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NARRATIVE REVIEW

The developing understanding of Human Health and Fitness: A Canadian perspective.

1. Prehistory: inferences from the lifestyle of indigenous peoples.

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Abstract

This paper is the first in a series of articles looking historically at the developing scientific interest in human health and fitness, with particular reference to the Canadian scene. This initial contribution considers available evidence on patterns of physical activity, fitness levels and health status during prehistory (the Paleolithic, Mesolithic and Neolithic Eras), drawing upon available information from archaeology, oral tradition, art, written histories, and the recent status of isolated communities thought to have conserved much of their traditional lifestyle. Current information supports the hypothesis that while a hunter-gatherer, *Homo sapiens* adapted genetically to a life requiring periods of sustained endurance activity. In more recent years, a number of indigenous populations in Canada and elsewhere have still encountered periods when their survival depended upon high levels of energy expenditure during various types of hunting. Moreover, such activity was often supplemented by traditional games that provided recreation, maintained fitness and propitiated the Gods. In 1969-70, Inuit from the small arctic community of Igloodik offered one example of a continuing hunter-gatherer lifestyle; hunting expeditions demanded expenditures of 15.4 MJ/day, and the population demonstrated associated high levels of aerobic fitness and muscular strength with a low body fat content. However, the need for vigorous physical activity in isolated communities had decreased rapidly with acculturation to the lifestyle of modern society. Fitness levels have decreased, with growing evidence of adverse health effects, particularly a rising prevalence of diabetes mellitus. Preventive tactics to address these trends include the promotion of territory-wide "native" or "white" sports competitions and (perhaps most effectively) the encouragement of

recreation and the consumption of country foods within local communities. **Health & Fitness Journal of Canada 2011;4(4):3-19.**

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Background

This is the first in a series of articles that explores human health and fitness over the centuries. Where appropriate, the material considered will have a specific Canadian orientation. This initial contribution focuses on health and fitness in pre-history. Unfortunately, we have little direct information on the health, physical activity patterns or fitness levels of prehistoric societies. However, inferences can be drawn from archaeology, paintings, oral and written histories, together with objective data collected on isolated indigenous communities at a time when they still largely conserved the lifestyle of earlier eras. As this narrative will show, the story of people such as the circumpolar Inuit over the past 40 years offers a telescoped account of the history of health and fitness, stretching from the hunter-gatherer societies of 1970 to today's largely acculturated settlements where health professionals are striving to find ways of restoring the health and fitness

levels that were characteristic of an earlier era.

The Paleolithic era began perhaps some 200,000 years ago. At that time, *Homo Sapiens Neanderthalensis* lived in very small hunter-gatherer communities of perhaps 50-100 people, and much of the year was spent in the search for large and small game. Around 35,000 BCE, for reasons yet to be explained, the Neanderthal tribes were supplanted by *Homo sapiens sapiens* (Stringer 1990). However, the hunter-gatherer lifestyle persisted, and some physical anthropologists and physiologists have argued that this is the lifestyle to which present-day humankind is genetically adapted.

The Mesolithic, or middle stone-age, began around 10,000 BCE. During this era, much of the population shifted from a generalized scavenging for berries, game and the carcasses abandoned by other predators to the development of sophisticated tools such as canoes, fishing nets and harpoons, allowing a search for more specific food items (Fagan 1989). The Dorset culture, dating back to about 2500 BCE provides an early Canadian example of such a society. Some of the Ulus used by the Inuit to scrape caribou skins date back to this period. The technological development of the Nunavut communities was further advanced around 1000 BCE, by the arrival of the Thule people (McGhee 1984). The Thules brought much greater efficiency to the hunting of large mammals through the introduction of hunting dogs and bows and arrows. Hunting parties became larger, and in some instances the solitary kayaks were supplemented by much larger umiaks.

In the more fertile regions of the globe, probably beginning with the Sumerians around 9,500 BCE, the

Mesolithic peoples were in turn supplanted by Neolithic societies. These last were pastoralist, characterized by a progressive development of agriculture, with the use of irrigation systems and domesticated animals, and the construction of larger and more substantial permanent settlements. In North America, Indian tribes such as the Huron who settled around Georgian Bay offer a window into this type of lifestyle. When the first Jesuit missionaries arrived from France, around 1615 CE, the Huron people were still catching fish and gathering berries, but they lived in quite large villages surrounded by cornfields, beans squash and pumpkins (Hathaway 1915). The Mayan civilization, with its corn Gods, provides another American example from this period (Bassie 2002).

Habitual Physical Activity Levels in Pre-history

Some physiologists have argued that the survival of prehistoric societies in challenging habitats must have demanded very high levels of daily energy expenditure. They have thus suggested that the human body is genetically adapted to prolonged periods of endurance effort, and that many of the chronic illnesses of modern society can be explained by abandonment of the physically active lifestyle that was typical of Neolithic and Mesolithic populations. Until the 1970s, information on habitual physical activity during prehistory was based mainly upon oral tradition and historical records, but direct measurement of daily activities and energy expenditures began with the Human Adaptability Project of the International Biological Programme (HA-IBP).

Oral and Written Tradition

Historical reports on indigenous Canadian populations (both Inuit and North American Indian) suggest that before their first contacts with “white” civilizations, such peoples had high levels of daily energy expenditure, at least when they were hunting or engaged in certain traditional games. The same seems true of some other indigenous populations in Mexico, Central America and the deserts of southern Africa.

Inuit Populations

The Inuit traditionally practiced not only physically demanding forms of hunting, but during the dark days of winter, they devised one- and two-person games and contests that served to maintain their fitness within the narrow confines of an igloo. Such activities included a seated, arm-straightening struggle, a high-kicking contest (the akaratcheak, a very demanding pursuit, where the competitor was required to kick a hanging target with both feet, with recorded jumps to 2.64 m for men and 1.98 m for women), a leaping game (the orsiktartut, where the contestant leapt up to grab a taut horizontal rope and pulled the body over it) and sustained drum dancing (where there was competition to see who could dance for the longest time, holding a large drum high above the head) (Glassford 1976). Often, these activities were supplemented by energetic blanket-tossing (the Nalukataq, when successive members of the community would be tossed several metres into the air). With the coming of spring, such indoor pursuits were supplemented by foot and dog races, a ball game (mukpaum), a community tug of war, and in Alaska a ritual football game that sought to promote a successful whale-hunt (Simri 1966).

North American Indians

Indian voyageurs on the northern rivers of Quebec sometimes concluded a long day of paddling by carrying as many as seven 42 kg bales of furs over rugged 1 km portages (Hillman 2010). Likewise, on the west coast, the Haida and Nootka peoples faced heavy labour in felling and hollowing out their 20 m ocean-going canoes, using stone mauls; then, they propelled their vessels on long voyages across turbulent seas, often racing against neighbouring tribes. And around the Great Lakes, people such as the Iroquois had a very active leisure, with games of lacrosse and amtahcha [the women’s version of this same sport (Culin 1907)]. Indian lacrosse involved as many as 1000 participants, and the game sometimes stretched over playing distances of 5-10 km (Weyand 1965; Liss 1970; Vennum 1994). Contests continued for 2-3 days (Jetté 1972; Salter 1972), although their annual frequency is less well-established. Such events were intended not only to appease the Creator, but also to settle boundary disputes and toughen young men for war. Foot races and other active games also marked the funeral rites of some Eastern Canadian tribes (Salter 1971), and although some critics have questioned the accuracy of his observations, the painter George Catlin [1796-1872] (Holbrook 1970) illustrated snow-shoe dances, canoe, foot and horse races and hoop and polo games with which American Indians heralded the first snowfall.

Other Pre-historic Societies

Traditional Kalahari bushmen are said to have practiced “persistence hunting,” hunting kudu, antelope, deer and buffalo by running their prey to exhaustion, while their womenfolk walked long distances gathering fruit,

berries, tubers, bush onions, ostrich eggs and various insects while carrying infants on their backs (Attenborough 2002-2003; Morris 2005).

The Taramuharan Indians of Northwestern Mexico, likewise, are thought to have practiced persistence hunting, running long distances (up to 200 km over two days) in the rugged terrain of the high sierra in order to capture their prey (McDougall 2009). Sometimes, they also engaged in ceremonial running, kicking a ball in relay races or (in the case of the women) using a stick and hoop.

Pastoralists in Central America also appear to have supplemented the physical demands of daily life with vigorous activities that had both recreational and religious significance. Thus, the pre-Columbian peoples of ancient Mexico and Central America played the ball game of Tlachtli within structured courts as large as 126 x 25 m. Archaeologists have discovered the solid and heavy rubber balls that were used; these have a diameter of 0.1-0.22 m, and a mass of 3-4 kg (Whittington 2001). The rules of Tlachtli remain uncertain. In different versions, players apparently struck the ball with their hips, used their forearms, rackets, bats, or hand stones. The general pattern of play may have borne some relationship to racquet ball (Glassford 1969).

Objective Data

One of the objectives of the HA-IBP was to supplement the subjective impressions gained from oral tradition and historical accounts by objective laboratory data. The IBP approach was to assess habitual physical activity and the associated fitness levels of isolated indigenous populations who were thought as yet to have undergone little

acculturation to the lifestyle of modern sedentary society. Detailed scientific information was collected on many such populations around the world (Weiner 1964), with our Toronto laboratory playing a central role in standardizing methodology and collating the data (Shephard 1978).

Unfortunately, by the time that cross-sectional surveys could be funded and organized (in the early 1970s), most even of the most remote communities had made some contact with developed societies, and the activity levels of previous generations may have been substantially greater.

Inuit Populations

The first nations of the arctic have had some sporadic contacts with white people for about a thousand years. The earliest European arrivals were the Norse, who came via Greenland around 1000 CE. They established a settlement in Newfoundland (L'anse aux Meadows), and their greatest influence was upon the Beothuk, a local group descended from the Dorset Inuit. European exploration of the North West Passage began in the sixteenth century, and in this era the Gaspar Corte-Real expedition captured several dozen Labrador Inuit and took them to Europe to prove the extent of their exploration. In the mid 1570s, the Inuit of Baffin Island encountered Martin Frobisher, and by the end of the seventeenth century Moravian missions and fur-trading posts were established along the arctic coastline.

Despite these contacts, a study from 1969-1970 showed traditional male Inuit from the settlement of Igloodik (Nunavut) with very high rates of daily energy expenditure, particularly when they were hunting (Godin and Shephard 1973). These studies used the factorial method,

as recommended by the WHO and FAO of that era (University 1985). The duration of each daily activity was recorded, and multiplied by corresponding Kofronyi-Michaelis respirometer estimates of task-specific oxygen consumption. Totals for male Inuit, averaged across 8 different types of hunting (Table 1) equated to an energy expenditure of 15.4 MJ/day, a larger figure than would be expected in even the heaviest forms of industrial work (Godin and Shephard 1973). In general, the data reflected not bouts of very intensive effort, but rather very extended periods of moderate physical activity (for example, tramping across the tundra for an entire day and night, with only short rest pauses, during the summer months of 24-hour daylight).

Table 1. Kofronyi-Michaelis respirometer estimates of energy expenditures in 8 types of Inuit hunt. Based on data obtained by Godin and Shephard for the community of Igloodik, Nunavut (Godin and Shephard 1973).

Type of Hunt	Estimated Energy Cost (MJ/day)
Summer fishing	18.6
Ice fishing	16.9
Summer caribou hunt	16.2
Winter caribou hunt	16.1
Walrus hunt	15.5
Seal hunt (ice hole)	14.5
Seal hunt (kayak)	14.4
Seal hunt (at floe edge)	10.6
Average (unweighted, 8 hunts)	15.4

Siberian Indigenous Populations

Siberian indigenous populations groups have been studied by several teams of Canadian investigators including W.R. Leonard, P. Katzmarzyk, A. Rode and R.J. Shephard. The various pastoralist groups of Northern Siberia underwent enforced collectivization in the 1930s,

with inevitable effects upon their traditional lifestyle. Nevertheless, the application of modern technology to their daily tasks such as herding, fishing and fencing remains much less than in other circumpolar communities. In the early 1990s, a combination of dietary and heart rate records suggested that adult male population had an average energy expenditure of 13.4 MJ/day, and in herders, values were as high as 16.2 MJ/day (Leonard and Crawford 2002).

Other Northern Populations

Dietary estimates of energy expenditures are in some respects less certain than measurements of oxygen consumption. Often, food intake is under-reported, and observations represent the average of expenditures over an entire week. In reindeer herding Saami Lapps, dietary estimates of energy expenditure showed a tendency to drop, from 12.3 MJ/day in 1962 and 12.1 MJ/day in 1967, to a range of 9.1-15.9 MJ/day for the men who were tested in 1975 (Haglin 1991).

In 1987-88, dietary estimates for Alaskan natives averaged 11.5 MJ/day (Nobmann 1991), and 1986 dietary estimates for American Indians in Northern Ontario were much lower, at 7.9-8.4 MJ/day (Aubrey et al. 1991). In this last population, it seems likely that many of the community had already abandoned their traditional caribou hunting.

Influence of “Rest Days”

Even in the most active indigenous populations, active pursuits usually have not continued for seven days per week. A detailed input-output analysis from Southern Africa suggested that the economic needs of that the !Kung bushmen were satisfied by working for no more than 2.2 days per week (Lee 1969).

Because of this periodicity, coupled with a small body size, their energy expenditures as averaged over an entire week were no more than 9.4 kJ/day for the men and 7.3 kJ/day for the women.

Details of the frequency of hunting expeditions and the duration of breaks in such activity are less clearly established for traditional Inuit of the Canadian north and for the Haida and Nootka of the west coast of British Columbia, but such groups undoubtedly faced periods of adverse weather when hunting was neither advisable nor possible. During such intervals, the main activities probably related to the repair of their equipment. We estimated that when averaged over an entire year, taking due account of rest periods, the energy expenditure of the Inuit hunter dropped to 12.6 MJ/day (Godin and Shephard 1973), a figure very similar to that of labourers who worked within the village. For married women, the annualized average was 10.0 MJ/day.

Issues of Methodology

Leonard and associates have questioned the factorial approach, particularly when the energy costs of individual elements in the day were not carefully determined; they found higher energy expenditures when estimates were based on heart rate recording (Leonard et al. 1995; Katzmarzyk et al. 1996).

One possible factor contributing to discrepant estimates between groups could be a substantial increase in either basal or resting metabolism, due to the very cold environment in most arctic settlements. However, efficient clothing provides many traditional arctic populations with a warm micro-climate. We did not observe any increase of resting metabolic rate in Inuit who were accustomed to the use of mouthpieces

and nose-clips, and the apparently high rates of resting energy expenditure seen by Leonard et al. could reflect no more than unfamiliarity with the use of breathing equipment. A further limitation when using the heart rate method is that in many indigenous populations, the heart rate is boosted by a substantial component of isometric work.

Conclusions

We may conclude that in many prehistoric communities, the hypothesis that daily tasks imposed periods of heavy energy expenditure upon male members of the community is supported by both subjective and objective evidence. In the most isolated and least acculturated settlements, high levels of energy expenditure persisted until the second half of the twentieth century, although more recently physical activity has progressively decreased with mechanization and the loss of traditional hunting pursuits. The prehistoric level of energy expenditures among the women is less certain. Some may have walked long distances, carrying their young, but others seem to have followed a more settled existence, spending much of their time in traditional domestic chores, with energy expenditures in the range 8- 10 MJ/day. One documented exception is that segment of the Evenki women who were a part of the reindeer herding brigade; their estimated energy expenditures averaged as much as 11.8 MJ/day (Leonard and Crawford 2002).

Fitness Levels of Pre-historic Societies

Some authors have argued that even in a well-educated western population, it is difficult to assess patterns of habitual physical activity, and that it is thus preferable to measure attained levels of aerobic fitness rather than rely upon

questionnaires as a means of estimating physical activity patterns (Blair et al. 1995; Blair et al. 2001). It could be argued that the tactic of examining attained fitness is even more desirable when dealing with indigenous populations, since problems of communication are frequent, and activity patterns are not constrained by any type of regular working week. The counter-argument is that any unusual levels of fitness may be a genetic response to challenges of the environment in which the populations live, rather than an expression of recent physical activity.

The IBP-HA project and subsequent studies have now provided information on body mass, body fat content, aerobic fitness and muscular strength for many isolated populations. The values observed in populations maintaining a traditional lifestyle appear to be an acute response to a physically active lifestyle rather than an expression of genotype, since they have largely disappeared with a few years of acculturation to a sedentary western lifestyle.

Body Mass

A number of authors have attempted to assess the body composition of isolated populations using the traditional tool of the epidemiologist, the body mass index (BMI). Values for 20 males living in Coppermine, Nunavut (67.8°N), in 1901 and 1923 were already overweight by Southern Canadian standards, averaging 28 kg/m² (Newman 1960), although figures for 30 men seen at Chesterfield Inlet in 1939 were more acceptable, at 25 kg/m² (Newman 1960). We noted that in the Igloodik Inuit (whom we knew to have a high level of physical activity), adult males frequently had an body mass that exceeded height-related actuarial norms

by as much as 8-10 kg (Shephard and Rode 1973).

The 1973 survey of Nutrition Canada published a separate Eskimo report, citing averages of 26 kg/m² for men, and 23-27 kg/m² for women (Nutrition Canada 1975); the authors thus concluded that many of the Canadian Inuit were obese. The BMI values that they observed were substantiated by further figures for various isolated arctic settlements collected over the period 1964-70; the latter averaged 25 kg/m² in men and 23-27 kg/m² in women (Schaefer 1977).

We suggested two factors other than obesity could possibly have contributed to the anomaly of vigorous activity and a large BMI- an increase of lean body mass, due to a well-developed musculature, and short limbs [which would tend to invalidate the use of standing height in the BMI calculation] (Shephard and Rode 1973). Like Andris Rode and myself, Otto Schaefer noted that high BMI readings were accompanied by low skinfold values, and he supported our suggestion that the BMI was yielding misleading information on the prevalence of obesity in arctic populations (Schaefer 1977). Nevertheless, the standard BMI has become a more appropriate measure of obesity as acculturation has led to a decrease of muscle mass and the body dimensions of the Inuit have approached those seen in southern communities.

A comparison of Chukchi from Bering Strait, Keewatin Inuit on the west coast of Hudson's Bay and Cree-Ojibway to the southwest of Hudson's Bay demonstrated that in 1994 the BMI was still lowest in those individuals who spent a great deal of time in traditional hunting pursuits; values increased progressively on moving southward to more acculturated settlements (Young 1994). Likewise, in

the relatively acculturated populations of American Indians and Alaskan natives tested in recent years, an excessive BMI has become associated with body fat as assessed by waist circumference, and with a low level of habitual physical activity (Slattery et al. 2010).

Body Fat

Early data for the skin fold thicknesses of circumpolar populations support the view that men who pursued a traditional lifestyle had little subcutaneous fat; however, even the earliest objective data for women, particularly those in the older age groups, showed figures more typical of sedentary societies (Table 2, (Shephard and Rode 1996)). In our studies of 1970, skin fold values were particularly low in the male hunters. However, by 1990, when the dog teams and kayaks of an earlier generation had been replaced by snowmobiles, power boats and all-terrain vehicles, levels of body fat matched those of other men from the same community (Rode and Shephard 1992).

Murphy et al. (1992) also noted a that there had been a substantial increase of obesity among Alaskan Yu’pik Inuit when observations that he had made 25 years earlier were repeated. Young (1994) compared data for the Chukchi (where averaged values for the triceps and subscapular folds were 9 mm in men and 14 mm in women, with his Inuit and Cree-Ojibway samples (where he saw values of 16 mm in men and 24-28 mm in women); he noted that even into the 1990s, those villagers who continued with their traditional hunting pursuits still had skin fold readings 3-4 mm lower than those of their less active peers.

The distribution of body fat in the traditional Inuit of Igloodik (Shephard and Rode 1996) tended to show a male

chest/waist circumference ratio, although this observation was a little hard to interpret, given that skin folds were very thin for both the chest and the waist. Nevertheless, the “masculine” pattern of fat distribution became more pronounced between 1970 and 1990, as most of the Inuit abandoned their traditional lifestyle (Shephard and Rode 1996). Likewise Young (1994) found a gradient of an increasingly “masculine” fat distribution with acculturation, as he compared Chukchi, Inuit and Cree-Ojibway populations.

Table 2: Thickness of skin fold in mm for triceps (T) or the average of three skinfolds (S) in selected circumpolar populations, both male (M) and Female (F), as accumulated by Shephard and Rode (Shephard and Rode 1996).

Location and Year	Skinfold Thickness			
	M 20-29 yr	M 50-60 yr	F 20-29 yr	F 50-60 yr
NW Alaska (T, 1980)	8	8	16	20
Foxe Basin (T, 1970)	5	6	8	15
Lapps (T, 1970)	5	6	10	15
Volchanka (S, 1991)	7	7*	16	25*
Igloodik (S, 1970)	6	8	9	19
Igloodik (S, 1980)	7	9	12	11
Igloodik (S, 1990)	10	16	15	35

*aged 40-50 yr

Further estimates of Inuit body fat content have been made using deuterated water (Shephard et al. 1973) and hydrostatic weighing (Rode and Shephard 1994). These techniques are limited respectively by possible abnormalities of tissue hydration and bone density in the Inuit. However, the findings appear to confirm the view that traditional Inuit carry a large part of their total body fat within the abdomen. In a very cold climate, it is probably an advantage to conserve body heat by a flexible amount of insulation (from highly

effective clothing) rather than by a fixed layer of superficial body fat. Other possible advantages of intra-abdominal fat storage in a cold climate include a reduction in the surface/body mass ratio, and a greater potential for thermogenesis (Beall and Goldstein 1992).

Aerobic Fitness

It is difficult to make comparisons of aerobic fitness between modern societies and traditional circumpolar populations, because of differences in body build, and (in some Inuit communities) adverse effects of anemia and tuberculosis upon oxygen transport. Nevertheless, figures for the directly measured maximal oxygen intake of young adult males obtained during the late 1960s suggest that several circumpolar populations, including the Igloodik Inuit (52 ml/[kg.min]), the Nellim Lapps (49-52 ml/[kg.min]) and the Kautokeino Lapps (53 ml/[kg.min]) all had an above average level of aerobic fitness (Shephard and Rode 1996). In support of this conclusion, when the Igloodik population was classified in terms of its lifestyle, the maximal oxygen intake of traditional hunters was 10-12% higher than that for more acculturated members of the same community, and average values for the entire population also dropped sharply over 20 years of acculturation to a modern, sedentary lifestyle (Rode and Shephard 1992).

Muscular Strength

The isometric muscle strength (hand grip and knee extension force) of the Igloodik Inuit, both men and women, was initially somewhat greater than would have been anticipated in southern Canadian populations, although interpretation of the knee extension data was complicated by the short limb length of the Inuit. Deuterated water studies

confirmed that the lean mass per unit of standing height was 18% greater than anticipated for a "white" population (Shephard et al. 1973), and the leg strength of the women was also 80-90% of that for the men, as compared with 60-70% of the male level in southern Canada. These advantages of strength disappeared progressively as power vehicles eliminated the need for the population to walk through deep snow for much of the year.

Conclusions

Data on body mass, body fat content, aerobic fitness and muscle strength all suggest that traditional circumpolar groups originally had a physically demanding lifestyle, with periods when levels of energy expenditure were high. However, there has been a progressive loss of fitness as traditional populations have become acculturated to the less demanding habits and lifestyle of southern Canada (Shephard and Rode 1996).

Some of the other indigenous groups studied by the IBP programme have always lived in much less challenging habitats than the arctic coastline; often, the daily energy expenditures of such populations were quite modest even during the early 1970s, and their fitness levels were no higher than those seen in sedentary western society (Shephard 1978). Thus, although some groups have traditionally had a high level of physical activity, this has not been a universal characteristic of prehistoric life.

Health of Pre-historic Societies

Little is known about the health of pre-historic societies. In traditional societies, the main factors limiting expansion of the population were probably accidents, starvation, and

neonatal and early infant deaths. In 1970, accidental deaths in Alaska were still three times the U.S. National average. Fertility was restricted by prolonged lactation; sometimes, children were suckled for several years after their birth. The blood of people living in isolated Inuit settlements lacked the antibodies to many major communicable illnesses, leaving the communities very vulnerable to diseases imported by visitors from other parts of the world. This may reflect in part the small original size of these communities, with little chance of exposure to such diseases (Simpson 1981). However, a low level of salivary immunoglobulin A and a poor response to vaccines also points to difficulty in producing the relevant antibodies (Nielsen et al. 1971; Persson et al. 1972; Sayed et al. 1976), perhaps because of dietary deficiencies (Gross and Newberne 1980). At the same time, a low level of immune function may have protected some traditional groups against auto-immune diseases such as juvenile diabetes (Svejegaard et al. 1975; Thomsen et al. 1975).

Cardiac Disease

Traditional communities appear to have had a low incidence of heart attacks (Dyerberg and Bang 1981; Choinière 1992). There may have been some under-reporting of cardiac problems (because of a lack of medical and nursing support), and early death from accident or starvation may have killed many members of traditional populations before they reached the coronary prone years. However, further important sources of protection were undoubtedly low levels of body fat (Rennie et al. 1970; Rode and Shephard 1973), a high consumption of fish and thus omega-3 fatty acids (Rode et al. 1995), and a low prevalence of hyperlipidaemia and

hyperchlesterolaemia (Corcoran and Rabinowitch 1937; Draper 1976; Leonard et al. 1994).

The progressive reduction of daily physical activity and the westernization of diet has been followed by appearance of the cardiac risk factors typical of modern city life- a loss of fitness, an increase in body fat (Rennie et al. 1970; Rode and Shephard 1973), diabetes mellitus (Szathmary et al. 1987; Young et al. 1992), and hypertension (Thouez et al. 1990; Leonard et al. 2006), with a growing prevalence of myocardial infarction and cerebrovascular disease (Bjerregaard and Dyerberg 1988; Alekseev 1991).

Nutrition

In some traditional circumpolar communities, the diet has lacked key nutrients, particularly vitamins C and D. The absence of green vegetables predisposed to scurvy. King Christian IV sent Captain Jens Munk with two ships and 62 mariners to explore the Northwest passage, but by the time that they had reached the western shore of Hudson's Bay, the ravages of scurvy were such that only four of the party had the strength to sit up (Stefansson 1946). Early missionaries who visited the arctic also fell victim to scurvy. However, the coastal Inuit [who ate raw fish, seal liver and whale skin (muktuk)] gained an adequate intake of vitamin C from their country foods, in part because their meals were often eaten uncooked (Brett 1969; Geraci and Smith 1979; Fediuk 2000).

Archaeologists have commented that some circumpolar populations (particularly the reindeer-herding Lapps) had a very narrow pelvis width. This was attributed to a lack of exposure to sunshine, and thus a vitamin D deficiency (Lewin and Hedegard 1971). More

recently, vitamin D deficiencies have also been seen in Manitoban first nations (Haworth and Dilling 1986; LeBrun et al. 1993). The Canadian Inuit, who lived primarily on the coast line, also had little exposure to sunlight, but nevertheless their traditional fish diet seems to have provided them with adequate vitamin D.

Infectious Disease and Suicide

Early contacts with European settlers introduced diseases such as measles, mumps, tuberculosis, anterior poliomyelitis and influenza, with devastating consequences for health (Nagler et al. 1949; Philip et al. 1959; Crosby 1976; Young and Bjerregaard 2008). Oral tradition suggests that at times of food shortage, elders who were no longer able to hunt would commit suicide by walking out into a blizzard. More recently, health problems such as heavy tobacco and alcohol consumption, substance abuse, a high risk of suicide, violent death, and a growing incidence of HIV/AIDS have been attributed to a progressive alienation of the population, associated with enforced residential schooling and limited access to traditional hunting grounds because governments have encouraged concentration of the population in larger settlements (Bjerregaard and Young 1998; Bjerregaard et al. 2004)].

Loss of Traditional Diet

Younger families have progressively substituted store-bought foods for the traditional “country fare” of caribou, arctic char, seal and whale meat (Shephard and Rode 1996); often their purchases have reflected poor dietary choices (Chansonneuve 2007). Dietary acculturation has reduced omega-3 intake (Rode et al. 1995), with a progressive increase in cholesterol and triglyceride

levels (Bang and Dyerberg 1972; Draper 1976). These changes are most apparent in populations living at lower latitudes, probably because they have had a longer exposure to acculturating influences (Young and Bjerregaard 2008).

Preventive Measures

Much as many Inuit and North-American Indians might romanticize and yearn for the return of their traditional lifestyle, the mechanization of hunting and the concentration of a rapidly growing indigenous population in ever larger settlements almost certainly precludes a turning back of the clock. The Canadian government has thus considered three possible options to reverse the adverse trend in physical activity levels among traditional societies: the fostering of traditional arctic games, the sponsoring of competitions typical of “white” society, and adult use of the recreational facilities in newly constructed high schools.

Traditional Arctic Games

The commissioners of the North-West Territories (Stuart Hodgson and James Smith) watched the trouncing of arctic athletes at the Canada Winter Games of 1967 that were held in Quebec City. Both men recognized that the small pool of potential competitors and the inadequate facilities and opportunities for training in the far north made the participation of indigenous groups an unequal struggle. With the support of Pierre Trudeau, and the Governor of Alaska (Walter Hickel), the Arctic Winter Games were thus initiated in Yellowknife in 1970, with some 500 competitors. The Arctic Games have since grown dramatically, and now include some 2000 contestants drawn from almost all circumpolar regions, including Alaska, the Northwest

Territories, the Yukon, Northern Alberta, Northern Quebec (Nunavik), Nunavut, the Russian province of Yamal, Greenland and the Sami people of Scandinavia.

Many of the competitions such as cross-country skiing and biathlon are of a similar type to what would be anticipated at the Canada Winter Games, albeit with a more appropriate level of competition for isolated populations. However, beginning in 1974, eleven traditional Inuit Games were also included: one-foot, two-foot, and Alaska high kicks; arm pull; knee jump; airplane; one-hand reach; head pull; knuckle hop; sledge jump; and triple jump. Each of these games requires a combination of strength, conditioning, technique, and pain tolerance. In contrast with “white” sports, competitors are expected to offer technical assistance and advice to their rivals during the competition. Winning remains important, but even greater value is attached to ensuring that all participants achieve their best performance.

“White” Sports

Traditional “white” sports such as ice-hockey, basketball and volleyball have been encouraged in individual circumpolar communities, but scant facilities, the vast distances separating individual settlements and the high cost of airfares have discouraged the formation of the junior leagues that encourage participation in southern Canada. Ice hockey is the principal “white” sport seen in the north, although some communities also have basketball, volleyball, soccer and badminton teams, as well as ice-skating competitions.

Most communities now have ice rinks, but not all have refrigeration equipment. In Pangnirtung, the local ice rink is cooled by the cold weather on the exterior of the building, and recent

climate change has shortened the period of ice and thus the playing season by as much as two months.

One Inuit (Jordin Tootoo) now plays with the Nashville Predators. He was born in Rankin Inlet, and his father not only taught him the skills of hunting, but also showed him how to skate and then play hockey at the Rankin Inlet rink. The Tootoo family has been seen by some as offering a role model to the Inuit; unfortunately, Jordin’s brother (who also entered professional hockey) was convicted of drunk driving, and like quite a number of “white” hockey players, he committed suicide at the age of 22 years. Other first nation and Méti youth such as Carey Price, Jonathan Cheechoo, Sheldon Souray and Rene Bourque have also entered the ranks of International ice-hockey teams.

At least one former NHL player (Joe Juneau of the Montréal Canadiens) is now coaching hockey full-time in the Nunavik community of Kuujuaq (population about 2000). Other NHL players have visited communities such as Pond Inlet as a part of “Project North,” a scheme that donates equipment and promotes fitness and literacy in the north. Yet others have worked as coaches at the Nunavut Stars hockey camp in Iqaluit, where each summer 140 promising Inuit children are flown free of charge by the Inuit airline First Air.

Community Recreational Facilities

The concentration of Inuit in larger communities has allowed the construction of well-equipped high schools and recreational facilities. In Igloolik (current population of about 1200), a school gymnasium with a regulation size basketball court was completed in 1971, a recreation hall and indoor swimming pool were opened in

the early 1980s, and an indoor skating rink and curling rink were built in 1991. Cross-sectional comparisons suggest that those members of the local community who participate in such pursuits as indoor soccer, floor hockey, basketball, volleyball and badminton have avoided some of the decline in fitness (particularly the decline of maximal oxygen intake) that has affected the rest of the local population (Table 3) (Rode and Shephard 1993). Nevertheless, longitudinal studies are still needed to demonstrate the causal nature of this relationship.

Table 3: Influence of use of local recreation facilities on the fitness of Igloolik Inuit upon the fitness of young adults (age 20-30 years). Based on data collected by Rode and Shephard in 1989-1990 (Rode and Shephard 1993).

	Active	Inactive	Active	Inactive
Body Mass (kg)	63.8	65.4	54	54.7
Skinfolds (sum of 3, mm)	26.5	32.5	40.5	45.6
Grip Force (N)	460	454	258	227
Knee Extension (N)	570	540	449	386
Maximum Aerobic Power (mL/[kg.min])	62	47.8	50	40.1

Conclusions

Over the past forty years, there has been some progress in encouraging the circumpolar populations to participate in both traditional games and “white” sports such as hockey, although the success of such initiatives remains limited by the vastness of the Canadian arctic. Surprisingly good results also seem possible from encouraging the use of sport and recreational facilities within small arctic communities. The challenge now is to persuade a much larger proportion of each indigenous settlement

to avail themselves of physical activity opportunities that often already exist.

Overall Conclusions

Information about the indigenous peoples of Canada in many respects epitomizes the history of health and fitness from prehistoric times. As in many other ancient cultures, the traditional lifestyle based on hunting and gathering across the arctic tundra often required sustained periods of heavy energy expenditure; as a result, physical fitness levels appear to have been high and there was a correspondingly low prevalence of both acute illnesses and chronic health problems. However, contact with the larger world has introduced acute bacterial and viral infections, often with disastrous consequences for health. Acculturation to the sedentary lifestyle of modern society has also been associated with a progressive decline of physical fitness and a growing prevalence of chronic ill-health; this has been exacerbated by widespread smoking, alcoholism and drug abuse, and a loss of “country” foods. However, as in urban environments, it appears that the adverse changes in physical condition can be stemmed or reversed by regular physical activity. The challenge is now to find the most appropriate means of encouraging such activity, whether through the promotion of native or “white” games, or increased use of local recreational facilities.

References

- Alekseev, V. P. 1991. Coronary atherosclerosis and ischemic heart disease in aboriginal and newcomer male populations of Yakutia. In: *Circumpolar Health 90*. Postl, B. D., Gilbert, P., Goodwill, J., Moffatt, M.E.K., O'Neil, J.D., Sarsfield, P.A. and Young, K.T. (eds.). Winnipeg, MN, Canadian Society for Circumpolar Research: 406-407 pp.
- Attenborough, D. (2002-2003). Food for thought-10. *The life of mammals*. London, UK, BBC 1.
- Aubrey, L. P., Langner, N., Lawn, J., Sainnawap, B. and Beardy, B. 1991. Nutrient intake of adults aged 15 to 65 years in two Northern Ontario communities. In: *Circumpolar Health 90*. Postl, B.D., Gilbert, P., Goodwill, J., Moffatt, M. E. K., O'Neil, J. D., Sarsfield, P. A. and Young, T. K. (eds.). Winnipeg, MN, Canadian Circumpolar Health Society.
- Bang, H. O. and Dyerberg, J. 1972. Plasma lipids and lipoproteins in Greenlandic west coast eskimos. *Acta Med. Scand.* 192: 85-94.
- Bassie, K. 2002. Corn deities and the complementary male/female principle. In: *Ancient Maya gender identity and relations*. Gustafson, L.S. and Trevelyan, A. N. (eds.). Westport, CONN, Bergin & Garvey: 169-190pp.
- Beall, C. M. and Goldstein, M. C. 1992. High prevalence of excess fat and central fat patterning among Mongol pastoral nomads. *Am. J. Hum. Biol.* 4: 747-756.
- Bjerregaard, P. and Dyerberg, J. 1988. Mortality from ischemic heart disease and cerebrovascular disease in Greenland. *Int. J. Epidemiol.* 17: 514-519.
- Bjerregaard, P. and Young, T. K. 1998. *The circumpolar Inuit: health of a population in transition*. Copenhagen, Denmark, Munksgaard.
- Bjerregaard, P., Young, T. K., Dewailly, E. and Ebbesson, S. O. E. 2004. Indigenous health in the Arctic: an overview of the circumpolar Inuit population. *Scand. J. Publ. Health* 32: 390-395.
- Blair, S. N., Cheng, Y. and Holder, J. S. 2001. Is physical activity or physical fitness more important in defining health benefits? *Med. Sci. Sports Exerc.* 33 (Suppl. 2): S379-S399.
- Blair, S. N., Kohl, H. W., Barlow, C. E., Paffenbarger, R. S., Gibbons, L. W. and Macera, C. A. 1995. Changes in physical fitness and all-cause mortality: A prospective study of healthy and unhealthy men. *J.A.M.A.* 273: 1093-1098.
- Brett, B. M. 1969. A synopsis of northern medical history. *Can. Med. Assoc. J.* 100: 521-525.
- Chansonneuve, D. 2007. *Addictive behaviours among aboriginal people in Canada*. Ottawa, ON, Aboriginal Healing Foundation.
- Choinière, R. 1992. Mortality among the Baffin Inuit in the 1980s. *Arct. Med. Res.* 51: 87-93.
- Corcoran, A. C. and Rabinowitch, I. M. 1937. A study of the blood lipids and blood proteins in Canadian eastern arctic Eskimos. *Biochem. J.* 31: 343-348.
- Crosby, A. W. 1976. Virgin soil epidemics as a factor in the aboriginal depopulation in America. *The William & Mary Quarterly* 33: 289-299.
- Culin, S. 1907. *Games of the North American Indians*. Mineola, NY, Dover Publications.
- Draper, H. H. 1976. A review of nutritional research. In: *Circumpolar Health*. Shephard, R.J. and Itoh, S. (eds.). Toronto, ON, University of Toronto Press: pp. 120-129.
- Dyerberg, J. and Bang, H. O. 1981. Factors influencing morbidity of acute myocardial infarction in Greenlanders. In: *Circumpolar Health '81*. Harvald, B and Hart-Hansen, J. P. (eds.). Oulu, Finland, Nordic Council for Arctic Research, Report Series 33: 300-303.
- Fagan, B. 1989. *People of the Earth: An introduction to world prehistory*. London, UK, Pearson Scott Foresman.
- Fediuk, K. (2000). *Vitamin C in the Inuit diet: past and present*. School of Dietetics & Human Nutrition. Montreal, QC: McGill University. M.Sc.Thesis.
- Food and Agricultural Organisation/World Health Organisation/United Nations University, 1985. *Energy and protein requirements*. Geneva, Switzerland, World Health Organization.
- Geraci, J. R. and Smith, T. G. 1979. Vitamin C in the diet of Inuit hunters from Homan, North West Territories. *Arctic* 32: 135-139.
- Glassford, R. G. (1969). The Meso-American rubber ball games. In: *1st International Seminar on the History of Physical Education & Sport*, Natanya, Israel: Wingate Institute, Natanya, Israel.

Understanding of Human Health and Fitness

- Glassford, R. G. 1976. *Application of a theory of games to the traditional Canadian Eskimo culture*. New York, NY: Amo Press.
- Godin, G. and Shephard, R. J. 1973. Activity patterns of the Canadian Eskimo. In: *Human Polar Biology*. Edholm O and Gunderson, E. K. E. (eds.). Cambridge, UK, Heinemann.
- Gross, R. L. and Newberne, P. M. 1980. Role of nutrition in immunological function. *Physiol. Rev.* 60: 188-302.
- Haglin, L. 1991. Nutrient intake among Saami people today compared with an old traditional Saami diet. In: *Circumpolar Health 90* Postl, B. D., Gilbert, P., Goodwill, J., Moffatt, M.E.K., O'Neil, J.D., Sarsfield, P.A. and Young, K.T. (eds.). Winnipeg, MN, Canadian Society for Circumpolar Health: pp. 741-746.
- Hathaway, E. J. 1915. *The story of the Hurons*. Toronto, ON, Ontario Historical Society.
- Haworth, J. C. and Dilling, L. A. 1986. Vitamin-D-deficient rickets in Manitoba, 1972-1984. *Can. Med. Assoc. J.* 134: 237-241.
- Hillman, M. 2010. *La Bonga: The Greatest Voyageur*. Boundary Waters Journal, Summer 2010: 20-25.
- Holbrook, G. (1970). George Catlin, 1796-1872. *1st Canadian Symposium on the History of Sport and Physical Education*, Edmonton, AL: University of Alberta, Edmonton, AL.
- Jetté, M. (1972). Primitive Indian lacrosse. *2nd World Symposium on the history of sport and physical education, Banff, AL*, University of Alberta, Edmonton, AL.
- Katzmarzyk, P. T., Leonard, W. R., Stephen, M. A., Berti, P. R. and Ross, A. G. 1996. Differences between observed and predicted energy costs at rest and during exercise in three subsistence-level populations. *Am. J. Phys. Anthropol.* 99: 537-545.
- LeBrun, J. B., Moffatt, M. E. and Mundy, R. J. 1993. Vitamin D deficiency in a Manitoban community. *Can. J. Publ. Health* 84: 394-396.
- Lee, R. B. 1969. Kung bushmen subsistence: An input-output analysis. In: *Environment and cultural behavior*. Vayda, A.P. (ed.). New York, NY, Natural History Press.
- Leonard, W. R. and Crawford, M. H. 2002. *Human biology of pastoral populations*. Cambridge, UK, Cambridge University Press.
- Leonard, W. R., Crawford, M. H., Comuzzie, A. G. and Sukernik, R. I. 1994. Correlates of low serum lipid levels among the Evenki herders of Siberia. *Am. J. Hum. Biol.* 6: 329-338.
- Leonard, W. R., Katzmarzyk, P. T., Stephen, M. A. and Ross, A. G. 1995. Comparison of the heart rate-monitoring and factorial methods: assessment of energy expenditure in highland and coastal Ecuadoreans. *Am. J. Clin. Nutr.* 61: 1146-1152.
- Leonard, W. R., Snodgrass, J. and Sorensen, M. V. 2006. Health consequences of social and ecological adversity among Siberian indigenous peoples. In: *Health, risk and adversity*. Fuentes, A. (ed.). Oxford, UK, Berghahn Books: pp. 26.
- Lewin, T. and Hedegard, B. 1971. Anthropometry among Skolts, other Lapps, and other ethnic groups in northern Fennoscandia. *Proc. Finnish Dent. Soc.* 67 (Suppl. 1): 71-98.
- Liss, H. 1970. *Lacrosse*. New York, NY, Funk & Wagnalls.
- McDougall, C. 2009. *Born to Run: A Hidden Tribe, Super-athletes, and the Greatest Race the World Has Never Seen*. New York, NY, Knopf.
- McGhee, R. 1984. Thule prehistory of Canada. In: *Handbook of North American Indians, Vol. 5*. Danas, D. (ed.). Washington, DC, Smithsonian Institute: pp.369-376.
- Morris, B. 2005. *Insects and human life*. Oxford, UK, Berg Publishers.
- Murphy, N. J., Bulkow, N. R., Schraer, C. D. and Lanier, A. P. 1992. Diabetes mellitus in Alaskan Yu'pik Eskimos and Athabaskan Indians after 25 years. *Diabetes Care* 15: 1390-1392.
- Nagler, F. P., van Rooyen, C. E. and Sturdy, J. H. 1949. An influenza virus epidemic in Victoria Island, NWT, Canada. *Can. J. Publ. Health* 40: 457-461.
- Newman, M. T. 1960. Adaptations in the physique of American aborigines to nutritional factors. *Hum. Biol.* 32: 288-313.
- Nielsen, J. C., Martensson, L., Gürtler, H., Gilberg, Å. and Tinsgaard, P. 1971. Gm types of Greenlandic eskimos. *Hum. Hered.* 21: 405-409.
- Nobmann, E. D. 1991. Dietary intake of Alaska native adults 1987-1988. In: *Circumpolar Health 90*. Postl, B., Gilbert, P., Goodwill, J., Moffatt, M. E. K., O'Neil, J. D., Sarsfield, P.

Understanding of Human Health and Fitness

- A. and Young, T. K. (eds.). Winnipeg, MN, Canadian Circumpolar Health Society. Nutrition Canada. 1975. *Eskimo Survey Report*. Ottawa, ON, Nutrition Canada.
- Persson, I., Rivat, L., Roussea, P. Y. and Ropartz, C. 1972. Tem Gm factors and the Inv system in Eskimos in Greenland. *Hum. Hered.* 22: 519-528.
- Philip, R. N., Reinhard, K. R. and Lackman, D. B. 1959. Observations on a mumps epidemic in a virgin population. *Am. J. Hygiene* 69: 91-111.
- Rennie, D. W., di Prampero, P., Fitts, R. W. and Sinclair, L. 1970. Physical fitness and respiratory function of Eskimos in Wainwright, Alaska. *Arctic Anthropol* 7: 73-82.
- Rode, A. and Shephard, R. J. 1973. Fitness of the Canadian eskimo: The influence of season. *Med. Sci. Sports* 5: 170-173.
- Rode, A. and Shephard, R. J. (1992). *Fitness and Health of an Inuit community: 20 years of cultural change*. Ottawa, ON, Circumpolar and Scientific Affairs.
- Rode, A. and Shephard, R. J. 1993. Acculturation and loss of fitness in the Inuit: the preventive role of active leisure. *Arctic Med. Res.* 52: 107-112.
- Rode, A. and Shephard, R. J. 1994. Prediction of body fat content in an Inuit community. *Am. J. Hum. Biol.* 6: 249-254.
- Rode, A., Shephard, R. J., Vloshinsky, P. E. and Kuksis, A. 1995. Plasma fatty acid profiles of Canadian Inuit and Siberian nGanasan. *Arctic Med. Res.* 54: 10-20.
- Salter, M. A. 1971. Mortuary games of the Eastern culture area. *Can. J. Hist. Sport* 2: 160-197.
- Salter, M. A. (1972). The relationship of lacrosse to physical survival among primitive tribes. *2nd World Symposium on the history of sport and physical education*, Banff, AL, University of Alberta, Edmonton, AL.
- Sayed, H., Sayed, J., Hildes, J. A. and Schaefer, O. 1976. Deficiency of secretory IgA in Eskimo saliva. In: *Circumpolar Health*. Shephard, R.J. and Itoh, S. (eds.). Toronto, ON, University of Toronto Press: 221pp.
- Schaefer, O. 1977. Are Eskimos more or less obese than other Canadians? A comparison of skinfold thickness and ponderal index in Canadian Eskimos. *Am. J. Clin. Nutr.* 30: 1623-1628.
- Shephard, R. J. 1978. *Human physiological work capacity*. Cambridge, UK, Cambridge University Press.
- Shephard, R. J., Hatcher, J. and Rode, A. 1973. On the body composition of the Eskimo. *Eur. J. Appl. Physiol.* 30: 1-13.
- Shephard, R. J. and Rode, A. 1973. Cardio-respiratory status of the Canadian Eskimo. In: *Polar Human Biology*. Edholm, O.G. and Gunderson, E. K. E. (ed.). London, UK, Heinemann Medical Books: pp. 216-239.
- Shephard, R. J. and Rode, A. 1996. *The health consequences of 'modernisation'*. Cambridge, UK, Cambridge University Press.
- Simpson, N. E. 1981. The load of genetic disease and genetic predisposition to disease in the Canadian north. In: *Circumpolar Health, 81*. Harvald, B. and Hart-Hansen, J. P. (ed.). Oulu, Finland, Nordic Council for Arctic Medical Research, Report Series 33: 145-153.
- Simri, V. 1966. *The religious and magical functions of ball games in various cultures*. Morgantown, W VA, West Virginia University.
- Slattery, M. L., Ferucci, E. D., Murtaugh, M. A., Edwards, S., Khe-Ni, M., Etzel, R. A., Tom-Orme, L. and Lanier, A. P. 2010. Associations Among Body Mass Index, Waist Circumference, and Health Indicators in American Indian and Alaska Native Adults. *Am. J. Health Prom.* 24: 246-254.
- Stefansson, V. 1946. *Not by bread alone*. New York, NY, MacMillan.
- Stringer, C. B. 1990. The emergence of modern humans. *Scientific Amer.* 264 (6): 68-74.
- Svejegaard, A., Platz, P., Ridjer, L. P., Nielsen, L. S. and Thomsen, M. 1975. HL-A and disease associations- a survey. *Transplant. Rev.* 22: 3-43.
- Szathmary, E. J., Ritenbaugh, C. and McDonald, C. S. 1987. Dietary change and plasma glucose levels in an Amerindian population undergoing cultural change. *Soc. Sci. Med.* 24: 791-804.
- Thomsen, M., Platz, P., Andersen, O., Christy, M., Lynsgoe, J., Nerup, J., Rasmussen, K., Ryder, L. P., Nielsen, L. S. and Svejegaard, A. 1975. MLC typing in juvenile diabetes mellitus and idopathic Addison's disease. *Transplant. Rev.* 22: 125-147.
- Thouez, J.-P., Ekoe, J. M., Foggin, P. M., Verdy, M., M., N., Laroche, P., Rannou, A. and Ghadirian, P. 1990. Obesity, hypertension, hyperuricemia and diabetes mellitus

- among the Cree and Inuit of northern Quebec. *Arctic Med. Res.* 49: 180-188.
- Vennum, T. 1994. *Lacrosse: Little Brother of War*. Washington, DC, Smithsonian Institution Press.
- Weiner, J. S. (1964). *Proposals for international research. Human Adaptability Project 5*. London, UK., Royal Anthropological Institute.
- Weyand, A. M. 1965. *The Lacrosse Story*. Baltimore, MD, Garamond Press.
- Whittington, E. M. 2001. *The sport of life and death*. New York, NY, Thomas & Hudson.
- Young, T. K. (1994). *Human obesity and arctic adaptation. Epidemiological patterns, metabolic effects and evolutionary implications*. Linacre College. Oxford, UK, Oxford University. Ph.D. dissertation.
- Young, T. K. and Bjerregaard, P. 2008. *Health transitions in arctic populations*. Winnipeg, MN, McNally Robinson.
- Young, T. K., Schraer, T. D., Shubnikoff, E. V., Szathmary, E. J. and Nikitin, Y. P. 1992. Prevalence of diagnosed diabetes in circumpolar indigenous populations. *International Journal of Epidemiology* 21: 730-736.

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