INCREASING OVERWEIGHT IN GREENLAND: SOCIAL, DEMOGRAPHIC, DIETARY AND OTHER LIFE-STYLE FACTORS

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ABSTRACT

Objectives. In several Arctic countries, weight gain is very evident among the local populations and the percentages of overweight and obese persons are increasing rapidly. Since the development of overweight among the Arctic populations seems to coincide with the westernization of their diet and other life-style factors, it is tempting to hypothesize that the transition to carbohydrate- and fat-rich western food causes the weight gain. The high relative content of (n-3) fatty acids in traditional foods presumably provides some protection against cardiovascular diseases, type 2 diabetes and various other diseases of affluent industrialized societies. In the present study, we have investigated the recent weight gain in Greenland and have tried to relate it to social factors, present dietary habits and other life-styles.

Study design. The cross-sectional study, which was part of the Arctic Monitoring and Assess Programme, included 410 men and women (18-49 years) from 5 districts in Greenland. It was based upon questionnaires including a dietary survey, anthropometric measurements and blood lipid analyses.

Results. Obesity (Body Mass Index (BMI) > 30 kg/m², corresponding to about 19% of the participants) increased with age, was most prevalent among higher household economic levels, and correlated with neither local, nor imported food intake.

Conclusion. Overweight was not found to be correlated with either western, or traditional food composition. Obesity had adverse effects on several health indicators, serum triglyceride, HDL and the cardiovascular risk index, (Chol-HDL)/HDL and TG/HDL, counteracting the positive effects of (n-3) fatty acids and should be considered as a serious health risk for the Greenlandic population. (Int J Circumpolar Health 2005;64(1):86-98)

Keywords: Greenland, obesity, social factors, diet, plasma lipids
INTRODUCTION

In many countries, the average body weights of the populations are increasing rapidly. This is evident both in industrialized countries and in developing countries. In particular, weight gain is very evident among the local Inuit populations of several Arctic countries and the proportion of overweight and obese persons is increasing rapidly (1).

Since the development of overweight among the Arctic populations seems to coincide with the westernization of their diet and other life-style factors, it is tempting to hypothesize that the transition to carbohydrate- and fat-rich western food is causing the weight gain. Modernization also creates a more complicated social economic structure, with a more uneven income distribution than the previous egalitarian hunter society. In many countries, the increase in overweight is observed mainly among the lower social economic classes (2, 3, 4). As westernization and modernization have arrived earlier in the larger towns in Greenland weight, increase would also be expected to develop earlier in larger towns.

However, westernization is a complex transition and Bjerregaard et al. (5) found that obesity in Greenland increased with the earlier stages of westernization and decreased during later stages.

The diets of Arctic Indigenous Peoples consist of both traditional food, and imported (market) foods. Although it varies by country, locality, sex and age group, traditional food provides 10 - 40% of the total energy intake, and this percentage has decreased over the last 30 - 40 years (6). In Greenland, recent dietary surveys have shown that the relative intake (weight) of traditional food is 25 - 30% (6,7,8). However, the compositions of the Greenlandic food and imported Danish food vary according to availability, depending mainly on season. In general, the diet is more versatile in southern and western Greenland.

The physical activity level, both as part of work and during leisure time, has also changed (9) and, now, less than 10% of the population has heavy physical work (hunters and fishermen), but, when work and leisure activities are considered together, 32% of the population has a high level of physical activity. The most popular leisure-time activities are hunting, fishing and preparing traditional food. Apart from hunting and fishing, there are not many possibilities for outdoor physical activities.

The traditional foods are the main contributors of protein, fat, most minerals (Fe, Zn, Se, I), vitamin D and, especially, of the essential long chain (n-3) fatty acids, which, in several ways, can be considered as health-promoting. The high relative content of (n-3) fatty acids in the traditional/country foods presumably provides some protection against cardiovascular diseases, type 2 diabetes and various other diseases of affluent, industrialized societies (10). The question is, does the traditional diet composition, rich in (n-3) fatty acids and low in saturated and total fat, also protect against the overweight that often precedes and correlates with the development of the mentioned diseases (long chain (n-3) fatty acids have been found to influence fat metabolism with weight-reducing effects (11,12). Or is the overweight simply a consequence of excessive energy intake relative to the energy needs?

At present, the best indicators available for traditional food intake of marine origin are the
relative concentrations of (n-3) fatty acids in various human lipid fractions, e.g. plasma phospholipids. The correlation between the intake of traditional food items measured by dietary surveys and blood levels of fatty acids has been demonstrated in both groups and populations (6,7,13,14). Thus, in order to analyze dietary risk behaviour, this study has aimed to demonstrate the correlation between individual dietary habits, other life-styles, plasma fatty acids, and various health indicators, such as blood lipids, body weight and the body mass index (BMI).

METHODS

Design and study population
The protocol of the studies was in accordance with the Helsinki Declaration II, accepted by the Ethical Committee for Scientific Investigations in Greenland, and all the participants gave informed written consent. The project is part of the human health program of the ongoing circumpolar "Arctic Monitoring and Assessment Programme" AMAP (15). The locations included four smaller districts (municipalities), of which two were in east Greenland, including Ittoqqortoormiit (Scoresbysund; population = 551) in the year 1999, and Tasiilaq (population = 2,913) in 2000, one was in west Greenland, Uummannaq, (population = 2,761) in 1999, and one was in north-west Greenland, Qaanaaq (population = 864), in 2003. The study also included one larger town in west Greenland, Sisimiut (population: 5,371), in 2003. Results are presented from 192 men and women from the east Greenland municipalities, Scoresbysund and Tasiilaq, and 221 from the locations inwestern Greenland, Sisimiut, Uummannaq and Qaanaaq.

The participants were young to middle-age (18 - 49 years), randomly drawn from the public register, and were all of Inuit decent, defined as having more than two Greenlandic grandparents. 14 separately selected non-smokers from Uummannaq were also included (14). All participants answered the standard questionnaire (developed by the Danish National Institute of Public Health for the Arctic Monitoring and Assessment Programme, AMAP. It included questions about demographic and life-style parameters, such as current and previous smoking levels, drinking habits and a simple questionnaire with 14 food items and 6 frequency categories. The participants were also asked separate questions about the monthly number of Danish, or Inuit meals.

Dietary Survey
In addition, the participants answered a more detailed semi-quantitative food frequency questionnaire, FFQ, adapted from (16), which consisted of 60 food items, namely 35 local Greenlandic food products, including mainly local fish, mammals, birds and local berries, and 25 imported Danish food types, including mainly meat products, grain, bread, milk products, fruit and vegetables. There were 10 frequency categories, ranging from once a year to several times a day, and all categories were used. Danish Standard portion sizes were used to estimate daily food intakes, expressed in grams, except for local meat and fish, for which the portion sizes were set 30% higher. The intake of alcoholic beverages is calculated from the national import statistics and distributed among men and women relative to their...
reported intake. Since not all possible available food items are included in a 60-item FFQ, the total estimated intake will be an underestimation of the real intake.

No nutrient database exists for Greenlandic food items, so macronutrients were calculated using a Danish nutrient table for imported food items (17) and using Canadian data for the local Arctic food items (18).

Calculated energy needs were obtained using a basal metabolic rate (BMR) and physical activity level (PAL) for a similar age and weight group. The PAL used was 1.6, which is equivalent to the "low physical activity" also used as the reference value for the Danish population (19, 20).

Anthropometric and social economic factors.
A medical doctor performed all the sampling and measured the weight and height of the participants, who wore underwear, or very light indoor clothes, and no shoes. The participants were classed into three BMI groups (normal < 25 kg/m², overweight 25 - 30 kg/m², and obese > 30 kg/m²).

Occupation was divided into 8 categories:
1. Hunter (full-time sealer, whaler, or fisherman, 12.2%)  
2. Self-employed (business man, 2.5%)  
3. Civil servant (20.7%)  
4. Skilled worker (5.7%)  
5. Unskilled worker (36.9%)  
6. Housewife (women not employed outside the home, 2.2%, 4 out of 9 "house-wives" were wives of hunters)  
7. Student (young person still taking education at technical, or merchant school, but not university, 4.7%)  
8. Retired/unemployed (more or less permanently on social welfare, or pension, but not age-retired, 13.7%).

Based upon the reported occupation of both man and wife, the participants were also divided into 5 "household economic levels", of which level 5 was the highest, including the combined income level of man and wife with, for example two self-employed, or fully employed persons. Level 1 comprised students, retired and unemployed persons and, in some cases, single person households.

School education was divided into 3 levels: 8th grade, 9-10th grade and 11-12th grade. The demographic and anthropometric results were gathered and analyzed along with blood lipids, fatty acid profiles, heavy metals and persistent organic pollutants (POPs). The contaminant results will be published elsewhere.

Finally, for the comparison of anthropometric data, retrospective material from 1976 was also included, comprising information about hunters in the Uummannaq district made available by Dyerberg (personal communication).

Analysis of indicators in blood samples
Determinations of plasma phospholipid fatty acids (indicators of the dietary content of traditional food), total plasma lipids, cholesterol and serum triglyceride levels, were performed in accredited laboratories in Canada (7,13,14,15). HDL, LDL and total cholesterol were determined at Aarhus University hospital.

Cholesterol, HDL and triglyceride levels, and the Chol-HDL/HDL ratio, were used as cardiovascular disease risk indices. The results were also referred to the ratio between triglyceride and HDL (Trigl/HDL), which has recently been used as an indicator of the
so-called metabolic syndrome with high risk of type 2 diabetes and CHD (21); see table VI.

Statistics
All the data were analyzed using the SPSS statistics program, version 10.0. Descriptive univariate analyses, and bivariate and partial correlation analyses, were carried out for almost all included variables. Spearman coefficients were used. Arithmetic means were calculated and compared by an independent samples t-test. Geometric means, medians and ranges were published previously by Deutch (6, 7). Multiple linear regression analyses were performed for a number of plausible models. Significance levels were p < 0.05*, p < 0.01 **, p < 0.001 ***.

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RESULTS

Dietary habits
The average intakes of macronutrients, expressed in grams and kilo-Joules per day, are shown in table I compared to the total energy

Table I.
Macronutrients and energy intake results from semiquantitative food frequency questionnaire among 355 Greenlandic men and women from five districts 1999-2003.

| Macronutrients/energy-mean values | men (n=187) | women (n=168) | NNR b |
|----------------------------------|------------|--------------|-------|
| Carbohydrates, local products g/day | <1         | <1           |       |
| imported products g/day          | 198        | 191          |       |
| added sugar g/day (E%)           | 90 (14.2 E%) | 83 (15.3 E%) | <10 E% |
| total kJ/day (E%)                | 3383 (31.6 E%) | 3264 (35.4 E%) | 55 E% |
| Fats, local products g/day       | 30         | 31           |       |
| imported products g/day          | 58         | 56           |       |
| total kJ/day (E%)                | 3382 (31.6 E%) | 3306 (35.8 E%) | <30 E% |
| Proteins, local products g/day   | 53         | 54           |       |
| imported products g/day          | 47         | 46           |       |
| total kJ/day (E%)                | 1843 (17.2 E%) | 1853 (20.1 E%) | <15 E% |
| Alcoholic drinks, kJ/day (E%)    | 2100 (19.5 E%) | 800 (8.6 E%) |       |
| Pure alcohol, kJ/day (E%)        | 1123 (10.5 E%) | 620 (6.7 E%) | <5 E% |
| Local products, kJ/day (E%)      | 2041 (19.1 E%) | 2096 (22.6 E%) |       |
| Total intake, kJ/day             | 10700      | 9223         |       |
| Total intake, Denmark kJ/day a   | 11400 (n=904) | 8700 (n=999) |       |
| Calculated energy needs, reference values, BMR x PAL (1.6 low physical activity) b | 11600 | 9300 |   |

a "Danskernes Kostvaner 1995" (18)
b "Nordiska Näringsrekommendationer 1996" (17)
Table II.
BMI distribution in Greenland according to district (population size in parenthesis), sex and ascending age tertiles (n=406) age (18-49 years). BMI, kg/m², increased with age in all districts (p<0.0001***).

| DISTRICT       | Sex    | Age tertiles | BMI Mean (SD) | Overweight % | Obese % |
|----------------|--------|--------------|---------------|--------------|---------|
| 1 Scoresbysund | men    | 1            | 25.11 (3.20)  |              |         |
| (551)          |        | 2            | 26.80 (4.04)  | 30.0         | 16.0    |
|                |        | 3            | 27.20 (4.00)  |              |         |
|                | women  | 1            | 24.49 (4.08)  | 39.0         | 22.0    |
|                |        | 2            | 27.09 (5.09)  |              |         |
|                |        | 3            | 30.44 (6.19)  |              |         |
|                | Total  |              | 26.79 (4.68)  |              |         |
| 2 Tassiilaq    | men    | 1            | 25.60 (2.82)  | 35.1         | 18.9    |
| (2913)         |        | 2            | 26.44 (3.12)  |              |         |
|                |        | 3            | 26.75 (4.44)  |              |         |
|                | women  | 1            | 26.28 (5.00)  | 33.3         | 16.7    |
|                |        | 2            | 25.46 (4.51)  |              |         |
|                |        | 3            | 24.76 (6.79)  |              |         |
|                | Total  |              | 25.99 (4.49)  |              |         |
| 4 Sisimiut     | men    | 1            | 25.36 (4.08)  | 42.3         | 17.3    |
| (5371)         |        | 2            | 27.07 (3.46)  |              |         |
|                |        | 3            | 28.20 (3.41)  |              |         |
|                | women  | 1            | 25.28 (5.01)  | 30.0         | 25.0    |
|                |        | 2            | 27.67 (6.11)  |              |         |
|                |        | 3            | 27.73 (6.92)  |              |         |
|                | Total  |              | 26.61 (4.88)  |              |         |
| 6 Uummanaq     | men    | 1            | 26.34 (1.18)  | 42.6         | 8.5     |
| (2761)         |        | 2            | 24.85 (3.49)  |              |         |
|                |        | 3            | 26.35 (2.85)  |              |         |
|                | Total  |              | 25.60 (3.19)  |              |         |
| 8 Qaanaaq      | men    | 1            | 24.49 (3.52)  | 27.9         | 32.6    |
| (864)          |        | 2            | 28.44 (5.34)  |              |         |
|                |        | 3            | 28.75 (4.23)  |              |         |
|                | women  | 1            | 24.17 (2.49)  | 34.7         | 14.4    |
|                |        | 2            | 24.19 (2.93)  |              |         |
|                |        | 3            | 27.44 (4.42)  |              |         |
|                | Total  |              | 26.58 (4.42)  |              |         |
|                | Total  |              | 26.39 (4.48)  | 35.0         | 18.8    |

All 5 districts

*Note: BMI, Body Mass Index; Overweight: BMI > 25; Obese: BMI > 30.*
intake by a similar age-group of Danish men and women (20), and to calculated energy needs (BMR x PAL) for the same age and weight group (19). For both men and women, the calculated total energy intakes were slightly lower than the applied reference values for energy needs. However, as mentioned above, an FFQ is likely to underestimate the total energy intake. Nevertheless, the total energy intake was consistent with calculated energy needs for women and was only 8% below the calculated level for men. The consumed weights of imported food products were consistent with the Greenland import statistics.

The relative content of local Greenlandic products was about 21% of the total energy. The relative composition of macronutrients (E%) deviated in several ways from the Nordic nutritional recommendations, NNR. The carbohydrate intake in general was lower than the NNR, but the intake of added sugar was higher. The fat and protein intakes were only slightly higher than the NNR, but the fat intake was lower than in Denmark (19). The alcohol E% was much higher than the NNR, especially among men.

**Anthropometric measures and socio-demographic conditions**

During the period 1999-2003, the average BMI in Greenland based upon 413 participants from five districts, was 26.4 ± 4.5 kg/m². Basically, no differences in mean BMI were found between the districts, which included both smaller settlements, Scoresbysund and Qaanaaq, and the larger town, Sisimiut. Men and women had the same average BMI (table II).

The average height for men was 1.71 m and that for women was 1.59 m. Neither of these values varied between districts. The average weights were 77 kg and 66 kg for men and women, respectively. BMI increased with age in all districts with a highly significant trend (r = 0.21, p < 0.0001***; table II). BMI was significantly lower among smokers (p < 0.01**), but previous smokers were often heavier than individuals who had never smoked. Thus, some BMI increase may be an effect of a recent smoking cessation.

Based on the total material, there was a very slight, borderline significant (p = 0.066) decline of BMI with higher school education, but this was most evident in the two smallest districts, Ittoqqortoormiit and Qaanaaq. Another indicator of educational level was the ability to speak Danish. A higher BMI was found among participants with poor, or no, Danish compared to those who spoke Danish well (borderline significance, p = 0.069).

**Dietary habits and BMI**

On an individual basis, none of the dietary factors, such as the frequencies of 35 Greenlandic, or 25 Danish food items, or meals, or plasma levels of (n-3)/(n-6) fatty acids, showed any significant correlations with the BMI. Thus, there were no correlations between the BMI and the intake of fast food, coca cola, or other soft drinks, butter, cheese, milk products, or added sugars in general.

However when the participants were categorised into the three BMI groups, the overweight and obese reported significantly lower monthly intakes of Danish meals. This
was supported by significantly lower plasma C18:2 (n-6), and higher C20:4(n-6) and (n-3)/(n-6) (independent samples t-test), yielding a fatty acid profile which indicates a higher consumption of local food. However, both the BMI and the consumption of local food are normally higher among older persons and, after adjustment for age, these predictors were no longer significantly correlated with the BMI. In addition, there were no significant differences between the BMI groups with regards to total energy intake, or the intake of carbohydrates, fat, or protein, although these numbers were all slightly higher in the normal weight group.

BMIs were unevenly distributed according to occupation. The lowest average BMI was found among students (young) and early retired, or unemployed persons (BMI = 24.7 and 24.9 kg/m², respectively). The highest average BMI was found among self-employed business men (29.1 kg/m²) followed by skilled workers (28.0 kg/m²) and hunters/fishermen (26.7 kg/m²).

The association with occupation was confounded by an uneven distribution of smoking habits. For most occupations never-, and previous-smokers were heavier than smokers. However, this was not the case for housewives, and retired and unemployed persons.

The effect of smoking alone could not account for the differences in BMI between different occupations.

Table III.
Mean Body Mass Index (BMI, kg/m²), age and n-3/n-6 ratio of plasma fatty acids in men and women 18-49 years at different Household economic levels (1-5).

| Household economic levels | BMI     | Age     | Plasma n-3/n-6 |
|--------------------------|---------|---------|----------------|
| 1                        | 24.6 (3.7) | 25.6 (7.7) | 0.33 (0.19) |
| N                        | 31      | 31      | 31             |
| 2                        | 25.7 (4.8) | 31.2 (8.1) | 0.39 (0.24) |
| N                        | 80      | 80      | 74             |
| 3                        | 25.9 (4.1) | 33.3 (7.9) | 0.46 (0.27) |
| N                        | 123     | 123     | 118            |
| 4                        | 27.4 (4.7) | 34.9 (6.3) | 0.47 (0.31) |
| N                        | 134     | 134     | 126            |
| 5                        | 27.5 (4.3) | 36.4 (7.0) | 0.47 (0.32) |
| N                        | 28      | 28      | 28             |
| Total                    | 26.4 (4.5) | 33.0 (7.8) | 0.44 (0.28) |
| N                        | 396     | 396     | 377            |

Household economic levels were based on the combined income level of man and wife, thus single persons most often range in the lowest category and category 5 include two fully employed or self-employed persons. Mean (SD) is given. N = number of subjects.
Based upon the reported occupation of both man and wife, the participants were also divided into five "household economic levels", of which level 5 was the highest and corresponded to double income households as self-employed, or hunter/fisherman (table III). Level 1 comprised mainly students and single unemployed persons. BMI increased significantly with the household income level. Age and household income were positively correlated. However, in multiple linear regression analysis, both age and household income were significantly correlated to BMI after mutual adjustment and adjustment for smoking (table IV). When the men and women were tested separately, the woman’s BMI was more strongly associated with the economic level of her husband than with her own occupation.

Thus, in this study group, it appeared that overweight/obesity was correlated with a good and stable economic situation and not, as expected, with lower social economic class. However, as mentioned above, the relative intake of imported food/Danish food, or fast food, was not higher among obese persons.

In all districts, in both smaller and larger towns, there was a high percentage of overweight and obese individuals, among both men and women (table II), and the percentage of overweight and obese individuals did not differ significantly between small and larger settlements.

Age, BMI and height were calculated for a retrospective material (1976) from Uummanaq, provided by (Dyerberg pers comm). Although the study population was, on average, older (mean age = 43.9 years), both the men and women were significantly slimmer than those in the present study and shown in table II (mean BMI: men = 25.1 kg/m², women = 23.4 kg/m², with a mean weight difference of about 10 kg, p < 0.05*) and the men were significantly shorter (mean height: men = 1.66m, women 1.57m, p < 0.05*). When the same age group in the present day material was compared, there was a significant increase in both BMI and height.

**Plasma lipids**

Plasma (n-3)/(n-6) (total mean 0.44) as an indicator of intake of traditional food also increased with higher household economic levels and, therefore, with the BMI (table III). However, as mentioned above, this was mainly an effect of older age and was neither significant, nor causative.

The mean serum cholesterol, 5.4 mmol/L, is still reasonably low in Greenland (table VI), but cholesterol and, especially, s-triglyceride levels were found to increase with increasing BMI. S-triglyceride levels among obese (2.01 mmol/L) and overweight (1.59

| Table IV. | Multiple linear regression analysis of predictors for BMI in 5 districts in Greenland (n=396). |
|-----------|--------------------------------------------------------------------------------|
| Predictors for BMI | Unstandardized Coefficients | Standardized Coefficients | t | Sig. |
| **Model** | B | SE | Beta |
| Age | 0.093 | 0.030 | 0.16 | 3.14 | 0.002 |
| Smoker | -0.87 | 0.33 | -0.13 | -2.63 | 0.009 |
| Household economic levels | 0.26 | 0.11 | 0.12 | 2.31 | 0.022 |
mmol/L) participants were significantly higher than among normal weight participants (1.18 mmol/L, p < 0.001*** and p < 0.001***). S-Triglyceride was, as expected, inversely correlated with the (n-3)/(n-6) ratio in plasma, but the increasing effect of BMI overrode the triglyceride-lowering effect of (n-3)/(n-6). HDL-cholesterol and the cardiovascular risk index ((total Chol – HDL)/HDL) were only measured among the participants from 2003. The same pattern was found using another cardiovascular risk index, Trigl/HDL, which is a strong indicator of metabolic syndrome (21). Both HDL and the cardiovascular risk indices were unfavourably affected by overweight and especially obesity, for which the indicators differed from normal weight persons (p < 0.05 and p < 0.001, respectively).

Table V.
Time trends in average percentage of obese (BMI > 30) men and women (18 - 59 years) in different countries. The average body weight increase in Greenland over a 7-10 year period was about 8 kg.

| Country        | Men          | Women        | References                  |
|----------------|--------------|--------------|-----------------------------|
| USA 1960-1990  | 23.0-32.0    | 23.6-33.5    | (Lev-Ran 2001(24))         |
| UK 1986-1993   | 6.0-13.0     | 8.0-16.0     | (Lev-Ran 2001(24))         |
| Norway 1984/86-1995/97 | 7.5-14.0 | 13.0-18.0    | (Lev-Ran 2001(24))         |
| Denmark 1985 -1995 | 5.0-8.8    | 5.3-6.6      | (Matthiessen et al 2001(22)) |
| Denmark 1990 -2000 | 10-13      | 9-11         | (Heitman 2000(23))         |
| Greenland 1993/94-1999/2003 | 8.7-18.1  | 7.7-19.5     | (Bjergaard et al 1995(9) & Present study) |

Table VI.
Blood lipids in normal, overweight and obese subjects.

| BMI group | CHOL- | CHD- | HDL- | Trigl/HDL | Trigl- |
|-----------|-------|------|------|-----------|--------|
|           | mmol/L| Index| mmol/L| mmol/L    | mmol/L |
| BMI < 25  |       |      |       |           |        |
| normal    | 5.29 (1.11) | 2.59 (1.12) | 1.55 (0.44) | 0.95 (0.62) | 1.18 (0.54) |
| N         | 178   | 66   | 66   | 178       |
| BMI 25 - 30 | 5.46 (1.14) | 3.36 (1.51)* | 1.35 (0.56)* | 1.45 (1.47)* | 1.59 (1.20)*** |
| overweight| N     | 135  | 54   | 54        | 135    |
| BMI > 30  | 5.57 (1.16) | 3.92 (1.91)*** | 1.23 (0.39)*** | 2.21 (2.2)*** | 2.01 (0.94)*** |
| obese     | N     | 73   | 37   | 37        | 73     |
| Total     | 5.39 (1.12) | 3.13 (1.54) | 1.42 (0.45) | 3.22 (0.9) | 1.47 (0.89) |
| N         | 396   | 157  | 157  | 157       |

*significantly different from normal weight, p<0.05
***significantly different from normal weight, p<0.001
LDL values are 3.1, 3.3, and 3.3 mmol/l respectively and do not differ significantly between groups. Mean (SD) is given. N = number of subjects.
DISCUSSION

In 1995, Bjerregaard et al. (9) reported that overweight and obesity was not a big problem in Greenland and was much less so than in Denmark and Canada, or other Arctic populations.

Since the 1993/94 study by Bjerregaard et al. (9), the average BMI for the same age group has increased from 25.0 to 26.4 kg/m² among men, and from 23.0 to 26.4 kg/m² among women, corresponding to a weight increase of 8-10 kg. The percentage of overweight has increased from 16.9 to 35.8 % for men and from 10.9 to 34.1 % for women. Although the mean BMI was the same in all the studied districts, the temporal change in BMI has been larger in the smaller settlements of Scoresbysund and Qaanaaq. In particular, the mean percentage of obese individuals has changed from 3.8 % in 1994 (9), to 19.0 and 24.5 % in Scoresbysund and Qaanaaq, respectively, representing a five- to six-fold increase in less than ten years.

The overall increases in actual obesity (BMI > 30 kg/m²) have been almost as large (table V), namely 8.7 - 18.3 % in men and 7.7 - 19.5 % in women. Compared to Denmark (22, 23) and other European countries (24), the obesity development in Greenland is becoming very fast. In contrast with the observations from 1993-94 (9), the results of the present study show that obesity in Greenland now is as prevalent as among Canadian Inuits. The average BMI among Greenlandic men is now almost as high as among Danish men (26.4 vs. 26.8 kg/m²) and among women it is higher (26.4 vs. 25.9 kg/m²). Furthermore, the percentages of overweight and obese persons in Greenland are now more than 50 % higher than in Denmark (table V). This change in Greenland has developed very rapidly, within the last ten-year period.

Jørgensen et al. (25) found that several metabolic risk indicators were correlated with obesity in both Denmark and Greenland, especially when referring to waist circumference and waist-to-hip ratio. Thus, obesity was positively correlated with p-glucose and insulin, s-triglycerides and blood pressure, and was inversely correlated with HDL-cholesterol. In the present study, we also found that both total cholesterol and s-triglyceride and the cardiovascular risk index increased with increasing BMI, while HDL decreased.

Despite the gradual transition to a more westernized diet, the intake of marine mammals and fish is still high in Greenland, resulting in a lower mean fat E% than in Denmark (18). Furthermore the mean plasma phospholipid (n-3)/(n-6) ratio is 0.44, which is two- to three-fold that of a Danish subpopulation (7). A high plasma (n-3)/(n-6) ratio is often associated with lower levels of cholesterol and triglycerides, and a higher level of HDL. However, in the present study this beneficial effect of (n-3) fatty acids on metabolic risk factors appears to be partially overridden by the effects of overweight and, especially, by those of obesity. Since the population study performed in 1999 by Jørgensen et al. (25), the mean HDL for the same age group in west Greenland 2003 has decreased from 1.60 to 1.46 (p<0.01) and s-triglyceride has increased from 1.10 to 1.52 (p < 0.001). The ratio between triglyceride and HDL (Trigl/HDL), used as an indicator of risk of metabolic syndrome, type 2 diabetes and CHD (21), is also significantly increased
among overweight and, especially, obese individuals. Thus, the increasing weight gain in Greenland can be considered as a potential serious population health problem.

Unfortunately, it is not simple to explain the causes of this weight gain. The weight gain coincides with a temporal change in the westernization and modernization of diet and other life-styles. However, in a previous study, Bjerregaard et al. (26) found no difference between the BMIs of Greenlanders eating “traditional” food and those with a “more westernized” diet. Furthermore, despite a more comprehensive dietary survey, nothing in the present study points to western food as being a causative factor for overweight. On the contrary, overweight and obesity were more prevalent among the higher age quartiles, in which the individuals were characterized by higher intake of Greenlandic food and higher plasma (n-3)/(n-6) ratios. After adjustment for age, the (n-3)/(n-6) ratio was not significantly related to BMI. Thus, a high intake of marine fatty acids cannot be considered as a causative factor for weight gain, but, on the other hand, neither does it seem to protect against overweight itself. However, there was still a protective effect on the cardiovascular risk factors compared, for example, to the Danish population (26).

Consequently, we must consider that lifestyle factors other than dietary composition changes are influencing the overweight and obesity among the Greenlandic population. In most populations, modernization is often followed by a more sedentary (and indoor) lifestyle, and this is definitely the case in Greenland. Physical activity has not been measured in the present study, but Bjerregaard et al. (5) found that obesity was less prevalent (OR < 0.6) among active persons than among sedentary individuals. However, the outcome was not significant and, furthermore, it is difficult to distinguish between cause and effect in a question like this through a cross sectional study. In the present study, overweight and obesity were found to be significantly associated with higher household economic levels, which again may be associated with less physically strenuous work.

Our results indicated that increased body weight was not correlated with the absolute level of westernization, nor with the transition to western food. On the other hand, it may be associated with a period of rapid change of society, improved economic situation and food availability, and a lower physical activity level.

The results strongly indicate that high body weight unfavourably influences the metabolic risk indicators, especially s-triglycerides, and should therefore be considered as a serious health risk for the Greenlandic population.

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