from seals, other marine mammals including whales and walruses, species of fish and birds, including eggs. Locally hunted terrestrial species such as caribou and musk ox were included, along with berries which are also part of the traditional diet.

Information on diet was obtained by an interviewer-administered Food Frequency Questionnaire (FFQ) with portion sizes. Information was obtained from 2,238 of the 2,247 Inuit participants (99.6%). The FFQ was developed from information obtained through a 24-hour dietary recall (6). Questions were asked about 67 food items, including 23 local and 44 imported items. The numbers of servings per day, week, month or year were taken, and for local food items, the length of the harvesting season was recorded. Portion sizes were estimated from photos of 4 different serving sizes. Consumed weights (grams per day) were calculated as portions per day x portion size (x refers to length of season, if applicable). Missing information on portion size was substituted by gender-specific medians; for individual dietary items, portion size was missing in 1.0% of cases (range 0.2–5.5%). Missing information on season was substituted by medians; for individual dietary items, information on season was missing in 27% of

all cases (ranging from 14% for frozen blubber to 52% for walrus). The intake of energy, macronutrients and certain micronutrients and contaminants was calculated from published concentrations (20–23, Greenland National Board of Nutrition unpublished analyses). Individuals reporting an average daily intake of less than 3,350/2,100 kJ (men/women) or more than 17,000/ 15,000 kJ (n=212) were excluded from the analyses (24).

The average daily intake of energy was 9,882 kJ for men (SD 3,229) and 7,964 kJ for women (SD 2,809), equivalent to 1.4 (SD 0.50) times the estimated basal metabolic rate of the participants. The intake of marine food was validated by comparing the energy percentage from seal meat and organs, which contribute the most to mercury exposure, with measured total blood mercury (Pearson's  $r=0.58$ ,  $p<0.001$ ; unpublished results). A further validation of the intake of marine food against a number of biomarkers is underway.

Two different approaches were taken to identify dietary patterns: a data driven and a normative approach. The data driven approach consisted of a factor analysis, with factor scores subsequently entered into an analysis that identified clusters of participants with similar dietary patterns. First, the 67 dietary items were combined into 24 pre-defined food groups in order to minimize within-person variations in intakes of individual foods (Table I). A factor analysis of the energy percentages of the 24 pre-defined food groups was performed in SPSS v. 17.0 with the principal component extraction of 6 factors with Eigenvalues above 1.1 without rotation. The model specifications were chosen from inspection of the scree plot in order to obtain factors that were straightforward to interpret. The 6

factors explained 43% of the total variation in the data. A subsequent cluster analysis of the factor scores (SPSS two-step cluster algorithm) auto-identified 6 clusters.

The normative approach was based on dietary recommendations. Table II shows the recommendations of the Greenland Board of Nutrition. These recommendations were translated into operational criteria using externally approved threshold levels (for fat and refined sugar), or based upon judgement of the authors.

In the normative approach, 5 dietary patterns were identified: (1) a balanced diet according to the recommendations of the Greenland Board of Nutrition; (2) an unhealthy diet, with 25 E% or more from soda pop, fast food, snacks, sweets and sugar added to coffee or tea; (3) a traditional diet with 25 E% or more from local food; (4) a diet with 20 E% or more from imported meat; and (5) a mixed, standard diet that did not fall into any of the above-mentioned groups. Participants were

**Table I.** Food groups (n=24) defined from individual food items (n=65) in the Food Frequency Questionnaire.

| Food group <sup>a</sup> | Food item in FFQ             | Food group <sup>a</sup>                           | Food item in FFQ  |
|-------------------------|------------------------------|---|---|
| <i>Local food</i>       |                              | Fruit   | Apples, pears, bananas<br>Oranges, grapefruit<br>Other fresh fruit<br>Canned fruit  |
| Marine mammals          | Seal meat                    | Fruit juice<br>Soda pop<br>Potatoes<br>Vegetables | Fruit juice<br>Soda pop<br>Potatoes   |
|                         | Beluga and narwhal           |   |   |
|                         | Other whales                 |   |   |
|                         | Walrus                       |   |   |
|                         | Seal organs                  |   |   |
| Blubber                 | Muktuk                       |   | Mixed frozen vegetables<br>Carrots  |
|                         | Dried seal and whale meat    |   | Cabbage   |
|                         | Seal blubber with meat       |   | Tomatoes  |
| Fish                    | Frozen or salted raw blubber | Dairy, eggs                                       | Green beans<br>Other vegetables<br>Chicken eggs<br>Whole milk<br>Low fat milk, skimmed milk<br>Yoghurt<br>Cheese<br>Ice cream |
|                         | Cod                          |   |   |
|                         | Greenland halibut            |   |   |
|                         | Capelin                      |   |   |
|                         | Arctic char, salmon          |   |   |
|                         | Other fish                   |   |   |
|                         | Dried fish                   |   |   |
|                         | Mussels, clams, shrimp, crab |   |   |
| Canned fish             |                              |   |   |
| Land animals            | Caribou or musk ox meat      | Whole grain products                              | Coarse wheat bread<br>Rye bread<br>Oatmeal<br>Breakfast cereal  |
|                         | Caribou organs               |   |   |
| Wildfowl                | Guillemot                    | Cereal  | Fine wheat bread  |
|                         | Eider duck                   |   |   |
|                         | Other game birds             |   |   |
| Eggs                    | Eggs from game birds         | Refined grain products                            | Pasta<br>Rice<br>Pizza, burger<br>French fries  |
| Berries                 | Berries                      |   | Chips<br>Cakes, cookies<br>Candy<br>Jam, marmalade<br>Sugar added to tea and coffee<br>Butter on bread                        |
| <i>Imported food</i>    |                              | Fast food   |   |
| Red meat                | Beef                         | Snacks<br>Sweets                                  |   |
|                         | Pork                         |   |   |
|                         | Lamb                         |   |   |
| Poultry                 | Chicken, turkey, duck        | Sugar<br>Butter                                   |   |
| Processed meat          | Wieners, meatballs           |   |   |
|                         | Frozen or canned dishes      |   |   |
|                         | Cold cut meat, liver paste   |   |   |

<sup>a</sup>Coffee/tea and non-caloric beverages were not included in food groups.

grouped into dietary patterns as follows: If 25 E% or more came from food items categorized as unhealthy (soda pop, fast food, snacks, sweets, added sugar) the diet was classified as “Unhealthy.” Only 30 of the participants (1.5%) conformed to all 9 criteria of the balanced diet recommendations, and in order to get a group of some size, 7 positive criteria were set as the threshold for a balanced diet. Thus, if the diet adhered to at least 7 of the criteria in Table II, the diet was classified as “Balanced.” Most participants failed to meet these criteria because their intake of fat and refined sugar was higher than recommended. If the diet was neither “Balanced” nor

“Unhealthy,” and contained 25 E% or more from locally harvested food, it was classified as “Local food.” Finally, if the diet was neither “Balanced” nor “Unhealthy,” and contained 20 E% or more from imported meat, it was classified as “Imported meat.”

Statistical analyses were performed in SPSS v. 17.0. Models included ANOVA (Table VI) and General Linear Models with control for age and sex (Tables VII–VIII).

The study was ethically approved by the Commission for Scientific Research in Greenland. Participants gave their written consent after being informed about the study orally and in writing.

**Table II.** Recommendations of the Greenland Board of Nutrition and their translation into operational criteria.

| <b>Recommendation</b>                             | <b>Operational criteria</b>   | <b>Percent living up to recommendations</b> |
|---|---|---|
| Eat varied  | n/a   | -   |
| Eat local food; often fish                        | 1. 10 E% or more of local food<br>2. At least twice weekly consumption of fish        | 68.1<br>61.7                                |
| Eat fruit and vegetables daily                    | 3. At least daily consumption of fruit<br>4. At least daily consumption of vegetables | 42.0<br>35.2                                |
| Eat whole grains daily                            | 5. At least daily consumption of rye bread, whole grain wheat bread, oatmeal          | 75.8  |
| Reduce fat intake                                 | 6. Less than 30 E% from fat   | 34.7  |
| Eat less sugar, candy, chips and cakes            | 7. Less than 10 E% from refined sugar<br>8. Less than weekly consumption of chips     | 32.7<br>79.4                                |
| Drink water – drink less fruit syrup and soda pop | 9. Less than weekly consumption of fruit syrup and soda pop                           | 41.4  |
| Eat frequently but not a lot                      | n/a   | -   |
| Be physically active at least one hour per day    | n/a   | -   |
| Think about what you eat                          | n/a   | -   |

RESULTS

A total of 2,026 Inuit participants conformed to the criteria for inclusion (90%); 865 men and 1,161 women, with a mean age of 44.6 years (SD 14.6; range 18–95). The 5 groups of the normative approach are shown in Table III and the 6 groups of the data driven approach are shown in Table IV.

The group size was more even in the data-driven model ranging from 211 to 426, than it was in the normative model, which ranged from 110 to a rest group of 772 participants. The dietary patterns defined by the 2 approaches

shared some common characteristics, but were not similar (Table V). The patterns of the normative model were, to a varying extent, repeated in the data driven model: 69% of the balanced diet of the former was in the healthy diet group of the latter; 78% of the imported meat group of the former was in the same group of the latter; 73% of the local food and 45% of the unhealthy diet corresponded in the same way. The reverse was not true, since a large proportion of those in the normative “Standard diet group” were classified in the data driven groups of “Healthy diet,” “Imported meat” and “Bread and butter.”

**Table III.** Dietary groups from normative approach.

| Dietary group  | Characteristics  | n (%)      |
|----------------|--|------------|
| Balanced diet  | Adherence to at least 7 criteria from Table II (See text)                        | 110 (5.4)  |
| Imported meat  | >20 E% from imported meat  | 189 (9.3)  |
| Local food     | >25 E% from local food   | 452 (22.3) |
| Unhealthy diet | >25 E% from soda pop, fast food, snacks, sweets and sugar added to coffee or tea | 503 (24.8) |
| Standard diet  | None of the above  | 772 (38.1) |

**Table IV.** Dietary groups from data driven approach (factor/cluster analysis).

| Dietary pattern (cluster name) | Characteristic food items  | n (%)      |
|--------------------------------|--|------------|
| Healthy                        | Fruit, vegetables, dairy, whole grain                              | 392 (19.3) |
| Imported meat                  | Imported red meat and poultry                                      | 426 (21.0) |
| Seal                           | Seal and added sugar   | 327 (16.1) |
| Fish and local meat            | Fish, caribou, musk ox, wildfowl                                   | 211 (10.4) |
| Unhealthy                      | Soda pop, breakfast cereal, fast food, snacks, sweets, fruit juice | 348 (17.2) |
| Bread and butter               | Bread and butter   | 322 (15.9) |

**Table V.** Relation between the dietary groups defined by the normative and the data driven approach. Absolute numbers.

|                     | Normative model |               |            |                |               | Total |
|---------------------|-----------------|---------------|------------|----------------|---------------|-------|
|                     | Balanced diet   | Imported meat | Local food | Unhealthy diet | Standard diet |       |
| Data driven model   |                 |               |            |                |               |       |
| Healthy             | 76              | 16            | 52         | 15             | 233           | 392   |
| Imported meat       | 17              | 148           | 29         | 75             | 157           | 426   |
| Seal                | 3               | 2             | 203        | 101            | 18            | 327   |
| Fish and local meat | 10              | 7             | 129        | 44             | 21            | 211   |
| Unhealthy           | 1               | 10            | 4          | 230            | 103           | 348   |
| Bread and butter    | 3               | 6             | 35         | 38             | 240           | 322   |
| Total               | 110             | 189           | 452        | 503            | 772           | 2026  |

Shaded cells indicate similarity between dietary groups.

As a sensitivity analysis, we tested other specifications of the factor analysis. For instance, applying Varimax rotation to the factors resulted in 7 dietary groups instead of 6 by an identical cluster approach, while setting the threshold of extraction at Eigenvalues of  $\geq 1.0$  along with Varimax rotation resulted in 8 factors and 9 dietary clusters. Performing the cluster analysis directly on the 24 dietary groups instead of being preceded by a factor analysis resulted in only 2 clusters.

The age and sex patterns were rather similar for both models (Table VI). The proportion of participants with a balanced/healthy diet was

higher among women than among men, and generally increased with age. Imported meat was chosen equally by men and women and was most popular in the middle-age groups. The proportion of participants with a traditional Greenlandic diet was higher among men than women and increased considerably with age. The proportion of participants with an unhealthy diet was also similar among men and women and decreased considerably with age, while bread and butter were more often the choice of men.

The variation by urbanization was also quite similar for the 2 models (Table VII).

**Table VI.** Dietary patterns by age and sex in Greenland 2005–2007 (n=2026).

| Age group                | Men                |                     |                     |                   | p for age | Women               |                     |                     |                   | p for age | p for men: women |
|--------------------------|--------------------|---------------------|---------------------|-------------------|-----------|---------------------|---------------------|---------------------|-------------------|-----------|------------------|
|                          | 18–24<br>n=77<br>% | 25–34<br>n=121<br>% | 35–59<br>n=495<br>% | 60+<br>n=172<br>% |           | 18–24<br>n=120<br>% | 25–34<br>n=194<br>% | 35–59<br>n=674<br>% | 60+<br>n=173<br>% |           |                  |
| <b>Normative model</b>   |                    |                     |                     |                   |           |                     |                     |                     |                   |           |                  |
| Balanced diet            | 3.9                | 0.8                 | 1.8                 | 3.5               | 0.29      | 4.2                 | 1.5                 | 9.6                 | 10.4              | 0.001     | <0.001           |
| Imported meat            | 3.9                | 9.1                 | 11.1                | 1.7               | 0.001     | 10.0                | 15.5                | 10.4                | 2.9               | 0.001     | 0.18             |
| Local food               | 7.8                | 15.7                | 27.3                | 44.8              | <0.001    | 5.8                 | 9.8                 | 20.6                | 28.9              | <0.001    | <0.001           |
| Unhealthy diet           | 50.6               | 41.3                | 21.2                | 13.4              | <0.001    | 40.8                | 32.5                | 21.5                | 16.8              | <0.001    | 0.82             |
| Standard diet            | 33.8               | 33.1                | 38.6                | 36.6              | 0.64      | 39.2                | 40.7                | 37.8                | 41.0              | 0.82      | 0.38             |
| <b>Data driven model</b> |                    |                     |                     |                   |           |                     |                     |                     |                   |           |                  |
| Healthy                  | 3.9                | 4.1                 | 9.9                 | 16.9              | 0.001     | 14.2                | 16.5                | 29.5                | 33.5              | <0.001    | <0.001           |
| Imported meat            | 14.3               | 17.4                | 28.3                | 8.1               | <0.001    | 14.2                | 29.9                | 22.7                | 6.9               | <0.001    | 0.65             |
| Seal                     | 0.0                | 8.3                 | 19.2                | 31.4              | <0.001    | 1.7                 | 8.2                 | 15.9                | 24.9              | <0.001    | 0.02             |
| Fish and local meat      | 10.4               | 12.4                | 12.1                | 18.0              | 0.20      | 8.3                 | 4.1                 | 9.3                 | 9.2               | 0.13      | <0.001           |
| Unhealthy                | 51.9               | 38.8                | 10.1                | 2.3               | <0.001    | 51.7                | 29.9                | 11.4                | 5.8               | <0.001    | 0.37             |
| Bread and butter         | 19.5               | 19.0                | 20.4                | 23.3              | 0.80      | 10.0                | 11.3                | 11.1                | 19.7              | 0.02      | <0.001           |



**Table VII.** Dietary patterns according to urbanization in Greenland 2005–2007 (n=2026).

|                          | Capital<br>n=424<br>% | Towns >2,000 pop<br>n=666<br>% | Small towns<br>n=488<br>% | Villages<br>n=448<br>% | p      |
|--------------------------|-----------------------|--------------------------------|---------------------------|------------------------|--------|
| <b>Normative model</b>   |                       |                                |                           |                        |        |
| Balanced diet            | 5.4                   | 6.0                            | 6.5                       | 3.4                    | 0.15   |
| Imported meat            | 13.7                  | 12.0                           | 8.9                       | 1.8                    | <0.001 |
| Local food               | 12.3                  | 17.5                           | 19.6                      | 42.0                   | <0.001 |
| Unhealthy diet           | 23.9                  | 25.2                           | 24.8                      | 25.2                   | 0.97   |
| Standard diet            | 44.6                  | 39.4                           | 40.3                      | 27.7                   | <0.001 |
| Total                    | 100                   | 100                            | 100                       | 100                    |        |
| <b>Data driven model</b> |                       |                                |                           |                        |        |
| Healthy                  | 22.4                  | 19.8                           | 25.5                      | 6.8                    | <0.001 |
| Imported meat            | 24.1                  | 24.2                           | 25.5                      | 8.5                    | <0.001 |
| Seal                     | 8.2                   | 10.0                           | 15.1                      | 33.9                   | <0.001 |
| Fish and local meat      | 10.9                  | 10.5                           | 3.3                       | 17.6                   | <0.001 |
| Unhealthy                | 20.3                  | 18.2                           | 15.7                      | 14.2                   | 0.05   |
| Bread and butter         | 14.0                  | 17.3                           | 12.8                      | 18.9                   | 0.03   |
| Total                    | 100                   | 100                            | 100                       | 100                    |        |

Adjusted for age and sex in General Linear Models.

**Table VIII.** Dietary patterns according to household socio-economic group in Greenland 2005–2007 in persons aged 18–62 yrs (n=1458).

|                          | Hunters/<br>fishermen<br>n=251<br>% | Blue-collar<br>employees<br>n=868<br>% | White-collar<br>employees<br>n=339<br>% | p      |
|--------------------------|-------------------------------------|--|---|--------|
| <b>Normative model</b>   |                                     |  |   |        |
| Balanced diet            | 4.4                                 | 5.0                                    | 6.8                                     | 0.37   |
| Imported meat            | 3.7                                 | 10.9                                   | 14.9                                    | <0.001 |
| Local food               | 37.6                                | 18.4                                   | 11.0                                    | <0.001 |
| Unhealthy diet           | 26.0                                | 25.6                                   | 25.5                                    | 0.99   |
| Standard diet            | 28.3                                | 40.2                                   | 41.7                                    | 0.001  |
| Total                    | 100                                 | 100                                    | 100                                     |        |
| <b>Data driven model</b> |                                     |  |   |        |
| Healthy                  | 12.9                                | 19.9                                   | 24.5                                    | 0.001  |
| Imported meat            | 15.9                                | 25.0                                   | 27.2                                    | 0.003  |
| Seal                     | 23.9                                | 13.3                                   | 7.5                                     | <0.001 |
| Fish and local meat      | 20.1                                | 8.3                                    | 9.7                                     | <0.001 |
| Unhealthy                | 16.0                                | 18.3                                   | 20.4                                    | 0.35   |
| Bread and butter         | 11.3                                | 15.2                                   | 10.8                                    | 0.07   |
| Total                    | 100                                 | 100                                    | 100                                     |        |

Adjusted for age and sex in General Linear Models.

The diet in the villages especially differed from that of the rest of the country, with fewer participants eating a balanced diet or a diet based on imported meat, while many relied on local food. Surprisingly, there was little difference with regard to the unhealthy dietary patterns.

In addition to the variation according to urbanization, local food patterns varied according to geography and due to the availability of specific species. On the northern west coast, the key species consumed were marine mammals, in particular different species of seals. On the central west coast, most of the local food was caribou, musk ox, wildfowl and fish. In the south, seal, wildfowl and cod were consumed.

The dietary patterns of socio-economic groups were also largely similar, regardless of which model was considered (Table VIII). White-collar employees were more frequent consumers of a balanced/healthy diet, but this was not statistically significant in the normative model. They were also more frequent consumers of imported meat than were hunters and fishermen, and less often consumers of traditional Greenlandic food, while blue-collar employees were in between. Again, the unhealthy dietary patterns and the bread and butter pattern showed no socio-economic differences.

## DISCUSSION

Using 2 different approaches, we identified 2 sets of dietary patterns for Inuit in Greenland. The dietary patterns share certain characteristics, but were not identical. We compared our results with a study of dietary patterns among the Sami of Norway (15). Both of our approaches identified a balanced/healthy diet which corresponded to the pattern of fruit and vegetable consumption among the Sami. Both approaches identified patterns characterized by the consumption of locally harvested food, which was also the case among the Sami. However, both identified a pattern of imported food which had no correspondence in the Sami study. Also, both approaches identified an unhealthy pattern which had no correspondence among the Sami. Standard/average dietary patterns were identified by the normative approach in Greenland and among the Sami, while the latter had a “Westernized- traditional-marine” pattern, and the data driven approach in Greenland had a pattern characterized by bread and butter.

One approach, the data driven model, was chosen among statistical models for data reduction, that is, factor analysis and cluster analysis. The other approach, the normative model, was based on the official nutritional guidelines for Greenland, which we operationalized in order to define dietary groups among the survey participants. Data driven models can be based on factor analysis and/or cluster analysis and a variety of parameters can be specified, resulting in different numbers and contents of dietary patterns (9). As an example of a data driven model, we chose a method used before among Indigenous peoples in the Arctic (15). Unfortunately, there is not much

guidance in the literature to assist researchers in choosing the parameters for studies such as these and no theoretically founded reasons for choosing one set of specifications over another, so the resulting patterns are subjective to a certain extent, in spite of the cogency of the statistical methods. For example, in a study among the Sami, the number of factors was chosen based on the interpretability of the factors, and the number of clusters on the interpretability of the clusters (15).

In his authoritative textbook on nutritional epidemiology, Willett warns against using factor analysis (24). A main advantage of the data driven model is that dietary patterns that were not known before may emanate from the results. The main disadvantage of this model is that the patterns are specific to the data set in which they were developed, and cannot be used on a different data set, for example, for comparisons of the diet of 2 populations.

Beyond its extensibility to other data, the main advantage of the normative model is that it is rooted in existing knowledge about diet and in dietary recommendations. Whereas the data driven model is explorative and suitable for further scientific analyses, the normative model is a practical tool for public health.

Nine participants failed to complete the FFQ and the calculated energy intake was below or above reasonable limits for another 212, leaving 2,026 (90%) with useable dietary information. On the one hand, the high proportion of participants with dietary information was partly obtained by substituting missing information on portion size with gender-specific medians in an average of 1.0% of cases. To the researchers this seemed to be a small uncertainty to introduce. Information on seasonality, on the other hand, was missing

in as many as 27% of cases. For only 7 of 23 types of country food, the median length of the season was indicated as less than 12 months, that is, for capelin, char, game birds and their eggs and berries. These species contributed only 11% of the total energy consumption from country food. This raises the question to what extent seasonal availability of country food is important to take into consideration in modern Greenland, where deep freezers are generally available to most households. However, disregarding the information on seasonality, the total energy consumption from country food was estimated at 2,053 kJ/day compared with 1,689 kJ/day when calculations included information on seasonality, a difference of 22%. Based on this background, it is advisable to improve methods to include information on seasonality in future dietary surveys in Greenland.

The total energy intake corresponded to 98% and 120% of the reported energy intake in men and women from the U.S. in a 1994 study, respectively (24), and to 90% of the reported energy intake of Alaska or Canadian Inuit in the 1970s and 80s (25). The FFQ captured, on average, 1.4 times the estimated basal metabolic rate of the population; 48% of the participants were within the range of 1.2–2.0, with 40% below 1.2. Willett (24) argues that a reported energy intake below 1.2 times the basal metabolic rate is unlikely to be correct, but that excluding participants with less than 1.2 times their basal metabolic rate in most data sets would lead to a substantial loss of subjects. Accordingly, we chose to use a fixed energy intake as the lower cut point for inclusion. The estimated energy intake relative to the basal metabolic rate was similar for men and women, decreased with age and

was higher in villages than in towns (data not shown). This was all in keeping with existing knowledge about the variation in physical activity level, and thus supported the assumption that the FFQ captured a large and similar proportion of the true total energy intake in subgroups of the population as well. There was a statistically significant correlation between a traditional diet and blood mercury with a Pearson's  $r=0.58$ . This is at the same order of magnitude as the correlation between blood mercury and FFQ reported in other studies from Greenland (6), and the correlations between various biomarkers and calculated dietary intake from other studies (24) and further supports the validity of the FFQ.

The two models exhibited, to large extent, similar distributions according to age, sex, urbanization and socio-economic group, and it is not possible based on these results to categorize one model as more accurately describing the data. Further analyses of the distribution of biomarkers such as RBC fatty acids or blood selenium (as markers for a marine diet) may help to determine advantages of one model over the other.

The results tell us that only few adult Inuit live up to the recommendations of the National Board of Nutrition. Most failed to meet the recommendations because of a high intake of fat and/or refined sugar. There is a large group whose diet is high in locally harvested marine mammals and fish, and another large group whose diet is high in empty calories. It is especially older people who adhere to the traditional diet and young people whose eating habits are unhealthy, while especially women aged 35 and above eat healthy. To the extent that this represents a generational pattern, there is an urgent need for dietary

intervention in order to control the already rampant epidemic of obesity and diabetes in Greenland (26,27).

Future studies should include an analysis of the effects on dietary pattern identification of different specifications of the factor/cluster approach. Furthermore, analyses of associations of dietary patterns with cardiovascular risk factors should complement and extend the already existing analyses of associations of n-3 fatty acids with these risk factors.

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### REFERENCES

1. Dyerberg J, Bang HO. A hypothesis on the development of acute myocardial infarction in Greenlanders. *Scand J Clin Lab Invest* 1982;42(suppl 161):7–13.
2. Hooper L, Thompson RL, Harrison RA, et al. Risks and benefits of omega 3 fats for mortality, cardiovascular disease, and cancer: systematic review. *BMJ* 2006;332(7544):752–760.
3. Whelton SP, He J, Whelton PK, et al. Meta-analysis of observational studies on fish intake and coronary heart disease. *Am J Cardiol* 2004;93(9):1119–1123.
4. Bertelsen A. Grønlandsk medicinsk statistik og nosografi II. Sundhedsvilkaarene i Grønland [Greenland medical statistics and nosography II. Health conditions in Greenland. In Danish]. *Meddr Grønland* 1937;117:2.
5. Uhl E. Nogle undersøgelser af grønlandske levnedsmidler og kostforhold [Some investigations of food and diet in Greenland. In Danish]. *Beretninger vedrørende Grønland* 1955;3.
6. Pars T. Forbruget af traditionelle grønlandske fødevarer i Vestgrønland [The use of traditional Greenlandic food in West Greenland. In Danish]. [Dissertation.] Copenhagen, National Institute of Public Health, Writings on Greenland 2000;11.
7. Hansen JC, Deutch B, Odland JØ. Dietary transition and contaminants in the Arctic: emphasis on Greenland. *Circumpolar Health Supplements* 2008; 2. 96 p.
8. Jeppesen C. Kost [Diet. In Danish]. In: Bjerregaard P and Dahl-Petersen IK, editors. *Befolkningsundersøgelsen i Grønland 2005–2007*. Copenhagen: National Institute of Public Health, Writings on Greenland; 2008. p. 96–108.

9. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* 2002;13(1):3–9.
10. Dam RB van, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. *Ann Intern Med* 2002;136(3):201–209.
11. Fung TT, Willett WC, Stampfer MJ, Manson JE, Hu FB. Dietary patterns and the risk of coronary heart disease in women. *Arch Intern Med* 2001a;161(15):1857–1862.
12. Fung TT, Rimm EB, Spiegelman D, Rifai N, Tofler GH, Willett WC, Hu FB. Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. *Am J Clin Nutr* 2001b;73(1):61–67.
13. Martínez-Ortiz JA, Fung TT, Baylin A, Hu FB, Campos H. Dietary patterns and risk of nonfatal acute myocardial infarction in Costa Rican adults. *Euro J Clin Nutr* 2006;60(6):770–777.
14. Hu FB, Rimm EB, Stampfer MJ, Ascherio A, Spiegelman D, Willett WC. Prospective study of major dietary patterns and risk of coronary heart disease in men. *Am J Clin Nutr* 2000;72(4):912–921.
15. Brustad M, Parr CL, Melhus M, Lund E. Dietary patterns in the population living in the Sámi core areas of Norway. *Int J Circumpolar Health* 2008;67(1):82–96.
16. Dyerberg J. Coronary heart disease in Greenland Inuit: a paradox. Implications for western disease patterns. *Arctic Med Res* 1989;48(2):47–54.
17. Bjerregaard P, Pedersen HS, Mulvad G. The associations of a marine diet with plasma lipids, blood glucose, blood pressure and obesity among the Inuit in Greenland. *Euro J Clin Nutr* 2000;54(9):732–737.
18. Weihe P, Hansen JC, Murata K, Debes F, Jørgensen P, Steuerwald U, White RF, Grandjean P. Neurobehavioural performance of Inuit children with increased prenatal exposure to methylmercury. *Int J Circumpolar Health* 2002;61(1):41–49.
19. Bjerregaard P. Inuit Health in Transition – Greenland survey 2005–2008. Population sample and survey methods [cited 2009]. Available from: [http://www.sifolkesundhed.dk/upload/metoderapport\\_endelig.pdf](http://www.sifolkesundhed.dk/upload/metoderapport_endelig.pdf).
20. Andersen SM. Vitamins and minerals in the traditional Greenland diet. National Environmental Research Institute, Denmark. NERI Technical Report, No. 528. 2005 [cited 2010 Jan 22]. Available from: [http://www.dmu.dk/Udgivelser/Faglige+rapporter/Nr.+500-549/Abstracts/FR528\\_uk.htm](http://www.dmu.dk/Udgivelser/Faglige+rapporter/Nr.+500-549/Abstracts/FR528_uk.htm)
21. CINE. Traditional Food Composition Nutribase. Québec: CINE, 2005 [cited 2007 Dec 1]. Available from: <http://www.mcgill.ca/cine/resources/nutrient/>.
22. Health Canada. Canadian Nutrient File v. 2007b [cited 2007 Dec 1]. Available from: [http://www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/index\\_e.html](http://www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/index_e.html).
23. National Food Institute. Danish Food Composition Databank, ed. 7.01. Copenhagen: Technical University of Denmark, 2008 [cited 2007 Dec 1]. Available from: [www.foodcomp.dk](http://www.foodcomp.dk).
24. Willet W. *Nutritional Epidemiology*. Oxford: Oxford University Press, 1998. 514 p.
25. Shephard RJ, Rode A. The health consequences of “modernization”: evidence from circumpolar peoples. Cambridge: Cambridge University Press, 1996. 306 p.
26. Jørgensen ME, Bjerregaard P, Borch-Johnsen K. Diabetes and impaired glucose tolerance among the Inuit of Greenland. *Diabetes Care* 2002;25(10):1766–1771.
27. Young TK, Bjerregaard P, Dewailly E, Risica PM, Jørgensen ME, Ebbesson SEO. Prevalence of obesity and its metabolic correlates among the circumpolar Inuit in 3 countries. *Am J Public Health* 2007;97(4): 691–695.

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