

Obesity and Obesity-related conditions among the Inuit

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20 text pages

2 pages cited references

6 tables and figures

Introduction

As the world's population becomes more urbanized and Western lifestyles spread to all areas of the globe, diseases of modernization are becoming increasingly common. Obesity, diabetes, high blood pressure, and other conditions associated with modern lifestyles are becoming increasingly prevalent among populations that lived a traditional lifestyle until recently. Some of these populations are widely recognized being more susceptible to conditions of modernization than European populations (Lieberman, 2003). Arctic Inuit are currently in the process of modernization (Pollex, 2004). The purpose of this paper is to investigate the prevalence of obesity and obesity-related health conditions among Inuit, in terms of adaptation, dietary patterns, and genetics. This will be accomplished through a review of the literature.

Global Trends in obesity and obesity-related conditions

Globally people are migrating to cities at an increasing rate, nations are becoming more industrialized, and their populations are becoming more sedentary. Accompanying these shifts are increasing rates of obesity. (Zimmet and Thomas, 2003) Currently more than more than one billion individuals are obese (Lieberman, 2003). The trend toward obesity has been observed in many countries around the world. The World Health Organization reports that the percentages of overweight male adults between the ages of 45-59 are at 60% in Europe, 62 % in North America, and 50 % in Latin America (Lieberman, 2003).

Obesity is associated with increased risk of numerous health problems, such as diabetes, which has been associated with obesity in over 80% of newly diagnosed cases (Lieberman, 2003). Diabetes mellitus is the term used to describe various metabolic

diseases involving hyperglycemia, a condition of elevated blood sugar. This becomes a chronic condition when the normal secretion of insulin from the pancreas is disrupted, or when not enough insulin is available to act in the muscles and fatty tissue (Lieberman, 2003).

Diabetes is associated with a wider range of associated risk factors called the metabolic syndrome, or insulin resistance syndrome (Zimmet and Thomas, 2003). There is not complete agreement on what constitutes the metabolic syndrome. Risk factors commonly included in the definition of the metabolic syndrome include impaired glucose tolerance (IGT), central obesity, dyslipidaemia, type 2 diabetes, hypertension, elevated triglycerides, and reduced levels of HDL cholesterol (Zimmet and Thomas, 2003).

Modernizing populations

Although rates of obesity are increasing around the world, populations are not equally affected by this trend. The health risks associated with obesity are elevated in some populations, many of which live in developing countries (Lieberman, 2003). Also at an increased risk are some ethnic groups living within developed countries, such as African Americans, Hispanics, and American Indians (Lieberman, 2003).

Many scientists have attributed the rise in obesity and diabetes as being a result a modernization. Modernization has been defined as a “nutritional transition” to a diet that is rich in sugar, refined foods, and saturated fat, and containing little fiber, accompanied by a sedentary lifestyle (Lieberman, 2003).

High carbohydrate diets have been significantly correlated with the incidence of hyperinsulinemia, due to raised levels of insulin in the blood and increased concentration of triglycerides. The ingestion of fats affects insulin secretion and how insulin acts in

skeletal muscles. The introduction of new fats to the diet changes membrane response to insulin and glucose metabolism (Lieberman, 2003).

“Thrifty” gene model

The differential impact of obesity on the health of populations has led to the hypothesis that genetic factors contribute toward insulin resistance and diabetes (Jorgensen, 2003). In the past there may have been a selective advantage gained by individuals with insulin resistance and accumulation, an idea known as the “thrifty” gene hypothesis (Jorgensen, 2003). According to one version of the “thrifty” gene hypothesis, certain populations were historically under selection pressure to maximize energy due to cyclical periods of feast, famine, and energetic balance (Bindon and Baker, 1997). In this model, hyperinsulinemia is the result of the increased efficiency of energy use in individuals with the “thrifty” gene (Bindon and Baker, 1997).

Beta cells in the pancreas secrete insulin, which transports glucose into cells. Elevated insulin levels over a prolonged period of time may improve the metabolic efficiency of individuals with the “thrifty” genotype by increasing the production of glycogen. The effect is pronounced in the peripheral muscle cells which are responsible for most of the excretion of glucose from the blood (Bindon and Baker, 1997).

Increased levels of insulin lead to the excessive production of fat in two ways. First, increased insulin levels break down triglycerides in the blood and store the materials as fat. Second, insulin suppresses the enzyme lipase, keeping it from breaking down triglycerides stored as fat (Bindon and Baker, 1997).

Unfavorable outcomes from this genotype, such as diabetes and obesity, historically would have been prevented by occasional famine, and by exercise, which reduces insulin secretion (Bindon and Baker, 1997).

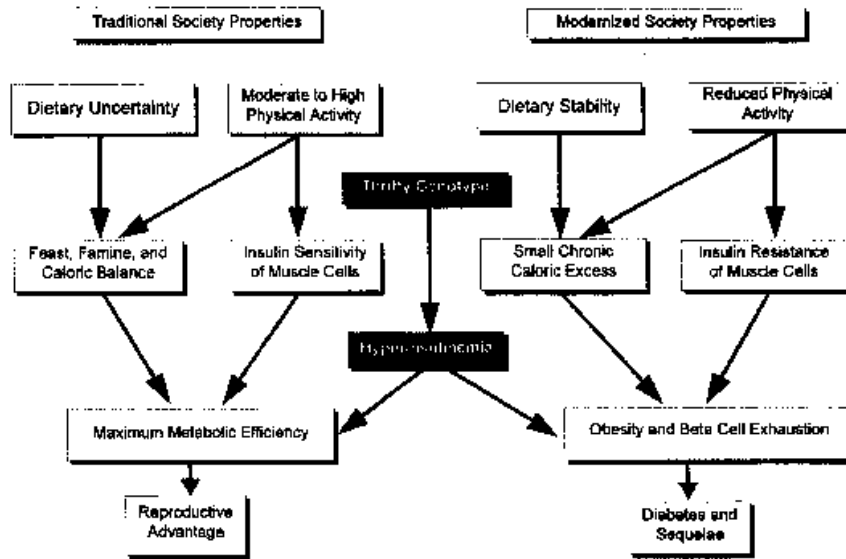


Figure 1

Figure 1 contrasts the effects of living in a traditional society with living in a modernized society for an individual with the “thrifty” genotype. An individual living in a traditional society would face periodic food shortages, and would be required to perform at least moderate amounts of physical activity. An individual possessing the “thrifty” genotype would have increased sensitivity to insulin which would improve his or her metabolic efficiency through hyperinsulinemia, making the individual more likely to survive and reproduce. An individual living in a modernized society where food is abundant and less physical activity is required, who had the “thrifty” genotype, would accumulate excess weight and suffer from insulin resistance. In this case, hyperinsulinemia would lead to obesity and diabetes. Bindon and Baker do not suggest

that obesity causes diabetes, but rather that they are both caused by increased efficiency of metabolic processes (1997).

Another version of the “thrifty” genotype has been applied to Indigenous peoples of North America who traditionally subsisted on a diet that was rich in protein and fat but contained scarce carbohydrate. This model suggests that for New World populations, natural selection may have favored metabolic efficiency for gluconeogenesis, production of glucose from fat and protein rather than carbohydrate (Lieberman, 2003; Merriam-Webster, 2002).

Different models for the “thrifty” gene hypothesis attempt to explain the prevalence of the metabolic syndrome in specific populations (Bindon and Baker, 1997).

LMNA Mutation

Another explanation for obesity among certain populations was proposed after the discovery of the LMNA mutation. A mutation found in LMNA was recently shown to be implicated in FPLD, a disease causing insulin resistance and diabetes (Hegele et al, 2001).

A single nucleotide polymorphism (SNP) was also discovered in relation to LMNA. This SNP causes a change from C to T at nt 1908 in exon 10 of LMNA. This alters the third base of codon 566. Research on the Oji-Cree Indians of Canada has associated this mutation with obesity (Hegele et al, 2001).

Traditional diet and historical trends among Inuit

In Greenland, people began migrating to cities and eating a modernized diet in the 1950’s (Jorgensen et al, 2003). Canadian Inuit ate nothing but traditional foods until stores opened in the early 20th century. Rates of obesity in Inuit throughout Canada and

Alaska did not begin increasing until the 1960's (Bjerregaard et al, 2002a). Rates of metabolic disorders and other diseases of modernization have been slow to develop. A 1966 study of Inuit in Greenland that tested 4,249 individuals for diabetes found only three incidences. Studies prior to the 1980's indicated that Inuit had lower rates of diabetes than Western populations such as the Danish. Between 1950 and 1974 only one case of diabetes was reported in the district of Upernavik (Jorgensen et al, 2002).

Current trends in Inuit nutrition

Inuit still eat many traditional foods. They retain cultural knowledge about 129 species of animals and 42 species of plants (Kuhnlein et al, 2004). Between 10-36 % of calories of Canadian Inuit now come from traditional foods. (Kuhnlein et al, 2004). Kuhnlein et al found the most frequently consumed foods were moose, caribou, fish, and seal (Kuhnlein et al, 2004). It was also found that Inuit had increased nutrition on the days traditional foods were eaten.

On the days when traditional foods were eaten, individuals increased their overall intake of energy, gaining a mean of 8577 ± 149 kJ on days when traditional foods were eaten, compared to mean of 7456 ± 196 on days when traditional foods were not eaten. On days when traditional food was eaten, more energy came from protein than on days when traditional food was not eaten. Conversely, a significantly greater percentage of calories came from carbohydrate, fat, and sucrose on days when traditional food was not eaten (Kuhnlein et al, 2004).

Micronutrient intake was also improved on days people ate traditional food. Days when traditional food was eaten included more iron at $37.4 \text{ mg} \pm 1.1$ compared to 15.0 ± 1.4 for days when traditional food was not eaten. More Vitamin E was obtained on days

when traditional foods were eaten, with a mean of $5.4 \pm .2$ mg compared to $3.1 \pm .3$ on days when traditional food was not eaten. Intake of Vitamin B-6 was increased on days when traditional food was eaten, with a mean of 4.0 ± 0.1 mg compared to 1.4 ± 0.1 mg on days when traditional food was not eaten (Kuhnlein et al, 2004). In contrast, sodium was higher on days when traditional food was not eaten, with a mean of 2199 ± 73 on days when traditional food was eaten and a mean of 2436 ± 95 on days when traditional food was not eaten (Kuhnlein et al, 2004). The overall improvement in nutrition on days when traditional food is eaten is underscored by the small percentage of total energy made up of traditional foods (Kuhnlein et al, 2004).

TABLE 2

Micronutrient, fiber, and energy intake on days with and without traditional food (TF) for Yukon, Dene/Métis, and Inuit adults¹

Nutrient	Yukon		Dene/Métis		Inuit	
	Days with TF (n = 410)	Days without TF (n = 387)	Days with TF (n = 661)	Days without TF (n = 346)	Days with TF (n = 968)	Days without TF (n = 832)
Vitamin A ² , $\mu\text{g RAE}$	697 \pm 45	523 \pm 52	1245 \pm 424	825 \pm 578	911 \pm 136 ^a	433 \pm 179 ^b
Vitamin C, mg	7.3 \pm 0.6 ^a	2.1 \pm 0.7 ^b	7.9 \pm 0.9 ^a	3.5 \pm 1.3 ^b	25.1 \pm 1.3 ^a	8.6 \pm 1.7 ^b
Vitamin E, mg	4.8 \pm 0.1 ^a	3.5 \pm 0.2 ^a	6.5 \pm 0.4 ^a	3.9 \pm 0.5 ^b	5.4 \pm 0.2 ^a	3.1 \pm 0.3 ^b
Vitamin K, mg	64.8 \pm 5.2	68.9 \pm 5.9	82.8 \pm 4.3	60.9 \pm 5.9	82.1 \pm 3.4 ^a	70.6 \pm 4.5 ^b
Flavonoids, mg	2.2 \pm 0.1 ^a	1.5 \pm 0.1 ^b	2.5 \pm 0.1 ^a	1.8 \pm 0.1 ^b	2.9 \pm 0.1 ^a	1.3 \pm 0.1 ^b
Vitamin B-6, mg	3.3 \pm 0.1 ^a	1.7 \pm 0.1 ^b	3.7 \pm 0.1 ^a	1.9 \pm 0.1 ^b	4.0 \pm 0.1 ^a	1.4 \pm 0.1 ^b
Folate, $\mu\text{g DFE}$	311 \pm 9	307 \pm 11	303 \pm 10	316 \pm 14	317 \pm 10 ^a	319 \pm 13 ^b
Calcium, mg	461 \pm 20	508 \pm 23	533 \pm 17	526 \pm 24	443 \pm 12	451 \pm 16
Iron, mg	23.3 \pm 0.8 ^a	14.1 \pm 0.7 ^b	26.5 \pm 0.9 ^a	15.6 \pm 1.3 ^b	37.4 \pm 1.1 ^a	15.0 \pm 1.4 ^b
Zinc, mg	27.7 \pm 0.9 ^a	13.1 \pm 1.1 ^b	33.8 \pm 1.0 ^a	15.4 \pm 1.3 ^b	21.5 \pm 0.5 ^a	9.5 \pm 0.6 ^b
Copper, μg	1855 \pm 46 ^a	1163 \pm 53 ^b	2025 \pm 89 ^a	1439 \pm 122 ^b	2676 \pm 44 ^a	1041 \pm 58 ^b
Magnesium, mg	297 \pm 6 ^a	240 \pm 7 ^b	305 \pm 5 ^a	237 \pm 7 ^b	597 \pm 31 ^a	280 \pm 40 ^b
Manganese, mg	3.7 \pm 0.1 ^a	3.3 \pm 0.1 ^b	3.6 \pm 0.1 ^a	3.3 \pm 0.1 ^b	3.3 \pm 0.1 ^a	2.7 \pm 0.1 ^b
Phosphorus, mg	1602 \pm 35 ^a	1155 \pm 40 ^b	1759 \pm 31 ^a	1224 \pm 43 ^b	1663 \pm 27 ^a	947 \pm 36 ^b
Sodium, mg	2334 \pm 89 ^a	2692 \pm 102 ^b	2544 \pm 80 ^a	3650 \pm 169 ^b	2193 \pm 73 ^a	2437 \pm 93 ^b
Potassium, mg	3520 \pm 76 ^a	2608 \pm 87 ^b	3516 \pm 63 ^a	2561 \pm 86 ^b	2967 \pm 63 ^a	1999 \pm 70 ^b
Selenium, μg	160 \pm 4 ^a	124 \pm 6 ^b	151 \pm 3 ^a	132 \pm 6 ^b	195 \pm 10 ^a	107 \pm 13 ^b
Dietary fiber, g	14.9 \pm 0.4	15.2 \pm 0.5	12.6 \pm 0.2	12.9 \pm 0.4	9.7 \pm 0.3 ^a	11.2 \pm 0.4 ^b
Total energy, kJ	8735 \pm 193	8971 \pm 221	8877 \pm 173	8769 \pm 236	8577 \pm 149 ^a	7456 \pm 196 ^b

¹ values are LSM \pm SEM (Kruskal-Wallis nonparametric ANOVA within each cultural area adjusted for food source, age, gender, season, site, and day of week); means in a row with superscripts without a common letter differ, $P < 0.01$.

² RAE, retinol activity equivalents; DFE, dietary folate equivalents.

Figure 2

Figure 2 depicts data comparing days when traditional food was eaten to days when traditional food was not eaten for three populations (Kuhnlein et al, 2004).

Inuit in Greenland

Inuit make up 90% of Greenland's population. Most Greenlanders are currently urban, with 80% living in towns and cities. The remainder of the population is divided between 60 small villages that number no more than 500 people. People make their living through subsistence hunting and fishing, commercial fishing, and working in the fish processing industry. Of families who make their living through subsistence hunting and fishing, 71 % also include a family member who works for wages. Greenland also receives Danish subsidies (Pars et al, 2004).

The shift away from subsistence living began in the 1950's, and Greenland has been undergoing the process of modernization since then. Urban areas show increased modernization of lifestyle compared to the villages (Jorgensen et al, 2002).

The map in Figure 3 shows the location of Nuuk, Qasigiannugit and Uummannq, where Bjerregaard et al collected their data in Greenland.

Inuit Migrants in Denmark

Another population Bjerregaard et al focused on in this study was Inuit migrants in Denmark. It is believed that 8000 Inuit migrants from Greenland live in Denmark. Some are permanent residents, while others are there as students. They typically live a Westernized lifestyle similar to that of the Danish (Bjerregaard et al, 2002a).

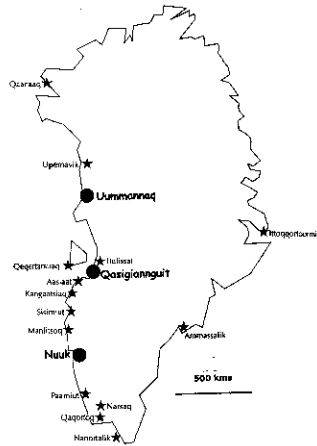


Figure 4. Map of Greenland found in Bjerregaard et al Decreasing overweight 1504

The map in Figure 4 shows Greenland in relation to Canada.

It was found that the percentage of overweight men in Greenland was 35 %, and the percentage of overweight women in Greenland was 33%, with overweight classified as a BMI of 25-29.9. The percentage of obese men and women was 22 %, with obesity classified as a BMI of greater than or equal to 30. The researchers found that 39% of men migrants were overweight, and that 31 % of women migrants were overweight. 12 % of men migrants were obese, and 11% of women migrants were obese (Bjerregaard et al, 2002a).

Trends were noted in terms of Westernization, which was determined by proficiency in Danish, and location of current residence. The most Westernized Greenlanders lived in Nuuk and were proficient in Danish. The least Westernized did not speak Danish and who lived in a small town or village. The remainder was classified as intermediate. In Denmark 96% had lived in Denmark for at least three years, and were not classified into groups (Bjerregaard et al, 2002a).

The women who were at an intermediate level of modernization had a higher BMI than the least and most modernized Inuit with intermediate women having a mean BMI of 26.4, compared to a mean of 26.2 for the least Westernized and 25.5 for the most Westernized (Bjerregaard et al, 2002a). Migrant women had a lower BMI than any group of women Greenlanders at 25.1. Because of this, the researchers suggest that there is a raised prevalence of obesity in early stages of Westernization, but that in later stages it is reduced (Bjerregaard et al, 2002a). Among men, Westernization did not significantly increase BMI (Bjerregaard et al, 2002a).

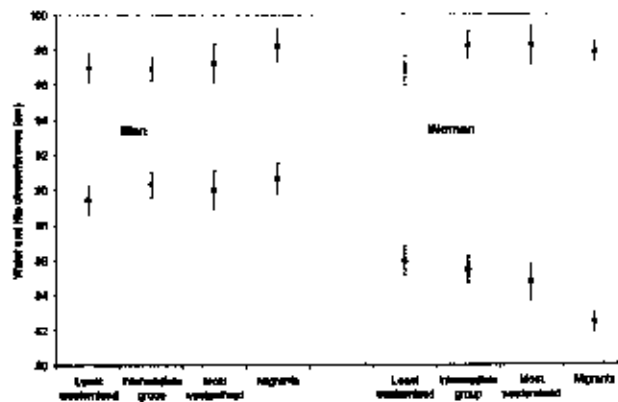


Figure 5. Bjerregaard decreasing overweight

Figure 5 shows waist and hip circumferences of four groups of Inuit, Greenlanders who are least Westernized, Greenlanders who are Westernized to an intermediate degree, Greenlanders who are the most Westernized, and Inuit migrants in Denmark. Although waist and hip circumferences for women are shown to differ based on level of modernization, waist and hip circumferences for men do not show much variation (Bjerregaard et al, 2002a).

Socioeconomic differences were associated with different rates of obesity among men and women. Obesity was most prevalent among men with a high socioeconomic status. Obesity rates for women were highest in those with a low socioeconomic status. The authors noted that the pattern observed in Greenlandic women frequently occurs in developed countries, and the pattern observed in Greenlandic men frequently occurs in developing countries (Bjerregaard et al, 2002a).

The authors concluded that significant increases in obesity had not occurred along with modernization (Bjerregaard et al, 2002a).

Alaska Inuit

Research by Risica et al focused on BMI and the obesity rate of four Inuit villages in Alaska representing three groups of Inuit. These groups are the Inupiaq who live along the northern and northwestern coast, the Yupik in the southwest, and the Siberian Yupik who live on St. Lawrence Island (Risica et al, 2000). Figure 6 displays the state of Alaska.



Figure 6. The State of Alaska

The groups vary in terms of the traditional foods they eat. Reindeer meat is commonly eaten by the Inupiaq. The Central Yupik frequently eat salmon, and the Siberian Yupik eat whale meat and blubber. All three groups eat seal, walrus, wild greens, and berries (Risica et al, 2000).

The average BMI of Alaskan Inuit exceeded the American average (Risica et al 2000). The average BMI for Alaskan Inuit women was 27.2, while the American average was 26.2. The average BMI for Inuit men was 26.2, which was the same for the national average for men. 32.8 % of Alaskan Inuit women had a BMI greater than 30 (Risica et al 2000). Of Alaskan Inuit women, 27.9 % were classified as overweight at with a BMI between 25 and 30. 15.6 % of men were classified as obese, and 36.2 % were classified as overweight (Risica et al, 2000).

Inuit and CVD

Nunavik Inuit of Quebec were studied in relation to two other populations of Quebec, the James Bay Cree and non-Native Quebecers in terms of cardiovascular risk. More people in Quebec die of a cardiovascular disease (CVD) than from any other cause. Risk factors for CVD include obesity, diabetes, high blood pressure, elevated plasma lipids and lipoproteins, high intakes of saturated fats and trans-fats, low levels of HDL cholesterol and high triacylglycerol. High intake of n-3 polyunsaturated fatty acids (PUFA), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) is thought to reduce risk of CVD. High levels of PUFA have been associated with diets rich in fish (Dewailly et al, 2003).

Research on ischemic heart disease (IHD) mortality rates in Quebec between 1992-1996 showed that Inuit had a low risk of mortality from IHD, at a rate of 66.3 per

100,000. This is a lower rate than for Cree and the overall population of Quebec, which were 92.8 and 140.2, respectively (Dewailly et al, 2003).

TABLE 2
Characteristics of Quebecers, James Bay Cree, and Inuit of Nunavik Who Participated in the Santé Québec Health Surveys^{a,b,c}

Characteristic	Quebecers (n = 1460)		Cree (n = 917)		Inuit (n = 426)		P-value
	Mean	(SEM)	Mean	(SEM)	Mean	(SEM)	
Total cholesterol (mmol/L)	5.3	(0.02)	5.0	(0.03)	5.3	(0.05)	<0.0001
LDL (mmol/L)	3.3	(0.02)	3.1	(0.03)	3.2	(0.04)	<0.0001
HDL (mmol/L)	1.3	(0.01)	1.3	(0.01)	1.5	(0.02)	<0.0001
Total/HDL cholesterol	4.3	(0.03)	4.2	(0.04)	3.8	(0.06)	<0.0001
Triglycerides (mmol/L)	1.6	(0.02)	1.4	(0.03)	1.2	(0.04)	<0.0001
Systolic blood pressure (mm Hg)	122.6	(0.36)	124.9	(0.47)	116.4	(0.67)	<0.0001
Diastolic blood pressure (mm Hg)	76.1	(0.23)	77.2	(0.30)	75.5	(0.43)	0.001
Glucose (mmol/L)	5.3	(0.04)	5.4	(0.05)	5.4	(0.07)	0.21
Insulin (pmol/L)	79.3	(1.71)	109.5	(2.35)	61.4	(3.32)	<0.0001
Waist girth (cm)	83.7	(0.32)	101.4	(0.42)	86.0	(0.62)	<0.0001
Body mass index (kg/m ²)	25.0	(0.13)	30.9	(0.16)	27.3	(0.24)	<0.0001
Prevalence (%)							
Smoking status							
Smoker	29.1		36.0		64.7		<0.0001
Nonsmoker	70.9		64.0		35.3		
Alcohol intake							
None	11.7		69.7		52.3		<0.0001
Occasional or regular drinkers	88.3		30.0		47.7		
CVD medication							
Yes	22.9		12.0		5.1		<0.0001
No	77.1		88.0		94.9		

^aMean adjusted for sex and age (SEM); P-value obtained from ANOVA.

^bPrevalence adjusted for sex and age (%); P-value obtained from logistic regression.

^cAbbreviation: CVD, cardiovascular disease.

Figure 6

Figure 6 shows health information about Quebecers, the James Bay Cree, and Inuit of Nunavik.

Inuit were found to have a mean LDL cholesterol 3.2 mmol/L, which is intermediate between the Cree mean of 3.1 mmol/L and the Quebec mean of 3.3 mmol/L. Inuit had the highest levels of HDL cholesterol, with a mean of 1.5 mmol/L compared to means of 1.3 for the other two groups. Triglycerides were lowest among Inuit, with a mean of 1.2 mmol/L compared to means of 1.4 mmol/L for the Cree, and 1.6 mmol/L for Quebecers. Inuit had the lowest systolic blood pressure, with a mean of 116.4, compared to a mean of 124.9 among the Cree and 122.6 among Quebecers. They also

had the lowest diastolic blood pressure, with a mean of 75.5 compared to a mean of 77.2 among the Cree and a mean of 76.1 among Quebecers. The low mean blood pressure among Inuit is surprising in light of their high rates of smoking. 64.7% of Inuit of Nunavik smoke, compared to 36 % of James Bay Cree, and 29.1% of Quebecers. Inuit formed the intermediate category for waist girth, with a mean of 88 cm compared to 101.4 cm among the Cree and 83.7 among Quebecers. They had a BMI of 27.3 compared to the mean Cree BMI of 30.9 and the Quebec mean BMI of 25 (Dewailly et al, 2003).

It was also found that Inuit had the highest mean intake of fish, at 131 g compared to 60 g for Cree and 13 g for Quebecers. Inuit also had the highest blood concentrations of EPA +DHA. The researchers demonstrated that HDL cholesterol increased with EPA+DHA (Dewailly et al, 2003).

Inuit had the highest concentrations of n-3 fatty acids, which was expected due to the large quantities of fish and marine mammals that they eat. Quebecers eat fewer fish, and the commercial fish that Quebecers commonly eat are less fatty than the wild fish Inuit eat. Cree, whose traditional food is freshwater fish and land mammals, had intermediate concentrations of n-3 fatty acids (Dewailly et al, 2003).

Based on this data, it appears that Inuit have considerable protection from CVD, probably due to their heavy reliance on fish as a food source.

Inuit and high blood pressure

Research has shown that when people living a traditional lifestyle migrate to urban areas, they frequently undergo a rise in blood pressure between 5-10 mm Hg (Bjerregaard et al 2002b).

Research comparing Inuit in Greenland with Inuit migrants in Denmark found that Inuit in Greenland had a lower mean blood pressure, at 117/72 than Inuit migrants, who had a mean blood pressure of 126/81. Differences were observed between Greenlanders in terms of education, which is a marker for modernization. Men Greenlanders with eight years of school or less had a mean systolic blood pressure of 115 compared to a mean systolic blood pressure of 132 among migrants with the same level of education. Men Greenlanders who finished high school had a mean systolic blood pressure of 127, while the mean systolic blood pressure of men migrants with the same level of education was 130 (Bjerregaard et al, 2002b).

Blood pressure increased with BMI and non-smoking for both groups. Men Greenlanders with a BMI between 25 and 29.9 had a mean systolic blood pressure of 118, while Greenlanders with a BMI of 30 or greater had a mean systolic blood pressure of 126. Men migrants with a BMI between 25-29.9 had a mean systolic blood pressure of 130, compared to those with a BMI of 30 or greater, who had a mean systolic blood pressure of 142. Men Greenlanders who had never smoked had a mean systolic blood pressure of 127, compared to 117 for those who smoke fifteen or more cigarettes a day. Men migrants who had never smoked had a mean systolic blood pressure of 136 compared to a mean systolic blood pressure of 130 for those who smoked fifteen or more cigarettes a day (Bjerregaard et al, 2002b).

Inuit migrants were thinner than Inuit of Greenland, with 57% having a BMI of 24.9 or less, compared to a 47% of Greenlanders. Inuit migrants had a lower incidence of obesity, with 10% having a BMI of 30 or above, compared to 19 % of Greenlanders. Migrants also had a higher blood pressure in all categories shown. In most studies of

migrants to urban areas, both blood pressure and BMI increase, and increasing BMI was thought to contribute toward increased blood pressure (Bjerregaard et al, 2002b).

This study supports the idea that blood pressure increases with modernization among Inuit.

Inuit and diabetes

Jorgensen et al examined the incidence of diabetes and IGT among Greenland Inuit, and focused on risk factors for glucose intolerance (2002). They found that 21.9 % of Greenlanders in the study had glucose intolerance, and 10.8% men, and 8.8 % women had diabetes, adjusted for age. Of those who were found to have diabetes, 61 % had not been previously diagnosed (Jorgensen et al, 2002).

Sedentary individuals were more likely to have diabetes, 10.5 % compared to 6.8 % who were very physically active and had diabetes. Sedentary individuals who were physically inactive were more likely to have IGT, at 24.7 % compared to 7.8 % who were physically very active (Jorgensen et al, 2002).

An increase in diabetes is believed to be predicted by the ratio between IGT and diabetes in a population. The high rates of IGT found in Greenlandic towns suggest that the prevalence of diabetes may increase in the future (Jorgensen et al, 2002).

Comparison between Inuit and the Danish

Jorgensen et al compared a sample of Greenland Inuit to a sample from a general population in Denmark (Jorgensen et al, 2002).

Inuit women had a higher average BMI, of 26.8 compared to the 25.9, the average BMI of Danish women. Inuit women's average waist to hip ratio was also higher, at .89, compared to .80, the average for Danish women. Inuit women's waist circumference was

87.9 cm, compared to the Danish average of 7.8. Both men and women of Greenland had higher rates of obesity than their Danish counterparts. In Greenland, the percentage of obese men was 18.4, compared to 17.7, the average for Danish men. Of Greenland women, 24.9 % were obese compared to 17.8 % of Danish women (Jorgensen et al, 2002).

Inuit had higher levels of HDL cholesterol, with a mean of 1.60 mmol/l for Greenland women, compared to a mean of 1.55 mmol/l for Danish women. Men had a mean HDL cholesterol of 1.6 compared to a mean of 1.3 for Danish men. Inuit had lower levels of triglycerides. Greenland men had a mean of 1.1 mmol/l compared to the Danish mean of 1.6 mmol/l. Greenland women had triglyceride levels at a mean of 1.1 mmol/l, compared to the 1.2, the mean for Danish women. Inuit also had lower blood pressure. The percentage of Greenland men with high blood pressure was 11.4 % compared to 32.2% for Danish men. The percentage of Greenland women with high blood pressure was 9.5 %, compared to 22.8 % of Danish women (Jorgensen et al, 2002).

Comparisons between Inuit and Cree-Ojibwa Indians

Research has shown that American Indians are at high risk for the metabolic syndrome, and are frequently found to have rates of obesity, high blood pressure, and diabetes (Young et al, 2002).

A study of Canadians found that Canadian Inuit had a BMI of 26.3, compared to a BMI of 27.7 for Cree-Ojibwa Indians. Inuit had a mean waist circumference of 87.2 compared to a mean waist circumference of 97 for Indians. Indians had a higher mean weight than Inuit, at 166.2 compared to 158.7 (Young et al, 2002).

In addition to exceeding Inuit on traits of obesity, Indians had increased incidence of other indications of the metabolic syndrome. Indians had a higher mean systolic blood pressure of 130.6 compared to 119.1 for Inuit. Diastolic blood pressure was also higher for Indians, with a mean of 79.8, compared to a mean of 75.2 for Inuit. Indians had higher mean levels of triglycerides, at 1.66 compared to 1.07 for Inuit. Indians also had lower HDL cholesterol, with a mean of 1.28 mmol/l compared to 1.45 mmol/l (Young et al, 2002).

Applications of the “thrifty” genotype model

Some researchers have asserted that the Inuit do not seem to have a “thrifty” genotype. Studies of Inuit from the late eighties and early nineties demonstrated that Inuit had a lower risk of the metabolic syndrome than “Caucasian” populations (Risica et al, 2002). Although the Inuit community they studied had higher overall rates of obesity and diabetes than the Danish sample they were compared with, Jorgensen et al pointed to their lower blood pressure, triglycerides, lower 2-h glucose and lower 2-h insulin, and higher HDL cholesterol to suggest that Inuit do not in fact demonstrate a raised risk of obesity-related conditions (Jorgensen et al, 2002). Inuit have been shown to have a lower average blood pressure than populations such as American Indians and Canadians (Dewailly et al, 2003). All of these factors indicate that Inuit enjoy protection from the metabolic syndrome, either through their genetic makeup or due to lifestyle factors.

However, there are indications to the contrary. High rates of IGT found in Greenland Inuit hint that they may be susceptible to a high prevalence of diabetes, and that it will manifest in time (Jorgensen et al, 2002). Modernized Inuit living in Denmark have been shown to have increased blood pressure compared to Inuit living a more

traditional lifestyle (Bjerregaard et al, 2002b). If lower prevalence among Inuit of conditions such as heart disease are related to their largely marine diet as some have suggested (Dewailly et al, 2003), then further shifts away from a traditional lifestyle could result in higher rates of these conditions. Bindon and Baker (1997) note that increased rates of diabetes often do not surface for a decade or more after rates of obesity have begun to increase. It is possible that they will also eventually exhibit the high rates of diabetes, high blood pressure, and heart disease characteristic of individuals with the “thrifty” genotype.

Application of the discovery of the LMNA SNP mutation

The LMNA SNP mutation was found to be associated with obesity indices among Inuit. Inuit with the 1908 T allele had a higher mean BMI of 26.9 compared to 24.8, the mean BMI of individuals without the 1908 T allele. Individuals with the mutation also had a larger waist circumference of 89.1 cm compared to 84.6 cm for Inuit without the mutation. Overall weight was higher for Inuit with the mutation, at 68.4 kg compared to 63.4 kg. It is unclear how the mutation causes an increase in obesity-related characteristics (Hegele et al, 2004).

Limits of the research

One problem with evaluating Inuit risk of obesity and obesity-related conditions is that much of the published data refers to studies made of data collected ten years ago. One factor in the “thrifty” genotype is that diabetes and other metabolic problems often occur ten or more years after the trend of obesity begins (Bindon and Baker, 1997). Further, modernization is a continuing process, and trends from around the world show increasing rates of diabetes (Lieberman, 2003). It is therefore important for researchers

to collect data at more regular intervals to track the occurrence of obesity and its related conditions through time.

The mutations of LMNA were only recently discovered. Researchers have yet to propose a mechanism to explain how SNP LMNA contributes toward obesity in individuals with the 1908 T allele (Hegele et al, 2001).

Conclusions

There is variation in obesity and obesity-related conditions among Inuit, often relating to degree of modernization. Although rates of obesity are high in some Inuit populations, they are low in others (Bjerregaard et al, 2002a). Related conditions such as high blood pressure are also variable (Bjerregaard et al, 2002b). Inuit have been shown to suffer less from CVD than populations of predominantly European and American Indian descent (Dewailly et al, 2003). It is not known whether further modernization will result in trends observed among American Indians and other populations with the “thrifty” genotype.

Health studies of Inuit populations should continue. Although Inuit do not appear to be as susceptible to obesity-related health conditions as other populations, such as American Indians, it is unclear whether or not that lack of susceptibility is related to genetic factors. Certain observations, such as high rates of IGT in Greenland, suggest that Inuit may be predisposed to diseases such as diabetes.

More research needs to be done on the LMNA mutations. It seems clear that the 1908 T allele contributes toward obesity-related characteristics in Inuit and Oji-Cree Indians. The mechanism by which it does so is still unknown. Further work should focus

on isolating a mechanism. Further research should also investigate other populations which may exhibit this mutation.

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