The Relationship Between Body Mass Index and Disease in Non-aboriginal and Aboriginal People Residing in the Bella Coola Valley

Robert Bruce Self

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Abstract

This study used a retrospective medical chart review of Bella Coola Valley medical clinic patients. Bella Coola is an isolated, remote community on the central coast of British Columbia, Canada. The medical charts of 1724 adult residents were examined. Height, weight, body mass index (BMI), and aboriginal status were recorded along with the presence of a number of diseases and conditions. The purpose of the study was to compare the relationship between body mass index and disease in this population. The results suggest that there is a positive relationship between increased BMI and some diseases and conditions. Persons of aboriginal descent have higher average BMIs than non-aboriginals. Additionally, the prevalence of dyspepsia, dermatitis, alcohol problems, diabetes, asthma and inflammatory arthritis are significantly higher in the Nuxalk, but the prevalence of hypertension, hypercholesterolemia, hypothyroidism and chronic obstructive lung disease are significantly higher in the non-aboriginal population.

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Chapter 1

Introduction

Obesity is an increasingly common phenomenon in North America. It has an impact on the health of individuals that is straightforward. That is, the more obese a person is, the greater likelihood they will suffer from one or more diseases or conditions that negatively affect their health.

An increase in obesity has contributed significantly to an increase in chronic lifestyle diseases such as: diabetes, coronary artery disease, hypertension, and cancer among others. These diseases consume a large portion of health care budgets today and projections are for them to consume even more in the future. Because obesity is a contributor to many diseases, it is a research topic of great interest.

The definition of what constitutes obesity and what is overweight, is the subject of an ongoing debate, but it is generally conceded by most, that body mass index (BMI) is a useful gross screening tool (Kuczmarski, & Flegal, 2000). It objectifies weight for height and eliminates some of the subjectivity inherent in terms such as obese, fat, and heavy. Body mass index (BMI) is the person's weight in kilograms divided by their height in meters squared, kg/m^2. Having an objective measure is a good beginning, but there still remains the issue of what thresholds to use for categories of BMI. There are many different schemes to label excess weight. For example the World Health Organization indicates that a BMI over 25 kg/m^2 is labeled overweight and having a BMI of over $30kg/m^2$ is labeled obese. On the other hand, a BMI of between 18.5 to 25 is considered to be a healthy weight range.

Most labeling schemes use some variation of overweight and obese, although some categorize obesity in several different stages; obesity class I, class II, or class III extremely obese. In some descriptions morbidly obese is the ultimate category. The name is indicative of the kinds of health implications that may result from prolonged excess weight.

Strategies to reduce obesity, of course, are ultimately the desired goal, but before there can be any reduction it is necessary to understand at least some of the causative or contributing factors. The reasons for this increase in obesity are many. They include a decrease in manual labor, increased time spent in the sedentary activity of viewing television or videotapes, an increase in availability of fast convenience food and a concurrent increase in average food portion size.

In the case of persons of aboriginal heritage, it is possible that the theory of the 'thrifty genotype' explains obesity levels. There are a number of different terms used to describe persons of aboriginal ancestry in North America. These include Indian, Aboriginal, Amerindian, Native, Native-American, and First Nation. For this project the terms First Nation(s) or aboriginal will be used unless quoting from published material.

The thrifty genotype theory contends that storing excess foods as body fat had a high survival value in preventing starvation, in the centuries before regular contact with Europeans. The theory goes on to propose that now that access to dependable food supplies is assured for most North Americans, storing excess food as fat is detrimental (Zimmet & Thomas, 2003). There is very likely no single causative factor for an increase in obesity in First Nations persons. Instead a number of possible causes, such as those already suggested for non-aboriginals include; a more sedentary lifestyle, change in the composition of diet to include more carbohydrates and highly processed foods.

It is important to find some of the causative factors because on the surface at least, obesity appears not to be caused by complex molecular, biological, chemical or environmental factors. At first glance it appears that *the solution* lies in lifestyle and diet, which are easily correctable with just a little will power. The reality is that people's reluctance to engage in weight loss and exercise make them among the most deeply entrenched of negative lifestyle issues. Likely, they are second only to the chemical dependencies of alcohol, tobacco, or opiates. One wonders if lifestyle modification is achievable for the majority of North Americans, without a direct matching of funding that equals the moneys spent by commercial interests that promote the lifestyle issues leading to obesity. If health authorities were to match the advertising campaigns of the food, convenience and entertainment sectors then people might have more balanced information to help them decide on strategies to succeed in losing weight, if indeed they should choose to lose weight.

Bella Coola – A profile

Notwithstanding the relatively clear-cut relationship, between obesity and disease in other populations, the impact of obesity on the health of an isolated community on the west coast of British Columbia, has not been investigated adequately.

Research that examines an isolated community divided effectively into two cultures, with many commonalities except their culture is especially useful. The data set of the Bella Coola valley community offers not only such an opportunity, but also the chance to compare an aboriginal population with a non-aboriginal one living in the same locale.

Bella Coola is a remote community of coastal British Columbia. It has marginal road access to the rest of the province and likewise both air and water access is weather

dependent. Often the weather in this area of the province is unsuitable for travel. It is located on the Pacific Ocean, at the eastern end of a deep fjord. The road to the rest of the province follows the river up the valley floor and negotiates very steep mountain terrain, which is subject to heavy unpredictable snowfalls that often close it to vehicles.

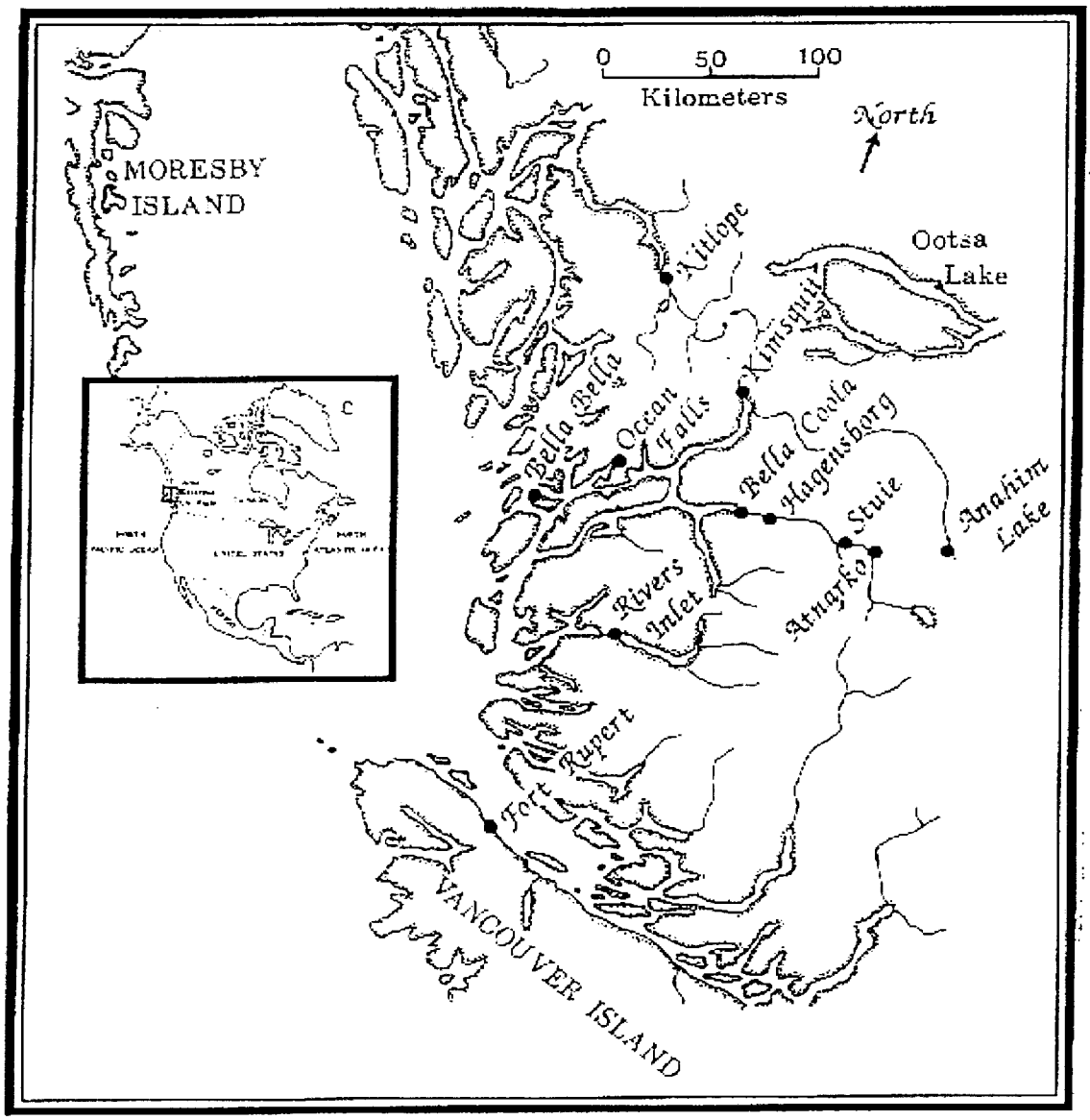

Fig.1 Central BC Coast and Bella Coola

For the last seven decades of the twentieth century Bella Coola was dependent on resource extraction activities, such as logging and commercial fishing. With the recent decline in both of these there is high unemployment, except in the sectors that are supported

by outside funds, mostly from different levels of government. Thus, employment opportunities, access to goods and services, including foods and healthcare, appear similar for both of the cultures. Any differences in obesity, BMI or health status between the Nuxalk and the non-Nuxalk in Bella Coola could presumably result from factors other than access to health services or food resources.

The population of the Bella Coola valley is approximately 2400 of which somewhat less than half (50%) are of Nuxalk descent. This area population is small enough that two or three long time residents can have knowledge of all or almost all of the residents. This isolation, limited in and out migration and small size enabled the researchers in consultation with lifelong residents to determine the origin and aboriginal status of every person enrolled in the study. Likewise, in what amounts to a contained population, it is possible to achieve a very high rate of inclusion. This approaches the 90th percentile, a figure very difficult to achieve in a larger less remote center.

The isolation of the study community, the Bella Coola valley, has both disadvantages and advantages for the researcher. On the con side it is possible that the very isolation of the Bella Coola valley affects different rates of obesity and co-morbid conditions than for a less remote or more urban area. On the pro side this isolation means that the researchers can access records of almost all of the patients of the clinic/hospital. Being able to compare basic demographics such as age, gender, and ethnicity was fundamental to this study. The examination of the medical records showed height and weight and either noted body mass index (BMI) or calculated it from the height and weight data. The charts were examined for the presence of a number of chronic diseases. These included: diabetes, hypertension, chronic obstructive pulmonary disease (COPD), diastolic and systolic blood pressure, coronary artery

disease syndrome (CADS), depression, osteo and rheumatoid arthritis, bone and joint problems, cancer. Problematic ethyl alcohol use was also noted. This research will compare the relationship between BMI and the above health conditions in both the First Nations and non First Nations populations in Bella Coola.

Research Questions

The goal of this project was to examine the prevalence of obesity and its associations with various diseases, in both the First Nation and non-First Nation populations in the isolated coastal community of the Bella Coola Valley on the West coast of British Columbia, Canada.

1. Are BMIs for Nuxalk in the Bella Coola Valley higher than non-aboriginals in the Bella Coola Valley?
2. Are diseases associated with higher BMIs in the Bella Coola Valley?
3. Are diseases more prevalent for Nuxalk or non-aboriginals in the Bella Coola Valley?

Chapter 2: Literature Review

The Problem of Obesity

It is clear from a survey of the relevant literature that obesity is a significant concern in North America (Choi, 2001; Flancbaum, 1998; Fontaine, 2000; Hall, 2002; Khaodhiar et al, 2000; Looker et al., 2001; Pickering, 2001; Rippe et al., 1998; Story, 1999; Trinano, 1999; Millar & Stephens, 1986). It impacts not only the health of individuals but contributes materially to the overall and rising costs of health care (Lau, 1999; Seidell, 1998; Philipson, 2001; Wolf & Colditz, 1998).

According to many authors there is an epidemic of obesity, in the developed Western world but in particular in North America. Friedenberg (2002, p. 629), says,

> The major increase in [obesity] commenced in the 1980's and became endemic in the 1990's, with various authors reporting a 60%-75% increase in obesity between 1991 and 2000. The prevalence of obesity defined by a BMI of over 30 as estimated by various authors, ranges from 15% to 27% in the United States, approximately one in five individuals in our [US] population.

Hall and Jones (2002, p. 657) state that, "Approximately 97,000,000 people in the United States are overweight or obese." There is no reason to think that the percentage of obesity is much different in Canada. For example, Lau (1999, p. 503) asserts that, "according to the Canadian Heart Health Survey, close to half of adult Canadians are overweight and 1 in 6 is obese." This is slightly better than the rate in the US, but is small comfort.

BMI and Other Measures of Obesity

One standard measure of obesity is that of body mass index (BMI). BMI equals weight in kg /height in meters^2. The BMI scale runs from 10 to 70. A BMI between 10 to 18.5 is considered to be underweight, 18.5 to 25 a healthy weight, 25 to 29.9 is considered overweight, greater than 30 is obese. Some previous scales notably that of the World Health Organization broke obesity into three classes: I, II, III, with class III as the most obese.

The use of the term BMI as a measure of overweight has a history going back only until 1989 (Kuczmarski, & Flegal, 2000). Prior to that a variety of weight vs. height tables and measures were used, Many of these approximated the present BMI, but none was standardized or used universally, but life insurance companies wanted to use a standardized measure. Even today BMI is not always used or defined in the same way but the most common operational definition is that stated above, which is used by the U.S. National Institutes of Health (Kuczmarski, & Flegal, 2000).

> Troiano and Flegal (1999) distinguish between overweight and obesity. The terms obesity and overweight are frequently used interchangeably, but they are distinct conditions. Obesity indicates excess adipose tissue, whereas overweight indicates excess weight for height, regardless of the composition of the weight. Obesity is often the variable of interest, but it is sometimes impractical to obtain a direct measure. To assess overweight, only a scale to measure weight and a stadiometer to measure height are needed (p. S-22).

There are many other non-invasive ways to accurately assess the amount of body fat a person has. Styne (2001), details some other methods of gauging body fat. He suggests that

these may be more accurate than BMI, but are likely more complex in either required training or equipment needed.

> Underwater weighing has long been considered the best method of evaluation of body fat. Dual-energy X-ray absorptiometry is considered to be close in accuracy. An air displacement plethysmograph (BOD-POD) is now available and has been shown to be accurate in children. Subcutaneous skin fold thickness determination is linked to the amount of body fat, but a trained observer in this technique is not available in most clinics. Bio-electric impedance measurements are easy to perform and seem to be as accurate as [sic] are skin fold determinations. CT and MR imaging scans will demonstrate the regional distribution of body fat (Styne, 2001, p.825-826).

Overweight is generally defined as weight that exceeds the threshold of a criterion standard or reference value. Reference values are generally based on observed population distributions of measured weight, whereas criterion standards are based on the relation of weight to morbidity or mortality outcomes. The distinction between references and standards is important because it indicates whether the source of the weight criteria is based on descriptive statistical distributions or on health outcomes. References, such as those based on the National Health and Nutrition Examination Survey (NHANES) and standards such as the Metropolitan Life Insurance Company (MLIC) tables have had widespread use in the United States. These standards were developed because there was no consistent way of defining obesity or overweight prior to the definition of BMI.

> Definitions of overweight have varied widely and there has not been a simple uniform definition. Numerous publications based on the recommendations of expert committees have struggled with developing working definitions of weight status.

These recommendations have evolved from weight for height standards to sex specific population dependent references. The most recent transition is a movement toward a single body mass index (BMI: in kg/m^2) standard that is *applicable to all adults. Because it is independent of age and reference population, BMI can be used for comparisons across both in the United States and internationally* [italics added] (Kuczmarski, & Flegal, 2000).

The use of BMI as the sole criterion for obesity is problematic. Kuczmarski and Flegal's assertion that BMI can be used internationally seems to fly in the face of common knowledge. One has only to imagine BMI applied to populations with obvious morphological dissimilarities. These include some Polynesians (Tongans, Samoans), the East African Masai and of course the Mbuti pygmies of Zaire. This is not to say that it is not possible that these other populations never suffer from obesity, but rather, questions whether or not BMI, as defined, is a completely appropriate measure of all populations. BMI, however, is still one of the primary markers for obesity. Most researchers use it as an initial measure for all ethnic groups, including First Nations.

Obesity Related Morbidity

Awareness of the association of obesity with health problems is longstanding. A classic example of the emergence of an obesity-disease link was the 1921 observation by Joslin that a large proportion of diabetes patients were overweight (Visscher & Seidell, 2001 p. 355). BMI has been shown repeatedly to be associated with excess morbidity and mortality, most notably from cardiovascular disease, diabetes mellitus, and hypertension, but also stroke, gallbladder disease, hyperuricemeia, gout, and osteo-arthritis (Khaodhiar,

McCowen, & Blackburn, 2000; Aronne, 2001; Reeder & Bouchard, 1999; Alexander, 2000; Flancbaum & Choban, 1998; Pickering, 2001; Bjerregaard, et al., 2003; Dobbelseyn, Joffres, Maclean, Flowerdew, & Canadian Heart Health Surveys Research Group, 2001; Trakas, Oh, Singh, Risebrough & Shear, 2001). In addition to all of the above morbidities associated with obesity and overweight, Visscher and Seidell (2001) point out that there is a strong correlation between endometrial cancer and obesity, and a moderate correlation between obesity and breast, kidney, colon and possibly gallbladder cancers, (p.363).

Interestingly however, Ikeda, Hayes, Satter, Parham, Kratina, Woolsey, et al (1999) contend that in the absence of bio-chemical risk factors such as elevated serum cholesterol, triglycerides, insulin, glucose, or blood pressure, it is fitness rather than overweight or obesity that determines morbidity.

> Barlow and colleagues have strong evidence in support of their contention that fitness, not fatness, makes the difference in chronic disease risk. In a study of more than 21,000 men of varying body sizes, they found that unfit lean men with body mass indexes of 25 or less, had twice the risk of mortality from all causes than fit overweight men with a body mass index of 27.8 or greater. (Ikeda, et al., 2000, p 919).

Obesity and Obesity Related Morbidity and Mortality in First Nations

The literature also makes it obvious that obesity is exceptionally problematic among First Nations populations . Young and Sevenhuysen (1989) state that this increase in obesity is of relatively recent origin.

> Ethnographic observations, clinical impressions, and limited survey data support the conclusion that obesity is now very widespread in many groups of Indians. Yet as recently as the 1940's two surveys in sub arctic communities in the James Bay region and northeastern Manitoba revealed a native population on the brink of starvation, with deficient energy and nutrient intakes. By the 1970's a nation-wide nutrition and anthropometric survey showed that Canadian Indians generally had much higher weight for age compared with Canadians nationally (1989, p.786).

Young, writing in 1996, looks at some of the socio-cultural and behavioral determinants of obesity in the Canadian Arctic. In his analysis, socio-economic status (SES) is linked with obesity. That is the higher a persons SES, the more disposable income they have, the greater likelihood they will become obese. He says that in part this may be because the higher SES allows them to indulge cultural and personal preferences.

The effect of SES on obesity probably operates through differential food intake and energy expenditure. Cultural values, which favor a fat body shape, assigning it social prestige and sexual attractiveness, promote greater food intake among the well-off, who possess the necessary means. (p.1665)

DeGonzague, Receveur, Wedll, and Kuhnlein (1999) contend that the translocation of First Nations to reserves and the consequent restriction in access to traditional foods, loss of cultural identity, and knowledge combined with ease of access to European foods, have contributed to the rise of obesity in the Ojibwa First Nations in Minnesota There is no reason to think that these factors are unique to the Ojibwa.

Bjerregaard et al., (2003), studying blood pressure in Inuit throughout the Arctic, found that even though the study populations had BMIs in the highest quartile, their blood pressures ranked lower than the non Inuit populations with which they were compared. They do suggest that higher rates of smoking among the Inuit studied may have contributed to lower blood pressures.

Coronary heart disease in at least one First Nation community was found to be higher than the mainstream Canadian population, but also associated with C-reactive protein, a predisposing genetic factor, which is associated with obesity. The study also found that C-reactive protein was associated with insulin resistance (Connelly, Hanley, Harris, Hegele, & Zinman, 2003). This supports the possibility that both obesity and associated morbidity in First Nations may have related genetic antecedents.

First Nations and Diabetes

Obesity contributes to the very high rates of non insulin dependent diabetes mellitus, in some First Nations groups (Benyshek, et al, 2001; Bruce,2000; Davis et al, 2000; Herdegen, 2002; Krosnick, 2000; Lee et al,2002; Levin et al, 2001,). Diabetes mellitus type II [1]was once known as adult onset diabetes. It is no longer referred to by this name as there has been a great increase in type II diabetes in children, some as young as five years old, especially in First Nations communities (Benyshek, Martin & Johnston, 2001; Story, Evans, Fabsitz, Clay, Holy-Rock, & Broussard, 1999; Krosnick, 2000; Lee, Welty, Cowan, Wang, Rhoades, Devereux, Go, Fabsitz & Howard, 2002; Levin, Mayer-Davis, Ainsworth, Addy & Wheeler, 2001).

[1] Diabetes mellitus, type II, is characterized by decreased insulin production or by insulin resistance, and has historically been seen as a disease of persons over 40 years of age. Diabetes mellitus, type I, is notable for the complete lack of endogenous insulin production.

Choi and Shi (2001) examined data from the 1996-97 Canadian National population Health Survey to determine the prevalence and risk factors for diabetes mellitus for the Canadian population as a whole. They found that prevalence rates varied with age but peaked at between 4.9 -5.8 percent of the adult population: "The prevalence rates increased with age and body mass index and increased inversely with energy expenditure in both males and females" (Choi & Shi, 2001, p. 1221).

A cross sectional survey of children aged 4-19 years old in a First Nation community in North-central Canada, found not only that there was a higher than normal rate of type 2 diabetes, but that the prevalence of obesity in this population was 48% for the girls and 51% for the boys.

> Of particular concern is that 33% of girls and 35% of boys in this population exceeded the 95th percentile. Rapid social change occurred in the past three decades in this and many other Northern Canadian communities, with increased reliance on store-bought food and decreased physical activity. Consequently, the prevalence of obesity and diabetes in adults has increased. (Dean, Young, Flett & Wood-Steiman, 1998, p.1523).

Costs of Obesity

Regardless of how it is measured, most authors agree that obesity, as opposed to mere overweight, is a predictor of illness often diabetes mellitus, especially type II.

Obesity and all of its resulting morbidity is an enormous problem in the developed world and costs billions of dollars annually (Philipson, 2001). Colditz (1999) reports that the costs of obesity in the U.S. alone, for the year 1995, were over 70 billion dollars. Keiss and

Boetner, (2002, estimate that "at least 30 billion dollars are spent annually in the U.S. on diet foods and products and programs to lose weight", (p. 182).

In the Canadian context, Lau (1999, p. 503) says,

> The economic costs of obesity are high, ranging from 2%-10% of the total health care budgets of different countries. For the first time we have a realistic estimate of the direct cost of obesity in Canada: about $2 billion per annum, or 2.4% of the total health care budget.

In addition to these direct costs, there are also the costs of early retirement and disability pensions, not to mention lost productivity (Colditz, 1999; Seidell, 1998; Wolf & Colditz, 1998 Visscher & Seidell, 2001).

Causes of Obesity

Much of the literature examined makes the point that the fundamental cause of obesity and overweight is a mismatch between the caloric value of food ingested and the energy expended in activity. This may seem so obvious as to be not worth mentioning, but ultimately all obesity treatment strategies must come back to either reducing the number of calories metabolized, increasing the amount of energy expended, or the most successful strategy, doing both simultaneously (Lau, 1999; Hall & Jones, 2002; Friedenberg, 2002; Keiss & Boettner, 2002; Robinson, 2001; Maehr, 2002; Stettler, 2002; Molnar & Livingstone, 2000). However, notwithstanding the mismatch between energy intake and energy expended, there are several other causes besides over consumption of food or inactivity that may contribute to obesity. These include genetic predisposition, hormone imbalance, and social and cultural factors.

A genetic predisposition to obesity may stem from an individual's parents or grandparents, but it is difficult to distinguish genetics from social and lifestyle issues. The child of obese parents may also be obese, not because of heredity, but because the parents consume unhealthy amounts of high calorie foods while maintaining a sedentary lifestyle and pass these habits on to their offspring.

Hormone imbalances do occasionally result in obesity, but they are much rarer than is commonly thought by members of the public (Merck Manual, 1992 p. 2281). Social and cultural factors, however, may both contribute substantially to obesity. Davis, Northington and Kolar (2000) indicate that in the U.S. African-American women may not view obesity as negatively as Caucasian women do. They report that many obese Black women view themselves as attractive and consequently there is less social pressure to lose weight. Cultures with a recent history of a hunter/gatherer lifestyle, may value food differently to the modern necessity for food security. That is, cultures in which, until recently, fear of starvation or inadequate nutrition was common, may place excessive value on food relative to the ease of obtaining food in a modern developed setting (DeGonzague, Receveur, Wedll, and Kuhnlein, 1999).

A cultural factor that undoubtedly plays a large role, at least in the developed world is that of the influence of the food industry, especially the processed food and chain restaurant sectors, as described by Lang & Heasman (2004). Purveying fast and convenience foods is very big business, and the substantial advertising budgets of these industries has considerable influence on the eating habits of North Americans and probably also on most other first world countries. As many of the foods sold by these sectors are high in fats, sugars, salt, and most especially calories, and since much of the advertising is aimed at segments of the

population that may not yet have fully developed critical thinking skills, namely children and adolescents, these industries may contribute to the obesity problem. Even more problematic than the issue of children and teens eating high caloric foods is that they may also be developing lifetime habits of eating these same foods (Lang & Heasman, 2004).

Not only may there be social and cultural pressures encouraging obesity, there may be a physiological predisposition to store excess food as adipose tissue. This is the premise of the thrifty genotype theory, first propounded by Neel in 1962 (as cited in Zimmet & Thomas, 2003).

> Humans have evolved with genes that determine increased fat storage, which in times of famine represent a survival advantage, but in a modern environment results in obesity and type II diabetes. This genotype was necessary for survival because during the course of history there was never a long period of uninterrupted food abundance, whereas famines were regular and frequent. ... The theory also assumes that the detrimental effects of being overweight were irrelevant after the procreative period in a population with a very short life expectancy. (Zimmet & Thomas, 2003, pp. 116-117)

Likely, this is somewhat oversimplified and while the thrifty genotype does contribute to the prevalence of obesity and type 2 diabetes, it is not the sole cause of obesity in indigenous peoples (Flodmark, 2002; Busfield et al., 2002).

Obesity in Children

In addition to an overall increase in obesity in North America, there has been a significant increase in obesity in children and young adults. Broadwater (2002) states that in the "1999 National Health and Nutrition Examination Survey (NHANES), 22% of children

and adolescents- that's more than one in five- are considered overweight, which elevates the condition to epidemic proportions"(p.37). Likewise, Deitz and Gortmaker (2001) indicate that between the second NHANES in 1980 and the third in 1994, the number of children and adolescents considered overweight increased by 100% in the U.S. Goran, writing in 2001, explores the metabolic and microbiologic research conducted on childhood obesity between 1990-1991. He acknowledges that there have been major advances in knowledge about the biochemical nature of obesity but also poses many unanswered research questions. However, Troiano and Flegal (1998) caution that:

> Studies comparing BMI with measures of adiposity have shown high correlations between the measures. However it must be noted that BMI is not as reliable a measure of fatness for children, especially across different ages and degree of maturity, as it is for adults, who have attained their peak weight. Studies that show good correlation between BMI and adiposity in youths find that other factors such as gender, race, age and maturational status are important to consider in predicting adiposity. The estimates of adiposity also are subject to a substantial degree of imprecision (p. 497-498).

Davis, Northington and Kolar (2000) argue that the influence of parents on obese children is a key factor, especially if the child is a member of the non-dominant culture. They contend that obesity in the parents themselves, and their cultural values, may have a strong influence on childhood obesity. This is especially alarming, as it may presage not only obesity in adulthood but also obesity-related disease at a younger age. Moran (1999), speaks to the issues of adult sequelae of childhood obesity.

> Treatment of obesity in adults is notoriously frustrating for patients and physicians alike, and it rarely meets with long-term success. Thus, prevention is the best hope for decreasing the prevalence of this condition. In many obese people, the roots of their disorder can be traced back to childhood. Obesity tends to `track` throughout life, meaning that its presence at any age will increase the risk of persistence at subsequent ages. While most obese infants will not remain so, they are at increased risk of becoming obese children. These children are in turn more likely to become obese adolescents, who are then very likely to remain obese as adults. (p. 861)

There are many negative sequelae associated with obesity in childhood. Ball and McCargar (2003) reinforce that obesity is on the rise among Canadian children and that it has been shown to be a predictor of cardiovascular disease and type 2 diabetes in adults who were obese as children. Deitz (1998) says that not only are there adult physical sequelae of childhood obesity, but there are also significant psychological issues related to adolescent obesity. "[O]bese adolescents develop a negative self-image that appears to persist into adulthood" (p.519). Deitz (1998) also says that overweight or obese children are often thought to be more mature than they actually are, with associated increased expectations based on this perception. They may be socialized differently and may become preoccupied with weight as adolescents or young adults. In addition to psychological issues, hyperlipdemia, glucose intolerance, hepatic steatosis and cholelithiais are associated with childhood obesity (1998, p.521). Keiss and Boettner (2002) assert that psychosocial issues are a cause of both some adolescent obesity and co-morbidity. They also think that lifestyle plays a large role in obesity.

> Exogenous factors such as over consumption of fat-rich diets, excessive use of modern media (in particular, television viewing) and lack of physical activity (sedentary life style) heavily contribute to the development of obesity, particularly in adolescence. Children and adolescents [in the U.S.] aged 8-18 years spend an average of 4.5 hours/day watching television and videotapes and playing video games. Demographic groups at highest risk for obesity, such as African Americans, Latinos, and children from families with low income tend to watch even more television than other US children. (p. 184)

Robinson (2001), a pediatrician, addresses the relationship of childhood inactivity with childhood obesity by suggesting that there are likely three possible mechanisms for the association between obesity and television or video watching. They are: (1) displacement of physical activity, (2) increased calorie consumption while watching or caused by the effects of advertising, and (3) reduced resting metabolism. He reports the results of a randomized control trial in San Jose, California that used as interventions; self monitoring of TV viewing, television turnoff periods, television budgeting and advocacy. These interventions were successful in reducing the BMI of the children by statically significant amounts after six months. Luepker (1999) notes that participation in high school physical education decreases in the more senior grades and that the overall rate of participation was almost 20 percent lower in 1990 than in 1984. This of course parallels the rise in obesity in youth. Molnar and Livingstone's (2000) review of numerous surveys and studies of childhood and adolescent activity levels indicate that the situation is similar in Europe and the United Kingdom.

Another physician, Stettler (2002), presents statistics indicating the influence of fast foods on the diet of North American children and adolescents. He states that the total

number of restaurants in the US increased by 89 percent between 1972 to 1995, and that fast food restaurants in particular increased by 147 percent in the same period. He notes that:

> Another societal change in the past few decades is the increase in the average portion size. For example, the normal size of a Coca Cola bottle increased from 6.5 oz in 1916 to 10 oz in 1950, to 20 oz in 2001. Furthermore, the `king sized` bottle was 12 oz in 1950 and 32 oz in 2001. It is interesting to observe that the present `child sized ` Coca Cola served at Macdonald's restaurants corresponds to what was the `king sized` in 1950 (2002).

Not all adolescent obesity is of purely environmental etiology. In fact, Maehr (2002) stresses that there is a genetic component to much adolescent obesity. She says that up to 80 percent of the variance in BMI was attributable to genetics when experiments with twins were carried out.

Although much of the responsibility behind environmental factors leading to childhood obesity would appear to lie within families, Story (1999) suggests other avenues for addressing this problem. In a review of the literature from 1965 to 1999 she examines the use of schools as delivery systems for intervention against childhood obesity. She looks at 11 controlled experiments that are secondary efforts, that is, they are targeted at children who are already obese, as well as a primary strategy that targets all children with the goal of obesity prevention. As the latter is a proposed strategy, there are no results as to efficacy. Story et al (1999), also detail obesity in American Indians and look specifically at childhood obesity programs aimed at First Nation children. They contend that since interventions aimed at obese First Nation adults are rarely successful, efforts should be made to circumvent the development of patterns of obesity in childhood.

Obesity Treatment

Although there is agreement about the health risks of overweight and obesity, there is less agreement about their management. Many health care providers seem to focus on the consequences, such as hypertension, dyslipidemia, and diabetes, rather than the root causes and treatment of obesity, per se. Some researchers have even argued against treating obesity because of the difficulty in maintaining long-term weight loss, the potential negative consequences of the weight cycling in obese subjects, and the overall costs of treatment. Others argue that that the potential hazards of treatment do not outweigh the known hazards of being obese. (Hall & Jones, 2002, p.657).

Gumbiner (1999) outlines several strategies to reduce excess weight and, as importantly, to avoid regaining the weight once it has been shed. He stresses that one of the most fundamental tasks is to set a realistic and attainable goal. This is usually a gradual weight loss of ten percent over a six-month period. He suggests the weight reduction strategy of not only decreasing caloric intake but also concurrently increasing exercise is likely to be most successful. He feels that lifestyle modification is at the heart of a successful weight loss program. This lifestyle modification might include behavioral therapy. If lifestyle modification has been tried for six months and is not sufficient, he suggests that other strategies, such as a pharmacological approach and surgery should be considered. Gumbiner(1999) also emphasizes that weight loss should be a multidisciplinary effort and, given the overall societal costs and the impact on the individual patient's health, that it be accorded a more prominent place on physician's agendas. Indeed, Hall and Jones, (2002, p. 657) cite the World Health Organization stance: In 1997, the World Health Organization (WHO), with data from

worldwide surveys, issued a statement indicating the 'obesity impact is so diverse and extreme that it should now be regarded as one of the greatest neglected public health problems of our time.

WHO also say

> [A] major obstacle in successfully treating obesity has been the lack of involvement of the health care profession. The mere suggestion by a physician of the need for weight loss will bring about a change in lifestyle of some patients. .... However, less than half of obese adults report being advised to lose weight by their physicians (p.658).

Other authors agree that physicians could do more to treat obesity. Lyznicki et al., (2001) offer reasons why physicians may be reluctant to treat obese patients suggesting they:

- Lack the time for patient education /counseling on weight loss and weight maintenance
- Lack recognition of obesity as a chronic condition that is difficult to treat, requires continuous and long-term management, and has high recidivism rates
- Have insufficient data on the effectiveness of physician weight loss counseling
- Are skeptical about the success of any medical treatment of obesity
- Lack data about the long term safety and efficacy of pharmaco-therapeutic agents for obesity
- Have negative and unsympathetic perceptions that obesity represents a lack of patient discipline, self-control or will power rather than a chronic disease
- Have inadequate training in the medical management of obesity (p. 2193)

Lastly there is a "Lack of patient interest or readiness for treatment " (p. 2193)

Another kind of obesity treatment is that of self treatment by means of popular or fad diets. Riley (1999) examines the spectrum of popular weight loss diets and evaluates each type as to its merits according to three criteria: the match between the program and the consumer, the soundness and safety of the diet program, and the outcomes of the program. She also distinguishes between those diets that are meant to be used by individuals alone, those that are aimed at lay groups, such as Weight Watchers, and those that are aimed at persons who will be undertaking a weight loss program under the guidance of a dietician, physician or other health professional. Riley stresses that the match between the diet program and the consumer is an important consideration when choosing a diet plan. Some popular diets can actually be dangerous to those with certain health conditions. For example, very low carbohydrate, high protein diets are effective because the dieter's body goes into ketosis. This is a potentially harmful condition to obese individuals, especially those with co-morbidities. Riley asserts that many popular diets do not adequately discuss safety and that several, including the above mentioned low carbohydrate, high protein diet exemplified by the very popular Atkins Diet, may be effective for short term weight loss but are unsound and not sustainable for weight maintenance, especially for those who are physically active.

However, while an Atkins-style diet may be unsuitable for active persons, numerous authors concur that exercise used in conjunction with diet is much more likely to be effective in achieving and maintaining weight loss. Additionally, exercise may well contribute to fitness; and as Ikeda et al., (1999) contend, being fat and unfit is often a precursor of disease while being fit and fat may not lead to disease. Other strategies that may be considered are: pharmacological treatments, psychological therapies and surgery. The other trend evident in a review of the literature is the comprehensive team approach, including a dietician,

physiotherapist, home care nurse, and perhaps even a personal fitness trainer, in addition to the physician, that may lead to a more successful outcome (Aronne, 2001; McInnis, 2000; Rippe & Hess, 1998; Ross, Janssen & Tremblay, 2000; Weiss, 2000).

Conclusion

The existence of commercial diet and weight loss programs and books in North America, and the fact that so many members of the public are willing to part with their money to try to lose weight, says much about both the success and the failure of the mainstream health services' efforts to promote healthy weight. On the one hand, health services have done an excellent job in convincing the public that being overweight or obese is unhealthy. No doubt part of the public's concern with weight is an unhealthy preoccupation with appearance as exemplified by anorexic super-models. On the other hand, the existence of a commercial weight loss industry speaks to the failure of physicians and dieticians to address weight loss. Anecdotally, many patients are told by their physicians to 'lose some weight' but given no strategies to do so. Many members of the public have no idea how to access a dietician even if they should have a chronic disease such as diabetes.

The authors of commercial diet schemes have discovered an unfilled niche. That of the frustrated dieter, and are providing what that group desires. Notwithstanding that this niche market is often addressed in a manner than is less than truthful or even ethical, those with commercial interests have figured out the marketing part of weight loss, as the mainstream health providers have not. Because weight loss involves life style change and not an immediate life threatening medical or surgical crisis, it needs to be marketed effectively if we are to stop or reverse the epidemic of obesity. Physicians in the past may

have been reluctant to advertise themselves or their services in this regard, perhaps because of a concern not to be seen as *snake oil* salesmen; but it is time for this to change. Obviously, a major part of the responsibility for weight loss resides with the clients; however, all health professionals, not only physicians, have a responsibility to assist those who desire to effect a change in themselves. The role of institutional players and regional health authorities in making commitments to health promotion activities around weight loss needs to be expanded.

Obesity and overweight are a major public health concern in North America and especially so in First Nations. Given that First Nations populations often have less than optimal access to health care services, frequently due to their geographic isolation, it is exceptionally important to help them to address the obesity in their communities. There remains a very large scope for further research and action in this area.

Chapter 3: Islands, Anthropometry, and the Nuxalk People

The concept of islands as a factor affecting health is a fairly new one, and one that has received relatively little attention except in regard to communicable disease epidemiology. The even newer issue of geographically isolated mainland or non-island communities as having much in common with islands has been investigated even less. This chapter will look at some of these issues in addition to that of anthropometry in isolated populations. Anthropometry relates to the issues of the appropriateness of BMI as an indicator of adiposity in all groups of people. It is possible that the Nuxalk have different BMIs from Europeans, not because they are obese or overweight but because, morphologically they are different. The important question is, of course, is there a relationship between their adiposity and disease prevalence. This chapter uses concepts of anthropometry to explore potential bio-cultural explanations for the morphology of the Nuxalk.

Islands

Islands are a fundamental geographical construct. Funk and Wagnall's dictionary defines island as "a tract of land entirely surrounded by water"(p.456). However, the second definition is "something resembling an island and set apart from its surroundings as a piece of elevated woodland or a section of a thoroughfare kept free of traffic for the safety of pedestrians" (Fitzhenry & Whiteside, 1989). Using the second definition, especially in relation to human population and physical communication, a remote and isolated town, village or area of human habitation can be, and in some circumstances should be, considered

an island. Thus Lewis and Rapaport (1995) include "isolated highland locations" in their discussion of island health transitions (p. 223).

Cliff and Haggett (1995), in their paper on the epidemiological significance of islands, said:

> Although islands appear to be simple and self-defining entities their operational definition for research purposes turns out to be surprisingly elusive.... For example, since islands form a classic example of one of Mandlebrot's fractal series, questions of their number will always remain unanswerable (p.199-200)

Bella Coola

The subject area of this project, Bella Coola, British Columbia (BC), may well be considered as an island. Bella Coola is a community including approximately 1200 people in the village itself with a further 1200 people throughout the rest of the narrow valley in the Coast mountains of British Columbia in which it is located. The population of those using the Bella Coola Valley Medical Clinic is higher than the 2400 people who live in the valley, as there are several more distant communities for whom the clinic is the nearest source of definitive health care. For this project only those persons resident in the Bella Coola valley were included.

The largest population group in the valley is made up of approximately 1120 Nuxalk (Bella Coola) First Nations people. The balance of the population is composed of non-aboriginals with numerous descendants of a Norwegian colony dating back to the last years of the Nineteenth Century. Economic activities in the past included resource extraction, primarily fishing and logging, but both of these resources have been seriously depleted and

hence resource extraction has assumed much less importance recently in the community's economy.

Before contact with Europeans, Bella Coola was but one of a series of Nuxalk village sites that existed up and down the fjord-like inlet; but since contact it has become the main village for the Nuxalk people. The Nuxalk culture was typical of Coast Salish speakers, with complex permanent and semi-permanent villages. The pre-contact Nuxalk were dependent for food on the locally abundant seafood, berries and indigenous mammals (Kopas, 1970).

Bella Coola is located on the Pacific Ocean at the end of an 85-km long fiord in the Central Coast section of BC. Residents have access to the rest of the province through a 500 km long road, with a very steep, unpaved, mountain section that is often closed due to avalanches or other weather conditions. Indeed, it has only had this road access to the rest of BC since 1953 when the villagers, with only minimal support from the provincial government, built themselves a road through the Coast Mountains (Kopas, 1970; Self, 1986). The terrain to both the north and the south of the valley is very steep, impassable, ice covered mountains. Bella Coola has scheduled air service, but this is also subject to interruptions because of weather. Likewise, while its harbor facilities can accommodate medium sized ships, marine access is also subject to weather conditions. In terms of access, it has many commonalties with islands even though it is on the mainland.

Access to Health Care

The island-like features are especially apparent when access to medical services is considered. There is a medical clinic and a cottage hospital in Bella Coola, staffed by between two and four physicians, with the appropriate support staff; that is, nurses, a

pharmacist, imaging and laboratory technologists and other ancillary staff. There is only very limited major surgical capability and then only for the stabilization of simple and straightforward emergency cases. Depending on the qualifications of whichever locum happens to be present, there are usually no anesthesia services, and obstetrics is limited to low risk pregnancies.

The similarity to a true island becomes obvious when both patients and health care providers are making plans to address health issues. The relatively limited services, combined with dependence on transportation options that may be severely impacted by weather conditions often renders access to secondary or tertiary health services for patients from Bella Coola problematic. Naturally, these kinds of situations can also arise at well-connected mainland sites as well. The famous Canadian ice storm in Ontario and Quebec no doubt resulted in lack of access for some patients for a brief time. This was, however, a very rare event in Eastern Canada, while it is almost a routine consideration in Bella Coola.

Royle (1995) said, about the United Kingdom's small island colonies in the South Atlantic ocean, "Regarding health service provision, population mass can be insufficient for high order services to be provided, whilst isolation leads to high costs for on-island services and in taking patients to off-island services" (p. 257) Writing about health care distribution on the large island of Sri Lanka, he notes that even with a population of 18 million people, there is a:

> ...marked concentration of state sector hospitals and key health personnel in the densely populated Columbo Metropolitan Region. Urban bias is evident in the lack of higher grade hospitals in peripheral areas ...[but] the highest priority is now being

accorded by the state to providing healthcare facilities to underserved and vulnerable populations in order to reduce existing disparities.(1995, p. 235)

Royle also notes,

> Another problem related to scale and isolation is that the islands' health care services cannot be geared up to deal with complex and expensive procedures, so medical evacuation is needed for such cases. The speed and frequency with which `medevacs' can be offered varies with the level of isolation. (p. 261)

An example of how these kinds of island health issues affect Bella Coola may be informative. A health care provider in Bella Coola, counseling a potentially high risk pregnant mother to be, will often suggest that the patient depart the community well in advance of the onset of labor, whereas the same patient in a small community with similar services but reliable transportation options might wait until just before or even after labor commences to seek secondary or tertiary care.

These issues of connections with the main body of Canada can also affect patients and service providers from other communities. Ruth Kuhl-Vehn, an RN who sometimes works in the outpost nursing station of Anahim Lake, the closest community to Bella Coola, said,

> You have to always be thinking about the weather and the time of year and darkness, before you decide whether to send them [a patient] to Bella Coola or Williams Lake. Bella Coola is way closer and they can see a doc within two hours or so, but if they need more than the Bella Coola docs can do and the weather is bad, they could be worse off than taking longer to go to Williams Lake.
>
> (personal communication, August, 17, 2003)

This mirrors the author's experience as an outpost nurse in Anahim Lake. Bella Coola is usually two hours away by road ambulance versus five hours to Williams Lake, but there is a general surgeon in Williams Lake versus none in Bella Coola. However, most importantly, Williams Lake has an airport that can accommodate air ambulance flights through a much greater range of adverse weather than Bella Coola can.

Equally, access to services for chronic or non-urgent or non-emergent conditions, necessitates either a minimum of a day long surface journey or an expensive flight with at least a one night layover; or waiting for a visit from a traveling professional. Some services are never offered in the community itself, and always require a journey by the patient. Other services may depend on the coincidental presence in the community of a health professional capable of the delivery of the particular service. For instance there is, at present, a dietician practicing in the community, but that person has only been in the community for two years. Prior to that, access to a dietician was dependent on annual or semi-annual visits or a journey to seek one out.

In a small remote community, the number and presence of health professionals is to some extent dependent on luck. Currently, whether or not some kinds of health professionals are practicing in Bella Coola is dependent on the increasingly problematic ability of the health professional's spouse to find employment.

Phillips (1995) notes that:

> In service terms, small populations may not reach critical thresholds to enable certain types of health and social services to be provided, although in larger islands this usually less of a problem. There may be difficulties of recruitment of highly trained staff and professional isolation may occur. Balanced against this is the advantage

some professionals perceive of working alone or in small teams often in pleasant environments. (p.195)

On the other hand, Phillips (1995) refers to a review by Hotchkiss who notes:

> ...a number of these [above] features and also points out that many islands have desirable features such as an orientation to primary care; easy access to whatever local services are provided, care by generalists, respect for local practices; and recognition of the need to establish links with larger centers for both service provision and professional development. (p.195)

Food Access

Another similarity between Bella Coola and many true islands is the price and availability of healthy foods. As Bella Coola is a relatively long way from grocery wholesalers, and as transport times are relatively long, fresh fruit and vegetables are more expensive than in a larger center. Additionally, as in any small community, there exists the potential for a shopkeeper to misjudge quantities to be ordered. The ability of a shop to absorb the losses associated with spoilage of fresh produce and dairy products necessitates the shopkeeper to raise prices to account for these losses. This may further decrease the access to these healthy foods, especially when one considers that a significant number of residents are seasonally employed or underemployed. The number of regular salaried jobs in Bella Coola is limited and these are often only accessible by those with educational qualifications greater than a high school diploma.

One partial solution to the high costs of healthy foods, at least for the Nuxalk, is to increase their use of traditional foods such as roots, greens, berries, wild game meat and

seafood. Kuhnlein (1987) reports that the project she was associated with was able to increase Nuxalk consumption of traditional foods a significant amount with relative ease. Reversion to traditional foods has several benefits: it is likely to be healthier, it helps isolate the person or family from the cash economy and allows them to reserve what cash they may have for other uses. The very act of catching or gathering the traditional food may well contribute to often much needed physical exercise.

Islands and Epidemiology

While reviewing some of the literature about islands and health matters some patterns became evident. Living on an island, depending on its size (continent sized islands or islands with large populations are a different case) may have both advantages and disadvantages.

> By their bounded nature, islands are often clear entities for health care research and, with a few exceptions, inhabitants are restricted to local services. This leads to problems and some opportunities. Islands are often isolated and there are potential problems of communication but this isolation can provide some protection from some types of diseases. However, the same isolation may lead to susceptibility to infectious disease owing to low immunity. (Phillips, 1995, p.195)

Certainly, in the context of early contact with Europeans, the Nuxalk experienced some of the same kinds of devastating virgin soil epidemics that decimated other First Nations in Canada, notably measles and smallpox (Waldram, Herring & Young, 1995). Lewis and Rapaport (1995) refer to this catastrophic exposure to novel disease as the first stage of epidemiological transition in their article on health transitions in Pacific islands.

Phillips (1995) describes some further health implications of islands some of which correspond to life in Bella Coola.

> Some island epidemiological problems such as the rapid emergence of non-communicable disease.... are in many ways a reflection of socioeconomic and health care success. However this type of success brings its own problems, particularly when resources are limited and other epidemiological needs from infections and nutritional problems continue. Today many islands seem to have epidemiological profiles that reflect all types of medical and social needs: infectious and parasitic conditions; chronic and degenerative diseases; psychological and psychiatric morbidity; and the social needs of very young and very old people. ... [T]here is evidence of social problems and emergence of industrial and road accidents at high levels in some places. Many islands do have low incomes and poverty can be widespread albeit in attractive settings.... Remoteness , small scale and populations mean that the economic opportunities and the health care facilities of these islands are limited and that inhabitants may have to make do with restricted emergency health care even if health appears remarkable good in the circumstances. (p.195-6).

Kalla (1995) refines the concepts of health transitions and epidemiological transition. These include: urbanization, industrialization, rising income, expansion of education and improved medical and public health technology. The latter leads to a decline in infectious disease mortality, which in turn leads to a decrease in fertility in the human population under the category of demographic transition. Under the heading of epidemiological transition Kalla identifies the decrease in fertility leading to an aging population which in turn leads to an increase in rates of chronic and non-communicable disease. These changes may be

accompanied by economic recession and increasing inequality, which may in turn result in the re-emergence of communicable disease.

Some of the transitions Kalla (1995) describes have taken place or are, indeed, taking place now in Bella Coola and this model informs about possible future developments. However, it should be remembered that Kalla was writing about the Indian Ocean island of Mauritius and not all of these concepts should be applied to Bella Coola unreservedly or simplistically. This is because Bella Coola is not truly an island, is not in the Indian Ocean, but most importantly is a part, albeit remote, of a First World industrialized nation, which undoubtedly provides financial support to Bella Coola far beyond what it might be expected to generate by itself.

Anthropometry

The *Encyclopedia and Dictionary of Medicine, Nursing and Allied Health* (1992) defines anthropometry as "the science that deals with the measurement of the size, weight and proportions of the human body" (p.91). Physical anthropology or biological anthropology are the disciplines that are usually involved in anthropometry although anatomists or physiologists might also conduct this kind of research.

Anthropometry in the past has had a somewhat tarnished reputation because of its use by eugenicists in their discredited efforts to prove the superiority of one human race or culture over others. Anthropometry is now recognized as a legitimate tool to make statements about various human populations without making value judgments about the populations. The use of anthropometry in this study is to examine BMI, a European construct, and whether or not it is useful in determining morbidity in non- Europeans.

> Physical anthropologists have long felt that average body measurements of an ethnic group carry information on the derivation and affinities of the group as a biological population. It is clear that differences of environment confound such interpretations at least in part. But it is equally clear that modifications of environment do not completely erase distinctions of body proportions among ethnic groups (Rhoads, 1987, p. 155).

Anthropometry has become much more sophisticated since its inception as an adjunct to physical anthropology. Originally using tools as simple as a scale, tape measure and calipers, it has now grown to use blood polymorphisms, odontometric comparisons and complex analysis of patterns in fingerprints, to help distinguish between and among various populations (Friedlaender, 1987). The advent of DNA analysis makes it unclear exactly where the line is drawn between physical anthropology, anthropometry, bio-chemistry and genetics.

Bridging the gap somewhat between anthropometry and geography, Birkbeck and Lee's (1987) study of two widely separated First Nation communities, Ahousat and Anaham outlines the risk of considering only a few factors when reaching conclusions about different populations. In this study they found that children of the Ahousat group have earlier bone maturation than those from Anaham. They attributed this difference to the availability of food for the two groups. Since Anaham is one of the geographically closer First Nations to Bella Coola one might expect that Nuxalk from Bella Coola might show similar retardation in juvenile bone maturation. However, as the group at Anaham are Chilcotin First Nation and their community is on the much more impoverished Chilcotin plateau, while the Ahousat are Nootka speakers off the West coast of Vancouver island, it seems likely that the Nuxalk

would have more in common in terms of diet and availability of traditional foods with the Ahousat than with the Chilcotin. The often very pronounced transition from one bio-geo-climatic zone to another that occurs throughout British Columbia can confound what looks like it should be a straightforward linear relationship between neighboring groups (Birkbeck, & Lee, 1973).

A study by Katzmarzyk and Malina (1999) entitled, *Body Size and Physique among Canadians of First Nations and European Ancestry,* looks at the differences between Europeans and two First Nations communities in Northern Ontario. In the introduction to this article the authors are careful to say that their results apply to the specific populations studied. However, in the body of the article they proceed as though there were only *one* homogenous population of First Nations in Canada. In the concluding remarks of this article, they say:

> Given that the sample population is from a restricted geographical location in a somewhat remote region of Northern Ontario, the results may not be generalizable to *all* FN groups in Canada. Further work is required to better characterize *the* body size and physique of *FN Canadians* using larger population studies [italics added] (p.171).

This kind of statement does little to increase the credibility of the authors and with non-critical readers may re-enforce the stereotype that *Indians* are the same all across Canada.

Nuxalk Morphology

Anecdotally, one has only to journey to Bella Coola and observe present day Nuxalk to be struck by their relatively short, stocky stature and particularly what appear to be very wide, powerful shoulders. On reflecting on their history and observing the traditional

Nuxalk territory, a possible reason for this apparent stature suggests itself; namely that this geographically isolated population developed morphology adapted to poling or paddling relatively heavy dugout canoes. Broad wide shoulders, relatively short legs and a low center of gravity should be beneficial to a culture that derives a significant amount of sustenance from the sea and whose main mode of long distant transport was via water.

Hall and Hall (1995) seem to indicate that this kind of cultural modification is possible but also make it clear that it may not be as straightforward as it first seems. They stated that:

> Studies of the effects of geography and the human phenotype presents innumerable challenges, as does investigation of any other factors affecting human development. Possible climatic effects associated with latitude, altitude and precipitation are filtered through *technological, nutritional, cultural and genetic variables* [Italics added]. If an investigation uses human subjects who live in specified geographic region, their genealogical history and their individual developmental experiences need to be considered. The great mobility of human populations offers an additional complication to finding the geographic contribution to variance of measurable physical features. Any study of geographic variation, therefore, must consider confounding effects from all these factors (p. 407).

While it is logical to suppose that arm size and to some lesser extent breadth of shoulder are readily modified environmentally, that is, by frequent use, in this case frequent paddling, it is not easy to imagine an easy way to environmentally modify stature, to ensure a short, wide aspect with a low center of gravity. One further consideration is that the Nuxalk appear to continue to display the morphology described above and yet are now fully

acculturated into European modes of transport. That is, dugout canoes are no longer used by the Nuxalk, and while many Nuxalk are still oriented to the marine environment, outboard or inboard internal combustion engines are the usual motive power. Apparently, what might first appear to be phenotypical attributes may really be genotypical characteristics.

Early Anthropological Research on the Nuxalk: Franz Boas

One of the pioneer anthropologists in North America was Franz Boas. In the late 1800's he began to study the First Nations along the Pacific Coast of North America, including the Nuxalk. Included in his studies were many anthropometric measurements of the various groups of First Nations. These early measures have given later anthropologists a baseline by which to judge changes that may have taken place. While in no case was Boas even close to the first European to have contacted these cultures, he may have studied them early enough that later changes had not yet taken effect or had only taken effect to a limited extent. Hall and Hall (1995) state that:

> The native people's historical experience with Europeans and Americans can be divided into three phases, which are associated with different effects on the availability of food. Initial contact often involved trade for European goods, including specialty foods (such as molasses) that were unknown previously, plants (such as the potato) that soon became widely used, and hunting tools (such as guns) that may have increased native food resources. Although moderate increase in resources characterized the first period, extreme depression in the native economy characterizes the second. The depression is due to the loss of land by the encroachment of settlers; skirmishes and occasional warfare with miners, settlers and soldiers; epidemic

> disease; and for some people removal to reservations. ... Adaptation to a mix of native and non-native resources, with a primary shift to European American extraction technologies characterized the third period. Stabilization of the diet and for many people an average increase of calories on an annual basis occurred even though the quality of the new diet in many respects was inferior. ... In British Columbia the native population became actively involved in European trade at least by the 1780's, obtaining staples such as molasses, biscuits, rice and bread. In the Cordilleran area of British Columbia the first effects of contact were indirect, coming by the trade through coastal Amerindian peoples, but they included depopulation by disease and an influx of trade goods. Native people in British Columbia were active participants in trade and were known to drive hard bargains. They quickly adopted agricultural practices such as growing of potatoes. The Haida tribe on the Queen Charlotte Islands is reported to have supplied Hudson Bay Company forts with potatoes in 1835, and the practice of growing potatoes spread southward. (p. 412-413)

Jantz, discussing Franz Boas' training says: "Boas was present in Berlin in 1885 when nine visiting Bella Coolas were measured by Virchow" (Jantz, 1995,p. 348). Clearly, if Nuxalk [Bella Coola] were traveling to Europe, even if this was more nearly in the context of an exhibition of exotic peoples, than truly a visit, contact with Europeans was well established. Kopas (1970) refers to these nine, as actor-artist-aborigines and says they were paid 20 dollars a month wages and returned to Bella Coola after thirteen months.

While there obviously had been a considerable amount of change from pre-contact, and there is a danger in trying to accurately assess the degree of change that contact may have initiated, it is nonetheless clear that in all cases these cultures were not yet as

assimilated in the 1890's into the dominant European culture, as they would become in the following century (Waldram, Herring, & Young, 1995). Hall and Hall (1995) say "Subjects in this study [Boas] cannot be considered unmodified representatives of the pre-Columbian population, but they come closer to this ideal than any other sample available" (p. 409).

Notwithstanding how much contact there had been when Boas gathered his data, one aspect of anthropometric measures that logically may not have been much affected by this contact with the European culture is that of shoulder width, specifically shoulder width culturally modified by paddling or poling small water craft such as canoes. In the 1890's even Europeans had no other means of propulsion for small watercraft other than sail or human power. Internal combustion engines had only recently been invented and were not common anywhere, much less on the Central coast of British Columbia. It is possible or even likely that sails would to some extent have supplanted human paddling when navigating larger open bodies of water for example fjords or inlets but it is unlikely that sails would have been used much on the local rivers as they are generally too narrow. It is difficult to determine what extent sails were used.

Szathmary (1995) seems to confirm that it might be possible to use Boas' anthropometric data in just such a manner when he says:

> Contrary to common assumption, anthropometric phenotypes can be used successfully to address questions about population relationships, and they can be used with proper caution to examine the impact of a variety of factors on the morphology of North American native peoples and adjacent Siberians before the twentieth century (p. 343).

Jantz, Hunt, Falsetti and Key (1992), in their statistical analysis of Boas's data, quantify the numbers of people measured by Boas from the Nuxalk [Bella Coola]. He (or his assistants) measured 22 male and six female Nuxalk [Bella Coola]. It is not precisely clear when this data was gathered but it was between 1891 and 1902 (Jantz, et al. 1992). This compares with Kuhnlein's (1983,1986), measurement of 374 and 443 Nuxalk in two separate studies, as well as Thommasen's measurement of 950 Nuxalk. Unfortunately each of those data sets is missing a different key component that would allow them to be compared to the others in a meaningful way in order to examine the issue of stature/BMI/shoulder/arm development. Boas's data has shoulder width but no weight and so BMI is not determinable. Kuhnlein's data has height and weight and arm muscle area but not shoulder width and Thommasen's data set has only height and weight. Whether there is a statistical analysis technique that would allow a researcher to compare these intriguing data sets is an open question but one that is outside the scope of this project.

Conclusion

The influence of an island environment (or near island like isolation), marine orientation in a pre-mechanical era, contact with European culture, access to health care, issues of access to and quality of food sources, and genetic heritage may all have contributed to the apparent stature and morphology of the present day Nuxalk. It is unlikely that we will ever be able to say with certainty that any one factor is key for what is most likely a multi-factorial causation. It is, however, interesting to consider possible mechanisms and their effects even if one is unable to quantify them. Regardless, the issue of whether higher BMI and the diseases and conditions that were studied here are associated in the Nuxalk, or

whether the increased BMI of the Nuxalk is morphologically independent of disease, is fundamental.

Chapter 4: Methods

Research Design

In view of the previously noted rise in the prevalence of obesity and its numerous implications for the health of persons who may be obese or overweight, the opportunity to study the height, weight, age, and BMI of a well defined population, in addition to looking at the relationship between BMI and other diseases and health conditions, was fortuitous. Accordingly, a retrospective chart audit was done on patients attending the Bella Coola Medical Clinic.

As Bella Coola is so isolated and since the Bella Colla Valley Medical clinic is the only nearby access to acute medical care for the residents of the valley, examining patient records at the clinic gave a fairly comprehensive view of patterns of health for the residents of the Bella Coola Valley. Some residents of the valley, particularly newer immigrants, may not have had a record in the clinic or hospital, but for the vast majority of the population those records existed. Data for this study were gathered during the period, August- October 2001, by a family practice physician at the Bella Coola Valley Medical clinic. He reviewed all charts at both the clinic and the hospital. Charts from those known not to be residents of the Bella Coola Valley were censored. Although the ability to know which records to exclude may seem unlikely, the geographically small, static nature of the Bella Coola population, combined with information from long term residents, made this process relatively easy and accurate. An estimated 2,400 people live in the Bella Coola Valley, but a further 1300 people live throughout the rest of the catchment area of the clinic. These include those who live on the Chilcotin Plateau at Anahim and Nimpo Lakes and those who live further west along the Dean Channel at Ocean Falls. Those who were known not to live in the Bella Coola Valley

were excluded from the chart review. Approximately 45% of the population of the valley (1120 people) is aboriginal, most of these people being of Nuxalk descent. Charts were reviewed and data was gathered for the 2378 patients who were residents in the Bella Coola valley. The data gathered included basic demographics such as age, gender, and ethnicity. In addition, height, weight and body mass index (BMI) was either noted or calculated from the height and weight data. The charts were also examined for the presence of a number of chronic diseases or conditions. These included: diabetes, hypertension, diastolic and systolic blood pressure, chronic obstructive pulmonary disease (COPD), coronary artery disease syndrome (CADS), depression, osteo and rheumatoid arthritis, bone and joint problems, cancer and any other unspecified chronic disease.

The charts of those aged more than 18 years at the time of the chart review were included, and those younger than 18 were excluded. BMI is an acceptable measure of adiposity in younger persons but in this case, as the BMI was calculated from height and weight that were sometimes temporally separated e.g. weight measured on one clinic visit and height measured some time later and as young persons usually exhibit normal growth and development, there is potential for skewing the prevalence analysis. In addition, many of the chronic diseases of interest often develop later in life. After eliminating the charts of those less than 18 years old, 1724 charts remained. Unfortunately only 1119 or 64.9% of the charts examined had a height measurement and as height is an essential part of the BMI calculation, only these 1119 charts where usable for the BMI vs. disease determination.

Definitions

The definitions used to categorize the patient's health status are as follows:

Arthritis. The term arthritis includes inflammatory arthritis and osteoarthritis. The term inflammatory arthritis includes gout (21%). The term arthritis does not include fibrositis / fibromyalgia syndrome.

Inflammatory Arthritis. A collection of diseases in which the joint or joints are involved in a presumed autoimmune, inflammatory process. In this study they include rheumatoid arthritis, systemic lupus erythematosus, mixed connective tissue disease, polyarthralgia with positive rheumatoid factor or positive ANA, polymyalgia rheumatica, ankylosing spondylitis, psoriatic arthritis, and gout.

Osteoarthritis. A common degenerative joint disease characterized by progressive loss of articular cartilage and by formation of new bone at joint margins. These patients were identified here by x-ray confirmation of above, or clinic / consultant note that the patient had had joint replacement surgery because of debilitating osteoarthritis.

Bone/joint injury (includes fractures). Patients said to be suffering from a bone / joint injury were those who presented to clinic with complaints of pain related to various musculoskeletal structures (66%); those who presented with pain associated with fractures (7%), trauma (8%), or amputation (3%); and those who presented with pain due to tendonitis (12%) or neuropathy (3%). The knee, shoulder, and hip were the most commonly mentioned joints causing pain and limitation.

COPD. Chronic Obstructive Pulmonary Disease includes emphysema and chronic bronchitis. Patients were identified as having COPD if there was a CXR report stating the person had COPD; if there was pulmonary function tests suggesting this person had COPD; or if there was a specialist report stating this person had probable COPD.

Coronary Artery Disease. Narrowing of the lumen of coronary arteries due to accumulation of atherosclerotic plaque in the arterial wall. These changes result in possible compromising of the blood supply to the heart. Patients with coronary artery disease included those with:

1. Effort related chest pains responding to anti-angina medications (i.e. angina); myocardial infarction
2. ECG changes consistent with recent or old myocardial infarction
3. Clinical presentation consistent with recent myocardial infarction (e.g. elevated cardiac enzyme levels)
4. Consultant report confirming this person has probable coronary artery disease
5. Angiographic changes consistent with coronary artery disease
6. If chart records this person had bypass surgery for their coronary artery disease.

Hypertension / high blood pressure. Hypertensive patients were identified as being patients who had elevated blood pressure (e.g. Systolic $\geq$ 160 mm Hg or Diastolic $\geq$ 95 mm Hg) documented on more than two clinic visits. The vast majority of these people (88%) were being prescribed anti-hypertensive medications (e.g. diuretics, B-blockers, Calcium channel blockers, ACE-inhibitors) and there is a note in chart that these medications are being prescribed for hypertension. .

Diabetes. Diabetes mellitus is a disorder of blood glucose metabolism. Diabetics were diagnosed on the basis of having repeatedly elevated blood glucose and / or elevated glycosylated hemoglobin (HGBA1c) values. Approximately 63% of diabetics in the chart review were taking oral hypoglycemic medications (e.g. glyburide, gliclazide, metformin); 15% were taking insulin; and 29% were 'controlled' by diet and exercise only. The diagnosis criteria

for diagnosing non-insulin dependent diabetes was the presence of a fasting glucose of ≥ 7.0 mmol/l. This diagnostic criteria is based on 1998 clinical practice guidelines for the management of diabetes in Canada (Meltzer, et al., 1998) and the recommendations of The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (2002). For the purpose of this study, people identified as having impaired fasting glucose were classified along with non-diabetics, as they do not meet the criteria for diabetes.

Cancer. Cancer is a condition of disorderly of cell division. Characteristics of cancer cells include lack of normal growth controls, decreased differentiation and function, ability to invade surrounding normal tissue and potential to travel to distant sites to produce secondary tumors (metastases). Cancer cells can arise from many different tissues in the body. The diagnosis of cancer is made by a pathologist based on observed changes to cell and tissue structure. Patients given the diagnosis of cancer had some sort of pathology report confirming malignancy; or had a specialist report stating this person had a pathology proven malignancy. The most common reported cancers in the clinic survey were breast (20%), gynecologic (20%), skin cancer (18%), urologic cancers (15%), gastrointestinal (14%), and others (12%). Gynecologic cancers include cervical, uterine, and ovarian cancers. Urologic cancers include prostate and testicular cancers. Skin cancers include squamous cell cancer, basal cell cancer, and malignant melanoma.

Depression / anxiety / emotional problem. Patients presenting to family physician with affective depressive disorder (62%), situation depression (6%), anxiety disorder (12%), a mixture of debilitating depressive / anxiety symptoms (18%), and bipolar disorder (2%) were said to be suffering from depression / anxiety / emotional problem. Approximately 79% of people identified as suffering from depression / anxiety / emotional problem were taking

an antidepressant medication. In this study it does not include patients with stress or anxiety symptoms alone.

Alcohol use. Patients were included in the alcohol category if there were any of the possible codes for alcohol in their chart.

Ethnicity. Depending on what the information is intended for, determining a person's ethnicity may be as simple as asking them what their heritage is or since the government of Canada has effectively divided aboriginal people into four categories it may require determining what the person's legal status is. The four categories are: status Indians, non-status Indians, Inuit and Metis.

Status Indians are those who have official status under the Indian act and a unique identification number. Status Indian is probably the most straightforward category and means that the person is of First Nations heritage and is recognized as an Indian by the Federal government. Non-status Indians on the other hand may have an identical genealogy with a status Indian but for some reason is no longer "status" Indeed, occasionally one sibling from the same parents will have status and another will not. The third category is that of Inuit. Effectively they are in the same position as status Indians but their position is not enshrined in law, as is that of Indians. The fourth category is that of Metis. These are persons who have, or claim to have part aboriginal heritage. Currently, they have no special legal position in Canada, however, this is in flux and there have been recent court decisions that may be leading toward some special standing for Metis people.

In addition to these aboriginal categories, the issue of place of residence and band affiliation also must be considered.

Persons of First Nations descent with a Nuxalk affiliation are entitled to live on reserve lands controlled by the Nuxalk band, but there is no obligation that Nuxalk band members *must* reside on reserve land. Numerous Nuxalk status individuals also live in the Bella Coola Valley but do not live on reserve land. In addition, persons who are status, non-status or Metis may also live on Nuxalk band reserves. Finally many persons with Nuxalk band status, who appear on the Nuxalk band roster, do not live in the Bella Coola valley at all. To complicate things even more, there are status First Nations persons resident in the Bella Cola valley who are not Nuxalk band members, but are members of some other band. These people may live on or off Nuxalk reserve land.

For the purposes of this project, aboriginal heritage was determined by consulting with Nuxalk band elders or by checking Nuxalk band status lists, or by asking the individual directly whether they considered themselves to be of aboriginal or Nuxalk descent. In this way it was possible to determine whether or not an individual had aboriginal heritage. Persons who met any of these criteria were included in the aboriginal data.

BMI. Height and weight were used to determine the person's Body Mass Index (BMI). Not withstanding that BMI may be somewhat problematic (see literature review), BMI is often used as an initial screening tool to determine if the person's weight is excessive for their height. To calculate BMI, weight in kilograms is divided by the height in meters and then squared, and the resulting number is the person's BMI. The BMI scale runs from 10 to 70.

There are many different cut off points in use and different descriptors for adiposity for instance: overweight, obese, morbidly obese, obese class I, II, or III. Many of these descriptors are weighted with meaning beyond that necessary to distinguish different

adiposity classification, and so, for the purposes of this project, a BMI of less than 20 is considered to be underweight, 20 to 24.9 acceptable weight, 25 to 27 overweight and greater than 27 is considered obese.

Data Analysis

After the data was collected, each patient was given a coded identifying number and any other identification data was removed. The physician retained the only key to the identification data and at no time was it ever possible to identify any individual. The information gathered from the charts was entered into an electronic EXCEL spreadsheet. After the data were coded, weights and heights against the ages of the patients were graphed, and any outliers were checked to make sure there were no errors. The family practice physician, the student researcher and the statistician collaborated and agreement was reached regarding the analyses and tests to use. The data was analyzed using the software SPSS (Statistical Package for Social Sciences) for Windows. Prevalence rates of obesity were calculated for both the aboriginal and non-aboriginal Bella Coola Valley population. The student researcher interpreted the results from the statistical tests and determined the implications of these outcomes. Rates of obesity and disease prevalence in both aboriginal and non-aboriginal populations were compared to determine whether there was a statistically significant difference.

To determine which diseases or medical conditions are associated with obesity in this community, prevalence rates of the chronic diseases of interest were calculated for the people in the Bella Coola Valley. Comparisons were then made between overweight and non-

overweight people. Likewise, prevalence rates for aboriginal and non-aboriginal persons were calculated.

Differences in the outcomes between overweight and non-overweight people, as well as the differences between ethnic groups (aboriginal and non-aboriginal), were evaluated using One Way ANOVA tests with significance being defined as p-value ≤ 0.05 for each outcome measure. The p-value is the probability of rejecting the null hypothesis when a specified test procedure is used on a given data set. This probability is the smallest level of significance at which the null hypothesis would be rejected. Significant results are presented in Chapter 5.

Limitations

The results from this study have several potential limitations. Although weight data (in kilograms) was available for over 90% of the population, only 65% of people had height and BMI data. It is possible that height data was measured in only the sickest, heaviest people, which would bias the data towards this group of patients. Alternatively, height may have been measured more often in those patients who *already* had a concern about BMI or overweight. This might have skewed the data in either direction.

As the student had no access to the uncoded data set and as this was a retrospective chart review there were some inherent limitations on the student researcher's ability to add in any supplementary questions that suggested themselves during the project. For instance, it would have been useful to differentiate between the various types of cancer rather than including them all under one general heading.

As Bella Coola has a truly unique geographic location and population, and consequently provides a unique set of demographics, the results of this study may be difficult to extrapolate to other communities. Bella Coola is an extremely remote community and few Canadian communities outside of the Arctic and Northern Canada are likely to be as isolated. Also the Bella Coola mix of Aboriginal and non-aboriginal populations is rare. In addition to the ethnic demography of the population, the aboriginal component is composed of a coastal people who appear to have different anthropometric characteristics than the majority of Canadians and therefore the results may not be generalizable on these grounds as well.

Ethics Approval

Ethics approval to collect the data used in this study was obtained from the Research Ethics Committee at the University of British Columbia. In addition, the Nuxalk Band Council granted permission to the physician to collect this data. Ethics approval for the use of this data set for this project was granted by the University of Northern British Columbia Research Ethics Board on July 7, 2003.

Chapter 5: Results

The data gathered by the Bella Coola physician in the retrospective chart review was analyzed using SPSS (Statistical Package for Social Sciences). This was used to generate tables, which compared rates of weight, BMI, obesity, and disease prevalence between the aboriginal and non-aboriginal populations. The data for BMI differences between heritage, (Nuxalk- non-aboriginal) and gender (male-female) were analyzed by testing with univarate analysis of variance (UNIANOVA), which is an analysis that looks at one independent variable at a time, in relationship to one dependant variable, in this case BMI. This analysis offers comparisons between groups (i.e. BMI for men versus women, etc). Statistical significance was determined from the results of the F-test and its p-value. Correlations, and any significance, were examined for both weight and BMI by age using Kendall's tau-b and Spearman's rho. The associations between diseases, BMI and heritage were analyzed using logistic regression, and statistical significance was determined based on the chi-square test. (Self, Birmingham, Elliot, Zhang, & Thommasen, 2005). Statistically significant differences in the rates were noted and are discussed in the discussion chapter. Significance was defined as a p value of, equal to, or less than 0.05. Some of the most notable differences include: a trend toward higher weights, more obesity, and higher BMIs in the Nuxalk; several strong associations between greater BMI and several diseases, but interestingly some of the associations were stronger for Nuxalk and some stronger for non-aboriginals.

Some of the demographics and base numbers of the Bella Coola Valley sample population are shown in the following table.

Table 1 Chart of Demographics.

	Total	Adults (≥ 18 years old)
Population	2375	1724
% Female	49%	49%
% Nuxalk	47%	42%
Mean Age	35.0	44.6
Charts with recent weight recorded	2217(93%)	1592 (92%)
Charts with recent height recorded	1534 (65%)	1126 (65%)
Charts where BMI could be calculated	1526(64%)	1119 (65%)
Mean Weight (kilograms)	68.4	81.4
Mean Height (meters)	1.597	1.683
Mean BMI	26	29

As can be seen in Table 1, 47% of the Bella Coola Valley sample was Nuxalk but only 42% of the adults were Nuxalk. There were 1592 charts for which a BMI could be calculated but only 1119 were charts of adults. These 1119 charts formed the basic data source for this project. As noted in the methods section, only data from adults was used as BMI in children is subject to variability as they grow and mature (Health Canada, 2003).

Table 2
The weight of the adult population of the Bella Coola Valley by gender and ethnicity.

Weight (kg.)	Total	Male	Female	Aboriginal	Non-aboriginal
N=	1724	883	841	719	1005
< 70 kg	26%	12%	40%	24%	27%
70 to 89.9 kg	39%	42%	37%	40%	38%
90 to 109.9 kg	21%	28%	13%	22%	20%
≥110 kg	7%	9%	4%	8%	5%

The table of weight for clinic patients shows that 21% of the patients were heavier than 90 kg. A further 7% were over 110 kg. Women were less likely to weigh more than 90kg. at 17%, while 37% of the men weighed more than 90 kg. Of people weighing more than 90 kg., 25 % were non-aboriginal while 30% of the Nuxalk patients weighed more than 90kg. Not surprisingly, both aboriginal and non- aboriginal men are shown to be significantly (P=<0.001) heavier than women.

Table 3
BMI data for the adult population in the Bella Coola valley by gender and ethnicity.

	BMI	Total	Male	Female	Aboriginal	Non-aboriginal
N=		1119	562	557	464	655
Underweight	<20	4%	2%	5%	2%	5%
Acceptable weight	20.0-24.9	25%	23%	26%	19%	29%
Overweight	25.0-27.0	17%	19%	16%	15%	19%
Obese	≥27.0	55%	56%	53%	64%	47%

This table of BMI data shows that women and men's BMIs were *not* significantly different (P=0.0935), but what was highly significant (P= < 0.001), was that Nuxalk people are not as tall, weigh more, and thus have greater BMIs than the non-aboriginal population. When the obese category is considered, the Nuxalk are 18% more likely to be obese, even though non-aboriginals are 4 % more likely to be overweight.

This accords with the impression one has when interacting with Nuxalk persons, namely that they are shorter and stockier than the non-aboriginals. Perhaps this is because Nuxalk people may have different diets, exercise patterns, occupation, economic status or genetics. Most probably it is a result of some combination of these and possibly other factors as well.

Table 4
The weight of the adult population of the Bella Coola Valley by age groups.

Weight (kg)	Total	18-29.9 y.o.	30-44.9 y.o	45-64.9 y.o.	≥65 y.o.
N=	1724	362	556	589	217
<70 kg	26%	35%	27%	20%	24%
70 to 89.9 kg	39%	36%	40%	40%	41%
90 to 109.9 kg	21%	13%	19%	24%	28%
≥110 kg	7%	6%	6%	9%	4%
No information	8%	10%	8%	7%	4%

In contrast to the preceding tables, the table of weight by age shows that weight increases as age increases. This is an entirely normal and expected finding. (Health Canada, 2003).

Table 5
BMI data for the adult population in the Bella Coola valley by age group.

		Total	18-29.9 y.o.	30-44.9 y.o	45-64.9 y.o	>65 y.o
N=		1119	196	334	413	176
Underweight	<20	4%	7%	3%	2%	5%
Acceptable weight	20.0-24.9	25%	35%	39%	21%	13%
Overweight	25.0-27.0	17%	18%	21%	15%	17%
Obese	≥27.0	55%	41%	46%	63%	66%

As with Table 4, showing adult weight, Table 5, adult BMI, shows the expected increase in BMI as age increases.

Table 6
BMI vs. chronic disease prevalence in the adult population of the Bella Coola valley

BMI	<20	20-24.9	25-27	27.1-29.9	30-34.9	35-39.9	40+	P =
N=	= 40 (4%)	275 (25%)	194 (17%)	190 (19%)	232 (21%)	122 (11%)	66 (6%)	
Diabetes mellitus	5%	1%	6%	11%	12%	23%	38%	0.000
Hypertension	10%	5%	10%	21%	21%	30%	38%	0.000
Hypercholesterolemia	3%	6%	6%	15%	13%	20%	23%	0.000
Osteoarthritis	5%	3%	7%	11%	7%	11%	12%	0.000
Asthma	3%	4%	4%	4%	6%	14%	20%	0.000
Diverticular disease	0%	0%	1%	4%	6%	7%	11%	0.000
Depression or anxiety	8%	9%	10%	14%	9%	15%	26%	0.000
Alcohol	13%	18%	19%	17%	25%	33%	39%	0.000
Dyspepsia	10%	8%	10%	17%	18%	24%	27%	0.000
Musculoskeletal problems	18%	22%	24%	29%	26%	36%	45%	0.000
Coronary artery disease	3%	2%	3%	5%	6%	5%	9%	0.004
Eczematous dermatitis	5%	8%	7%	6%	10%	8%	18%	0.010
Atrial fibrillation	3%	1%	1%	5%	2%	6%	2%	0.082
Cerebrovascular disease	5%	1%	1%	5%	3%	6%	2%	0.091
Hypothyroidism	3%	3%	5%	7%	4%	4%	11%	0.112
Inflammatory arthritis	5%	3%	2%	4%	3%	4%	3%	0.112
Chronic back/neck pains	5%	10%	6%	9%	7%	10%	14%	0.241
Peripheral vascular disease	0%	1%	1%	3%	2%	0%	3%	0.434
Chronic obstructive lung disease	8%	2%	2%	5%	2%	0%	5%	0.437
Congestive heart failure	5%	1%	1%	5%	1%	1%	3%	0.641
Cancer	10%	3%	4%	4%	3%	3%	8%	0.935

Table 6 shows that there are numerous highly significant correlations between BMI and chronic disease. Specifically these are: coronary artery disease(CAD), diverticular disease depression or anexiety, alcohol use, dyspepsia, musculoskeletal problems, osteoarthritis,

asthma hypercholesterolemia, hypertension and diabetes mellitus, and dermatitis . Diabetes and hypertension have long been known to be associated with elevated BMI. Likewise, an association between hypercholesterolemia and coronary artery disease is easy to imagine. That is, elevated cholesterol might lead to obstruction in blood vessels and thus CAD. It is possible that both musculoskeletal problems and osteoarthritis are caused in part, simply by the mechanical damage involved in moving an overweight body around. One can imagine that a person with an elevated BMI may have a negative body image, which might lead to depression and perhaps problematic alcohol use in an attempt to feel better about themselves. Logical associations between diverticular disease, dyspepsia, asthma, and dermatitis are not as immediately apparent, although one could possibly postulate an association between the two gastro-intestinal conditions and BMI , if no other than simply that increased BMI must involve an increase in food consumption. Further implications of all these significant findings will be explored in the discussion section.

Table 7
Disease prevalence between adult Aboriginal and non-aboriginal residents of the Bella Coola Valley

Ethnicity	Aboriginal	Non–Aboriginal	P =
N=	719	1005	
Alcohol	34%	13%	0.000
Dermatitis	11%	4%	0.000
Dyspepsia	17%	10%	0.000
Hypertension	9%	16%	0.000
Diabetes	10%	6%	0.001
Hypercholesterolemia	7%	10%	0.001
Inflammatory arthritis	4%	1%	0.001
Hypothyroidism	2%	5%	0.001
Asthma	7%	4%	0.011
Chronic obstructive lung disease	1%	2%	0.040
Cancer	3%	4%	0.160
Depression/anxiety	9%	10%	0.231
Congestive heart failure	1%	2%	0.254
Cerebrovascular disease	2%	2%	0.322
Chronic back/neck pains	7%	8%	0.458
Atrial fibrilation	2%	2%	0.578
Osteoarthritis	6%	6%	0.722
Coronary artery disease	2%	2%	0.747
Peripheral vascular disease	1%	1%	0.876

This table comparing disease prevalence vs. ethnicity, shows that there are significant relationships between Nuxalk heritage and inflammatory arthritis, diabetes, dyspepsia, dermatitis, and alcohol use. It also shows that the association between hypothyroidism, hypercholesterolemia and hypertension, and COPD while still highly significant is between these last diseases and non-aboriginals.

The association between the Nuxalk and inflammatory arthritis is possibly a result of a putative, higher rate of this disease and coastal First Nations people. The association between First Nations peoples and diabetes has long been identified. Dyspepsia may be as simple as culturally based dietary preferences. The author, while practicing in the coastal First Nation community of Kitkatla, saw numerous cases of dyspepsia caused by combining the traditional foods of oolichan (candlefish) and sea lion meat. Both of these foods are extremely fatty and rich. As noted above, there is no obvious association between dermatitis, alcohol or asthama. Possible causes and implications for these will also be explored in the discussion chapter.

For the non-aboriginal group the four diseases, hypothyroidism, hypercholesterolemia, hypertension, and chronic obstructive lung disease are significantly higher than in the Nuxalk. Naturally, for chronic obstructive lung disease one wonders this simply represents a higher rate of cigarette smoking than in the Nuxalk. For the other three diseases it is possible that this disparity is a result of some unknown protective mechanism in the Nuxalk or it may represent some increased risk factors in the non-aboriginals.

Chapter 6: Discussion

In the results section there are results that would be expected, such as that BMI and weight increase with increasing age, and un-expected results such as the differences in disease prevalence between Nuxalk and non-Nuxalk.

It comes as no great surprise that there is a significant association between disease prevalence and increased BMI. The presence of increased disease and pathological conditions associated with higher BMI squares well with the body of the obesity literature. This association has been noted many times before and so it would only be unusual if it were *not* present here. Since the relationship between BMI and disease is well known there is no need to invoke extraordinary circumstances to rationalize it.

There are however some interesting and counter-intuitive results, namely, where one would expect to see a relationship and yet there is none. For example, since Visscher, and Seidell (2001) assert that there is a strong relationship between certain cancers and obesity one might expect that cancer would correlate significantly with increased BMI in this study. That it does not may well be because cancer is clearly multi-factorial and the other factors may overshadow the significance of BMI. Additionally, since numerous cancers were included in the definition, *cancer*, used in this study, it is possible that individual types of cancer might have shown a significant association, but that they did not show in the aggregation.

Likewise one would expect that the significant relationship we see between increased BMI and osteo-arthritis would exist presumably as a result of the mechanical damage a person with a high BMI would likely incur. Equally we might also expect to see a significant relationship between BMI and the bone-joint-muscular category and we do. It would be

interesting to be able to discover whether a presumptive lack of activity on the part of those with higher BMIs is slightly protective against joint problems. If in fact, persons with higher BMI are more sedentary than others this might decrease their risk of injuries to the muscular–skeletal system. Apparently, however increased BMI does correlate to increased joint problems. This also is logical, for no matter how sedentary a person is simple activities of daily living would result in some joint use, unless the person was frankly bedridden.

Conversely since inflammatory arthritis is an auto-immune disease one would not expect to see an increased prevalence of it with increased BMI. This accords with the data, that is, no significant relationship exists between BMI and inflammatory arthritis, in the *general* population. It does not however, explain the increased rate of in the aboriginal population. Perhaps, the Nuxalk are genetically predisposed to inflammatory arthritis. Anecdotally, the author's experience among the coastal Tsimshian people, in a community North of Bella Coola, Kitkatla, indicated that they had very high rates of Juvenile Rheumatoid Arthritis

The reason for the significance of problematic alcohol use is unclear. The definition is given as any of the possible codes for alcohol in the patient's chart. Since there are at least 40 possible codes for alcohol in the International Classification of Disease, Ninth Revision-Clinical Modification (ICD9-CM), it is difficult to interpret the significance of this result. Perhaps it is partly a reflection of substantial alcohol consumption being the *reason* for excess weight and consequently the elevated BMI in the first place.

If it is possible that Ikeda et al's, (1999), concept that it is *fit rather than fat* that matters in predicting morbidity and mortality, then we might expect to see different results; however, since this is a retrospective chart review we are unable to analyze this aspect.

A possible future study could investigate this.

BMI and the Nuxalk

It is clear from the data presented that there is a significant difference between aboriginal and non-aboriginal in BMI. Whether the higher BMI for the Nuxalk is a result of genetics, lifestyle, diet or some combination of social or economic determinants, remains to be determined. It is even possible that a higher BMI is viewed as desirable by the Nuxalk as it is in some other cultures. (Davis, & Kolar, K.2000 p.130). This also might be fertile ground for a future study. Nevertheless, the residents of the Bella Coola Valley, including the Nuxalk, clearly show an increased prevalence of disease and pathology associated with an increase in BMI.

Disease prevalence and the Nuxalk

It is interesting to note that the diseases for which there is a significant relationship between the Nuxalk and the non-aboriginals are mostly composed of the same diseases for which there is a relationship between BMI and disease. However, for hypertension, hypercholesterolemia, hypothyroidism and chronic obstructive lung disease, the non-aboriginals have a statistically signifigant higher prevalence than the Nuxalk. This would seem to indicate that BMI is a better predictor of disease than is aboriginality. Since the tables also show a slightly higher percentage of overweight or obese males and also of increased BMI in the older age groups it is possible that either of these variables may influence the disease prevalence.

Since BMI is associated with disease prevalence in the Nuxalk it suggests that BMI *is* relevant to this population and that morphology is not as much a factor as was suggested in

chapter 2. Nevertheless, since elevated BMI in the Nuxalk was *not* associated with some diseases, (as noted above), as it was in the non-Nuxalk, it is possible that morphology or genetic predisposition may still have some small role to play.

Recommendations

Not withstanding the possible limitations of this study noted above, the issues of obesity, disease, and the appropriateness of BMI for aboriginal populations should be investigated further. Since only 64% of the charts from the clinic had both height and weight data, improved information gathering at the clinic would make future research easier and more useful. Further investigation of the reasons for the significance of problem alcohol use in this community would likely yield interesting and useful information.

Obesity research seems to be heading toward more sophisticated predictors of disease associated with obesity rather than simple BMI, more along the lines of Ikeda et al's *fit rather fat* concept, including abdominal fat as a predictor of morbidity (Porth, 2004. p. 171). Use of these more sophisticated tools might lead to an improvement in health for those at risk in the Bella Coola Valley.

Because this study shows that there are differences in disease prevalence for persons of differing heritage, it is important that health providers keep the influence of heritage in mind when treating or counseling persons of either group in the future. Familiarizing practitioners with these differences might help them be aware of them and plan accordingly.

A sophisticated analysis of the anthropometric data available might be able to determine whether the Nuxalk have changed morphologically since contact with Europeans. In addition, future studies might attempt to determine which of the putative multi-factorial causes of these diseases had the most influence.

Increased fitness and especially weight loss is notoriously difficult to achieve in any population and there is no reason to expect that it will be any less difficult for the residents of the Bella Coola valley. When one adds in the issue of culture, it may become even more difficult. One small step to help with these issues may be the food self-sufficiency program that is being piloted now. This program aims to encourage *all* valley residents to grow and consume their own produce. Not only would this likely lead to a healthier diet but also save the participants money and provide needed exercise (personal communication, D. Methven, September 23, 2006). Promoting a "box a week" of locally grown vegetables and fruits could also increase access to healthy foods. This type of initiative is well known and potentially benefits both consumers and local producers.

In addition to the community garden initiative noted above, other avenues that might improve health and reduce BMI in Bella Coola could include a move away from the medicalization of obesity treatment and the development of a public awareness campaign on the implications of not only obesity but of the results of this study. This might include healthy schools strategies to reduce the availability of less healthy foods in the schools. Some of the other kinds of programs that might help reduce obesity in children could also include sports and activities initiatives at the school itself. Suggestions to parents that might help reduce video and computer use during daylight hours when children could be active outside but especially creative strategies to reduce the doubly problematic issue of children eating high calorie food *while* watching videos or playing games

For the Nuxalk encouragement to return to a more traditional diet in addition to, as much as possible, a return to traditional methods of obtaining that diet would likely be useful.

Traditional methods of food acquisition that would increase exercise would include non-motorized fishing and hunting.

If the residents of Bella Coola were aware that their collective BMI was higher than the national average they might take steps to reduce it. As there are already several friendly competitions between the Nuxalk and non-aboriginal communities one can even imagine a "Battle of the BMI" to see which community could reduce BMI the most. Public health nurses could promote knowledge about BMI statistics and in conjunction with various levels of government offer prizes to the community segment that achieved the most reduction in BMI. These prizes could consist of sports or exercise equipment that members of both communities could use

Regardless of future investigations, and specific strategies, since this study shows a clear association between increased BMI and several diseases, encouraging *all* residents of the Bella Coola valley to become more fit and for most, to reduce their BMI, would almost certainly improve their health.

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