HEALTH AND FITNESS: A COMPARATIVE STUDY OF CANADIAN INUIT AND SIBERIAN nGANASAN

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HEALTH AND FITNESS: A COMPARATIVE STUDY

OF

CANADIAN INUIT AND SIBERIAN nGANASAN

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ABSTRACT

This study collected comparative data on the anthropometric physiological and biochemical charachteristics of the Native population of the highly acculturated society of Igloolik, Northwest Territories (NWT), Canada, and the less developed community of Volochanka, Taimir, Russia. We compared 379 Canadian Inuit (1989-1991) and 146 Siberian nGanasan (1992-1993) in terms of body composition, growth and development, fitness and strength, lung function, blood lipid and fatty acid profiles and major cardiovascular risk factors.

There were no significant inter-population differences in the heights of adults or children, but the Inuit men, boys and girls were heavier and significantly fatter than their nGanasan counterparts. The Inuit women were significantly lighter than the nGanasan women but both groups of women were substantially fatter than the men of their group.

Average grip strength was significantly higher in the Inuit men but the nGanasan men had substantially higher leg strength. Grip strength was similar in both groups of women but the Inuit women had higher leg strength. Aerobic power was essentially similar in both groups of men and women but the Inuit children were fitter than their nGanasan counterparts. Lung volumes were in the normal range for age and gender in both populations, but the Inuit men and women showed a greater aging coefficient for dynamic lung volumes.

Relatively few individuals in either community reached pathological levels in any of the 12 plasma lipids that were measured. Total fatty acid concentrations were significantly higher in the Inuit men and women and sphingolmyelin levels were higher in the Inuit men. The Inuit showed a steep age gradient in the total omega-3 fatty acids, with very high plasma concentrations in the older Inuit. In general, the nGanasan showed a higher proportion of men and women at cardiovascular risk than the Inuit.

The high level of aeroblic fitness, muscle strength and low body fat that previously characterized the Inuit has disappeared with acculturation, and the plasma fatty acid profile also suggests that the younger generation now obtain much of their food from market sources. The Inuit are now more obese than the nGanasan, and neither population has an outstanding level of fitness. Relatively few of either group, as yet, have a pathological lipid profile, but the nGanasan have substantially higher blood pressures than the Inuit, possibly explaining the growing incidence of cardiovascular disease in the Russian North.

RÉSUMÉ

L'étude rassemble des données comparatives portant sur les caractéristiques anthropométriques, physiologiques et biochimiques de la population autochtone fortement acculturée d'Igloolik, Territoires du Nord-Ouest (T.N.-O), au Canada, et de celle peu

développée de Volochanka, dans la presquîle de Taïmyre, en Russie. Nous avons comparé 379 Inuit canadiens (1989-1991) et 146 nGanasan sibériens (1992-1993) sur le plan de la morphologie, de la croissance et du développement, de la condition et de la force physiques, de la fonction respiratoire, des profils de lipides sanguins et d'acides gras et des principaux facteurs de risque cardio-vasculaire.

Nous n'avons noté aucune différence marquée entre ces populations pour ce qui est de la taille des adultes ou des enfants; cependent, les hommes, les garçons et les filles inuit avaient un poids plus élevé et étaient beaucoup plus gras que leurs homologues nGanasan. Le poids des femmes inuit était considérablement moins élevé que celui des femmes nGanasan, mais dans les deux populations les femmes étaient beaucoup plus grasses que les hommes de leur groupe respectif.

La force de préhension des hommes inuit était nettement plus grande que celles des hommes nGanasan, mais ces derniers avaient les jambes plus fortes. Chez les femmes des deux groupes, la force de préhension était similaire, mais les Inuit étaient plus fortes des jambes. La capacité aérobique était essentiellement la même chez les hommes et les femmes des deux groupes, mais les enfants inuit étaient en meilleure forme physique que leurs homologues nGanasan. Le volume pulmonaire se situait dans les limites normales, pour l'âge et le sexe, parmi les différents groupes des deux populations; cependant, les Inuit, hommes et femmes, présentaient un facteur de viellissement plus élevé relativement aux volumes pulmonaires dynamiques.

Un nombre relativement restreint de sujets parmi les deux populations avaient atteint un taux pathologique pout l'un ou l'autre des 12 lipides plasmatiques mesurés. Les concentrations d'acides gras totaux étaient considérablement plus élevées chez les Inuit des deux sexes, et les taux de sphingomyéline étaient plus élevés chez les hommes inuit. Les Inuit présentaient un gradient selon l'âge fort prononcé pour l'ensemble des acides gras oméga 3, accompagné de concentrations plasmatiques très élevées chez les sujets plus âgés. Dans l'ensemble, le risque d'être atteint d'une maladie cardio-vasculaire était plus élevé chez les hommes et les femmes nGanasan.

Le haut degré de capacité aérobique et de force musculaire, de même que le faible taux de tissus adipeux qui caractérisaient les Inuit ont disparu avec l'acculturation. Les profils des acides gras plasmatiques semblent indiquer en outre qu'une bonne part de l'alimentation de la jeune génération provient du commerce. Les Inuit sont maintenant plus obèses que les nGanasan et aucune des deux populations ne jouit d'un niveau de forme physique exceptionnel. Bien que relativement peu de sujets des deux groupes présentent pour l'instant un profil lipidique pathologique, les valeurs de tension artérielle sont nettement plus élevées chez les nGanasan que chez les Inuit, ce qui pourrait expliquer l'incidence croissante des maladies cardio-vasculaires dans le Nord de la Russie.

ᓇᓗᓇᐃᕐᓯᓯᒪᔪᑦ

ᕐᑲᐅᔨᓴᕐᑕᐅᔾᔪᑎᑎᒍᑦ ᕐᑲᐅᔨᔭᐅᓪᓗᑎᒃ ᑎᑎᕋᕐᑕᐅᓯᒪᔪᑦ ᑎᒥᐅᑉ ᕐᑲᓄᐃᑦᑑᓂᖕᒐ, ᕐᑲᓄᕐᓗ ᐃᓅᓕᓴᐅᑎᑦ ᐊᑐᕈᓐᓇᕐᓂᖕᒋᑦ ᑎᒥᒥ, ᒪᕐᕈᐃᖕᒍᓪᓗᑎᒃ ᕐᑲᐅᔨᓴᕐᑕᐅᔪᑦ ᐱᕐᑲᑎᖕᒋᑦ ᐃᓄᖕᓂ ᐃᓕᕐᑯᓯᖕᒋᑦ ᐊᓯᓐᖕᒍᕐᐸᓪᓕᐊᕐᓚᓴᕐᑐᓂ ᐃᒃᓗᓕᖕᒥ, ᓄᓇᑦᑎᐊᒥ ᑲᓇᑕᒥ ᐊᒻᒪᓗ ᑕᕆᐅᑉ ᐊᑭᐊᓂ ᐊᓯᖕᒍᕐᐸᓪᓕᐊᕐᓚᓴᓗᐊᖕᒋᑦᑐᓂ ᑫᓗᓴᓐᑲᒥ, ᑕᐃᒪᕐᒥ, ᕋᐃᓯᐊᒥ. ᑖᒃᑯᐊᒃ ᑕᒪᕐᒥᒃ ᕐᑲᐅᔨᓴᕐᑕᐅᔪᓂ ᐃᓄᐃᑦ 379ᖕᒍᔪᑦ ᑲᓇᑕᒥᐅᑕᐃᑦ ᑕᒫᓂ 1989ᒥᑦ 1991ᒧᑦ ᐊᒻᒪᓗ 146 ᕋᐃᓯᐊᒥᐅᑦ ᓄᓇᒥ ᒫᓇᓵᓐᖕᒍᓂᕋᕐᑕᐅᔪᒥ ᕐᑲᐅᔨᓴᕐᑕᐅᓗᑎᒃ 1992ᒥᑦ 1993ᒧᑦ. ᒪᑯᓄᖕᒐ ᕐᑲᐅᔨᓴᕐᑕᐅᓪᓗᑎᒃ ᑎᒥᖕᒋᑦ ᕐᑲᓄᐃᑦᑑᖕᒪᖕᒑᑦ, ᐱᕈᕐᐸᓪᓕᐊᓂᖕᒋᑦ, ᑎᒥᖕᒋᑕ ᓴᓐᖕᒋᓂᖕᒋᑦ, ᐳᕕᖕᒋᑕ ᓴᓐᖕᒋᓂᖕᒋᑦ, ᐊᐅᖕᒋᑕ ᐃᖕᒋᕐᕋᓂᖕᒐ, ᕐᑲᓄᕐᓗ ᕐᑯᐃᓂᑎᒋᖕᒪᖕᒑᑦ ᐊᒻᒪᓗ ᐆᒻᒪᑎᖕᒋᑕ ᓴᓐᖕᒋᓂᖕᒋᑦ.

ᑖᒃᑯᐊ ᕐᑲᐅᔨᓴᕐᑕᐅᑎᓪᓗᒋᑦ ᑕᒪᕐᒥᒃ ᐊᖕᒋᓂᖕᒋᑦ ᐃᓐᓇᐃᑦ ᓄᑕᕐᑲᓪᓗ ᐊᔾᔩᓐᖕᒋᓗᐊᓚᐅᓐᖕᒋᑦᑐᕐᒃ, ᑭᓯᐊᓂ ᐊᖕᒍᑎᓪᓗ, ᓄᑲᑉᐱᐊᓪᓗ, ᓂᕕᐊᕐᓵᓪᓗ ᐅᕐᑭᓐᖕᒋᓐᓂᕐᓴᐅᓚᐅᕐᑐᑦ ᕐᑯᐃᓂᓂᕐᓴᒻᒪᕆᐅᓪᓗᑎᒃ ᑕᐃᒃᑯᓇᓐᖕᒐᑦ ᕐᑲᐅᔨᓴᕐᑕᐅᕐᑲᑎᒥᖕᓂᑦ ᒫᓇᓵᓐᒥᐅᓂᑦ. ᐃᓄᐃᑦ ᐊᕐᓇᖕᒋᑦ ᐅᕐᑭᑦᑑᑕᓂᕐᓴᐅᒻᒪᕆᓚᐅᕐᑐᑦ ᒫᓇᓵᓐᒥᐅᓂᑦ ᑭᓯᐊᓂ ᑖᒃᑯᐊ ᑕᒪᕐᒥᒃ ᐊᕐᓇᐃᑦ ᕐᑯᐃᓂᓂᕐᓴᐅᒻᒪᕆᓚᐅᕐᑐᑦ ᐊᖕᒍᑎᓂᑦ ᑕᒪᖕᒋᖕᓂ ᕐᑲᐅᔨᓴᕐᑕᐅᔫᖕᓂ.

ᐊᒃᒫᒥᖕᓄᓪᓗ ᑎᒍᔨᓪᓗᑎᒃ ᐃᓄᐃᑦ ᐊᖕᒍᑎᖕᒋᑦ ᓴᓐᖕᒋᓂᕐᓴᐅᒻᒪᕆᓚᐅᕐᒥᔪᑦ ᒫᓇᓵᓐᒥᐅᓂᑦ. ᑭᓯᐊᓂ ᑕᐃᒃᑯᐊ ᓂᐅᖕᒋᑦ ᓴᓐᖕᒋᓂᕐᓴᐅᒻᒪᕆᓚᐅᕐᓗᑎᒃ. ᑎᒍᔨᓪᓗᑎᒃ ᐊᕐᓇᐃᑦ ᑕᒪᕐᒥᒃ ᐊᔾᔩᑭᕈᔫᓚᐅᕐᑐᑦ ᑭᓯᐊᓂ ᐃᓄᐃᑦ ᐊᕐᓇᖕᒋᑦ ᓂᐅᖕᒋᑦ ᓴᓐᖕᒋᓂᕐᓴᐅᓪᓗᑎᒃ. ᐃᕐᑲᐃᓕᓴᕐᓗᑎᒃ ᐊᕐᓇᑦ ᐊᖕᒍᑎᓪᓗ ᐊᔾᔩᑐᐃᓐᓇᓚᐅᕐᑐᑦ ᑭᓯᐊᓂ ᐃᓄᐃᑦ ᓄᑕᕋᖕᒋᑦ ᒫᓇᓵᓐᒥᐅᓂᑦ ᑕᕐᑲᓴᕋᐃᓐᖕᒋᓐᓂᕐᓴᐅᓚᐅᕐᑐᑦ. ᐊᒻᒪ ᐳᕕᖕᒋᑕ ᐊᐅᓚᓂᖕᒋᑦ ᑕᒪᕐᒥᒃ ᐊᔾᔩᖕᒍᓪᓗᑎᒃ ᑕᐃᒪᐃᓚᐅᕐᑐᑦ. ᑭᓯᐊᓂ ᐃᓄᐃᑦ ᐊᕐᓇᐃᑦ ᐊᖕᒍᑎᓪᓗ ᐃᓐᓇᕈᕐᐸᓪᓕᐊᓪᓗᑎᒃ ᐳᕕᖕᒋᑦ ᓴᓐᖕᒌᓕᕙᓪᓕᐊᑲᐅᕐᑐᕐᓂᕐᓴᐅᕙᒃᓗᑎᒃ ᑕᐃᒃᑯᓇᓐᖕᒐᑦ.

ᐅᓄᓐᖕᒋᑐᑦ ᕐᑲᐅᔨᓴᕐᑕᐅᔪᓂ ᑖᒃᑯᖕᓇᓂ ᓄᓇᑖᖕᓂ ᕐᑯᐃᓂᓗᐊᓪᓚᑖᕐᑐᕐᑲᓚᐅᕐᑐᕐᒃ. ᐊᔾᔩᖕᒋᑦᑐᑦ ᐅᕐᓯᐃᑦ ᐱᒋᔭᐅᓪᓗᑎᒃ ᐊᕐᓇᓂᑦ ᐊᖕᒍᑎᓂᓪᓗ. ᕐᑯᐃᓂᓂᖕᒋᓪᓕ ᐃᓄᐃᑦ ᑖᒃᑯᓇᓂ ᐃᓐᓇᐅᓂᕐᓴᓂ ᑕᑯᒃᓴᐅᓂᕐᓴᐅᕐᑲᑦᑕᓚᐅᕐᐳᑦ. ᑕᐃᒃᑯᐊ ᒫᓇᓵᓐᒥᐅᑦ ᐊᖕᒍᑎᖕᒋᑦ ᐊᕐᓇᖕᒋᓪᓗ ᐆᒻᒪᑎᕐᓗᑐᐃᓐᓇᕆᐊᕐᑲᕐᓂᕐᓴᐅᓪᓗᑎᒃ ᐃᓄᖕᓂᑦ.

ᐃᓄᐃᑦ ᑕᕐᑲᓴᕋᐃᓐᖕᒋᓐᓂᕆᓚᐅᕐᓯᒪᔭᖕᒋᑦ, ᓴᓐᖕᒋᓂᖕᒋᓪᓗ, ᕐᑯᐃᓂᔪᕐᔪᐊᖕᒍ-

ᖕᒋᓐᓂᕆᓚᐅᖅᓯᒪᔭᖕᒋᑦᑐ ᐱᑕᖅᑲᔫᓐᓃᖅᐹᓪᓚᖅᓯᒪᒐᑦ ᐃᓅᓯᖕᒋᑦ ᐊᓯᒋᐋᓪᓚ-
ᖅᓯᒪᓕᖅᑎᓪᓗᒋᑦ, ᑕᒪᒃᑯᐊᓗ ᒪᒃᑯᒃᑐᑦ ᐱᔾᔪᑎᖅᑲᖅᓱᒋᔭᐅᒐᑦ ᒫᓐᓇ ᓂᖅᑭᒋᖅᑲ-
ᖅᑕᓕᑕᖕᒋᓐᓂᐅᓇᓱᒋᔭᐅᒐᑦ. ᒫᓐᓇ ᐃᓗᐃᑦᖅᑯᐃᓂᔪᖅᔾᔪᐊᖅᑕᖅᑲᖅᓂᖅᓴᐅᓕᖅᑐᑦ
ᒫᓇᓵᓐᒥᐅᓂᑦ, ᑖᒃᑯᐊᓗ ᑕᒪᖅᒥᒃ ᑕᖅᑲᓴᖃᐃᓐᖏᖅᑐᖅᔪᐊᖅᑕᖅᑲᓗᐊᖃᑎᒃ. ᐊᒻᒪ
ᖅᑲᒃᔫᓇᐅᒪᓗᐊᑦ ᑖᒃᑯᓇᓂ ᖅᑲᐅᔨᓴᖅᑕᐅᔪᓂ ᖅᑯᐃᓂᓗᐊᓗᑦ ᓈᒻᒪᖕᒋᓕᐅᕈᑎ-
ᖅᑐᐃᓐᓇᓇᐊᖅᑲᖅᑐᖅᑲᖅᑯᓂ, ᑭᓯᐊᓂ ᒫᓇᓵᓐᒥᐅᑦ ᐊᐅᖕᒋᑕ ᐃᖕᒋᖅᓴᓂᖕᒋᑦ
ᓱᒃᑲᓗᐊᖅᑐᖅᑲᖅᓂᖅᓴᐅᓪᓗᑎᒃ ᐃᓗᖕᓂᑦ, ᑕᐃᒪᐃᒻᒪᐅᔪᒃᓴᐅᔪᖅ ᐆᒪᑎᖅᓗᑐᐃ-
ᓐᓇᓇᐊᖅᑲᖅᓂᖅᓴᐅᒐᑦ ᖃᐃᓯᐊᑯᑦ ᓄᓇᖕᒐᓐᓂ.

ᑖᒃᑯᐊ ᖅᑲᐅᔨᓴᖅᑕᐅᓯᒪᔪᑦ ᐊᓐᑎ ᔫᑦᒍ (ᖅᑲᐅᔨᓴᖅᑎᑯᓗᖕᒍᑦ) ᐃᒡᓗᓕᐅᖅ
ᖅᑲᐅᔨᓴᖅᐱᖕᒐᓂ ᑖᓐᓇ ᓴᓇᔫᓴᓚᐅᖅᓯᒪᔪᖅ ᐊᖅᖄᒍᒐᓴᖕᓂᒃ ᖅᑲᐅᔨᓴᖅᐱᖕᒥ
ᑲᒪᔨᐅᓪᓗᓂ ᐊᒻᒪᓗ ᖅᑲᐅᔨᓴᖅᐸᒃᓗᓂ.

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SUMMARY

The objective of this study was to collect comparative data on the anthropometric, physiological, and biochemical characteristics of the Native populations of a highly acculturated society (Igloolik, NWT, Canada) and a less extensively developed community (Volochanka, Taimir, Russia). To that end, we compared 379 Canadian Inuit (1989-1991) and 146 Siberian nGanasan (1992-1993) in terms of growth and development, body composition, fitness and strength, lung function, blood lipid and fatty acid profiles and major cardiovascular risk factors.

Height and Body Mass. There were no significant inter-population differences in the heights of adults or children, but the Inuit men ($p=0.004$) and boys ($p=0.049$) were substantially heavier than than their nGanasan counterparts. The Inuit girls tended to be heavier than the nGanasan girls but this difference was not statistically significant. The Inuit women were significantly lighter ($p=0.032$) than the nGanasan women.

Body Composition. Skinfold measurements showed that the Inuit men, boys, and girls carried significantly ($p=0.001$) larger amounts of subcutaneous fat than their nGanasan counterparts, and a substantial proportion of the women were now clinically obese. However, there were no significant differences in the average subcutaneous fat readings between the Inuit and nGanasan women.

In adults, predictions of total body fat based on skinfold measurements suggested that the Inuit men were significantly fatter ($p<0.0001$), but the lean body mass was essentially similar in both groups of men. In the women, there were no significant differences in total body fat or lean body mass between the two groups. Both populations of women had significantly higher levels of subcutaneous fat and total body fat than the men of their group.

Strength. Neither population showed remarkable figures for muscle strength. Average grip strength was significantly higher in the Inuit than in the nGanasan men at all ages ($p=0.019$); however, the nGanasan men had substantially higher ($p=0.019$) leg strength than their Inuit peers. In the women, grip strength was similar for both populations, but the Inuit women had higher ($p=0.007$) leg strength. In the boys, grip strength was similar for the Inuit and nGanasan but, as a group, the nGanasan boys had higher knee extension force ($p=0.005$). In the girls, grip strength was higher in the nGanasan ($p=0.005$) and knee extension force was similar in the two populations, with a trend (NS) to higher leg strength values in the older Inuit girls.

Predicted Aerobic Power. Aerobic power was predicted by step test, with direct measurement of oxygen consumption. Data for both populations fell in the sedentary range. In the men, mean absolute aerobic power was higher in the Inuit ($p=0.027$) but relative values were essentially similar for men of the two populations. In the women,

there were no significant differences in absolute or relative aerobic power between the two groups. In the children, the Inuit boys and girls had significantly higher mean levels of absolute (boys, $p<0.0001$; girls, $p=0.003$) and relative (boys, $p<0.0001$; girls, $p=0.024$) aerobic power than their nGanasan counterparts.

Dynamic Lung Volumes. Gender-specific mean values for $FEV_{1.0}$ and FVC were similar in both populations, values generally lying in the normal range for age and gender. However, Inuit men and women showed a greater ageing coefficient for both $FEV_{1.0}$ and FVC. Lung volumes were comparable in Inuit and nGanasan boys, but the Inuit girls had a higher FVC ($p=0.016$) than their nGanasan peers.

Plasma Lipids in Inuit. Inuit women had significantly higher concentrations than the men for 5 of the 12 lipids measured: - free cholesterol ($p=0.041$), phosphatidyl choline ($p=0.041$), diglyceride + ceramide ($p=0.019$), total phospholipids ($p=0.019$) and sphigomyelin ($p=0.025$). Significant age effects were seen in 3 of the 12 lipids. Both men and women tended to age-related decreases in phosphatidyl choline (M, $p=0.024$; F, $p=0.057$) and the PC/FC ratio (M, $p=0.037$; F, $p<0.0001$). The men showed significant increases in sphigomyelin with age ($p=0.002$); a similar trend in the women was not statistically significant.

Plasma Lipids of Inuit versus nGanasan. Total fatty acid concentrations were significantly higher in the Inuit men (+222%, $p<0.0001$) and women (+226%, $p=0.004$) than in their nGanasan counterparts. Sphingomyelin concentrations were 14% ($p=0.012$) higher in the Inuit than in nGanasan men. However, relatively few individuals reached pathological levels in either community.

Unsaturated Fatty Acids. Our sub-sample of 86 male and 59 female Iglulingmuit showed a steep age-gradient in total plasma omega-3 fatty acids (ΣW3 FA), with parallel trends in 20:5W3 and 22:6W3 but not 18:3W3 FA levels. The ΣW7+W9 ($p<0.001$) and W9 FA (M, $p<0.001$; F, $p<0.008$) also decreased with age. These differences probably reflect a greater consumption of market foods by younger Inuit. Our sub-sample of nGanasan (30M, 11F) had similar ΣW3 and ΣW6 FA levels to the young Inuit, with little age-related change in either measure. Correlation matrices for Inuit men showed quite strong negative associations of ΣW3 FA with total triglycerides ($r=-0.34$, $p<0.001$) and the PC/FC ratio ($r=-0.36$, $p<0.001$). In the Inuit women, ΣW3 levels were strongly related to the PC/FC ratio ($r=-0.60$, $p<0.001$), but not to triglyceride concentrations. The PC/FC ratio was also correlated with ΣW6 levels ($r=0.55$, $p<0.001$). In the nGanasan men, triglycerides were correlated with ΣW6 ($r=-0.35$, $p<0.050$), but the female sample was too small to establish useful correlations.

Major Cardiovascular Risk Factors. In keeping with recent reports of a growing incidence of cardiovascular disease in Siberia, the nGanasan showed a higher proportion of men and women at cardiovascular risk than the Inuit. The most remarkable difference between the two groups was a higher incidence of high blood pressure in the nGanasan. Further study should examine the extent of salt use in preserving foods in Volochanka.

Conclusions. The high level of aerobic fitness, muscle strength, and low body fat that previously characterized the Inuit has disappeard with acculturation, and the plasma fatty acid profile also suggests that the younger generation now obtain much of their food from market sources. The Inuit are now more obese than the nGanasan, and neither population has an outstanding level of fitness. Relatively few of either population as yet have a pathological lipid profile, but the nGanasan have substantially higher blood pressures than the Inuit, possibly explaining the growing incidence of cardiovascular disease in Siberia.

FOREWORD

Our primary objectives in preparing this document are:

1. To meet our reporting obligations to Health Canada, the Department of Health, Government of the Northwest Territories, the Igloolik Hamlet Council, the Science Institute of the Northwest Territories and the Circumpolar Liaison Directorate, Indian Affairs and Northern Development Canada.

2. To provide a compendium of our findings, allowing a comparison of health and fitness between the Iglulingmuit of Igloolik and the nGanasan of Volochanka.

Although this report is accurate and fairly detailed, it does not constitute a final or definitive analysis of our results. Such analyses are now in preparation and are in process of submission as separate papers to relevant professional journals.

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1. BACKGROUND

In 1991, we completed a 30-month study on the effects of 20 years of cultural change on the health and fitness of the Inuit living at Igloolik, NWT, Canada. In 1970, we had found the Iglulingmuit to be generally very fit, lean, and strong. In 1990, we noted that changes in lifestyle, diet, and material culture had significantly eroded these physiological advantages, to the point where many of the Iglulingmuit had fitness levels similar to those anticipated in the average sedentary population of Toronto. The changes in many aspects of personal fitness - increases in total body fat, decreases in lean tissue mass and muscle srength and decreases in aerobic power - can almost certainly be ascribed to a reduced level of habitual physical activity brought about by:

a) decreased hunting activity;
b) increased mechanization of both hunting and settlement life; and
c) near-universal television, VCR, and video game ownership and use.

Our research in Igloolik had shown that the rapid cultural and lifestyle changes affecting the Iglulingmuit had led to a significant deterioration of average cardiorespiratory fitness and a marked trend to an increasing prevalence of obesity among the population of this settlement. It was thus thought useful to compare the health and fitness status of the present day Igloolik population with that of an ethnically similar but genetically distinct and less acculturated Arctic Aboriginal group living in a differing social and geographical habitat.

Our previous work in Russia,(1) together with the recent (1989-90) political changes there, encouraged us to examine directly a Native population in the Russian Arctic living at a similar latitude to Igloolik but under economically less-developed and acculturated conditions. "Glasnost" notwithstanding, we did not have a free hand in choosing the Russian counterpart to the village of Igloolik. In collaboration with our Russian colleagues, we reviewed Native villages in Russia that were at a latitude of 70° N or higher and were:

a) predominantly Native;
b) interested in participating in our study; and
c) accessible by air at a reasonable cost.

Candidate settlements were not plentiful. Our Russian colleagues, who had worked with us in Igloolik on a feasibility study for this project, recommended the predominantly nGanasan village of Volochanka as being the closest to meeting our requirements because:

a) for practical purposes, its circumpolar location was comparable with that of Igloolik;
b) the population was largely Native (80%);
c) much of its food supply and economy still depended on hunting, fishing and trapping;

d) it was relatively isolated from the rest of the country; and
e) the Native population was apparently interested in our work and willing to co-operate with our project, having participated in previous studies conducted in Volochanka by our Russian colleagues.

Igloolik (69° N, 81° W) and Volochanka (71° N, 94° E) are about the same size (approximately 900 people) and the permanent residents are mostly Native. However, the two villages currently differ in many other respects such as climate, topography, social and material culture, diet, housing, health care and sanitation, and the degree of mechanization and thus habitual physical activity. We thought it would be useful to see how far such differences in environment and lifestyle have affected human growth and development, lung function, physical fitness, body composition and strength. It was also thought useful to compare these two populations in terms of modifiable cardiovascular risk factors (smoking, blood pressure, body fat and build and blood lipid profiles) and to examine to what degree any current differences in risk profile could be attributed to the respective lifestyles of the two communities.

1.1 Aboriginal Peoples and Early Settlers of the Taimir

The earliest peoples of the Taimir Region appear to be the nGanasans. Current residents also include later waves of immigrant groups such as the Yakuts, Dolgans, and Russians. In the early 1600s Russian hunters and trappers appeared near the major rivers in the area (Pyasina, Dudypta, Bogadina, Kheta, and Khatanga); they later settled there and subsequently became known as the tundra peasants. The first Yakuts appeared in the late 1600s on the Kheta river. Then, during the 1700s, the ancestors of the present-day Dolgans migrated into the area from the southeast.(2)

The climate of the Taimir Peninsula is severe and continental. Heavy blizzards are common in winter, often covering the entire peninsula. Taimir fauna include white fox, wolf, bear (polar on the northern coast, brown to the south and inland), moose, and wild reindeer.

1.1.1 The nGanasan

The nGanasan of the Taimir Peninsula are the most northerly Aboriginal group in Russia. Other Native groups in the area include the Entsy and Nentsy to the West, and the Dolgans and Yakuts to the South and East.

The nGanasan language belongs to the Samoyedic linguistic group. Reference to the nGanasan or the "Avam Samoyeds" first appeared in Russian historical documents in the early 1600s.(3) The Russians first encountered the nGanasan in 1618 when the Mangazeya

Cossacks reached the Pyasina river basin and imposed the payment of a fur-tax on the "Pyasina Samoyeds". By the 1630s, all the nGanasan groups had become Russian subjects.

Traditionally, the nGanasan economy depended on hunting and trapping, reindeer breeding, and fishing, and, as distinct from their neighbours, to the Nentsy, reindeer hunting was an important part of their lifestyle. Domesticated reindeer were used primarily to draw sledges but were not ridden as practised by the Dolgan. The traditional nGanasan were nomadic, dependent on the seasonal migrations of the wild reindeer. In the spring they would follow the reindeer herds North, deep into the tundra on the Taimir Peninsula and away from the forests where most of them had spent the winter. During these summer migrations, groups of nGanasan went as far North as the Byrranga Plateau and the coast. In the autumn, many would set up hunting camps at key river and lake crossings and intercept the reindeer on their southward migrations, and then follow the herds South to the forests for the winter. Other nGanasan spent the winters on the tundra living in dwellings made of stone slabs, driftwood, and turf.

1.1.2 The Dolgans

The Dolgans are currently the largest group of Native peoples in the Taimir National Okrug. With the exception of the nGanasan and the Evenks, practically the entire indigenous population of this area can be considered Dolgan. Although they speak a dialect of the Yakut language, they do not consider themselves Yakut and are ethnologically distinct from them.(3) The Dolgans migrated into the Taimir region from the Southeast during the 1700s, displacing the ancestors of the present-day nGanasan and becoming the dominant Native group in the areas of the Norilsk lakes, and the Popigay, Khatanga and Boganida River basins.

The traditional Dolgans were primarily reindeer herders, but hunting, trapping and fishing were also very important occupations. The Dolgans were essentially "edge-of-the-forest dwellers", with winters spent in the forests and summers in the tundra, just north of the tree line. Unlike the nGanasan, the Dolgans milked their domestic reindeer and used the reindeer for riding as well as sledging.

1.2 The Village of Volochanka

1.2.1 The Population

The village of Volochanka was established in the early 1930s as a part of the overall collectivization process imposed by the Soviet government during that period. At the time of our visit, the village had about 900 permanent residents made up of some 400 nGanasans, 300 Dolgans and 200 Russians. The nGanasans, who consider themselves as the original inhabitants of the Taimir region, looked upon the Dolgans (who had migrated into the area from the south-east about 300-400 years ago) as relative newcomers and intruders. Most of the Russians are relatively recent immigrants; however, unlike the majority of the 20-30 "white" residents of Igloolik, most of the non-Native inhabitants of Volochanka were long-time residents and many had children who had been born and raised in Volochanka.

In comparison to the Inuit, the Native population of Volochanka appeared to be more assimilated into the dominant (Russian) culture. All of the nGanasan and Dolgan spoke fluent Russian; whereas, among the Inuit, very few people over the age of 45 or under 7-8 years could speak English. All schooling was in Russian, as was all TV and radio programing. All government business transactions were in Russian only, as were all communications, publications and signs. However, despite the lack of state support, the Native culture has not only survived but was showing signs of a small renaissance. There were plans to introduce teaching in the Native languages in the early grades. A nGanasan dictionary was being compiled by the village elders. A small museum of nGanasan and Dolgan artifacts had been established in a room at the local school. And, in the turmoil of the political changes following "glasnost", there was much talk about forming an nGanasan Autonomous Region.

Of the two Native groups, the nGanasans were the more "traditional" in their customs, dress and lifestyle. The Dolgans were substantially "acculturated" to the Soviet/Russian lifestyle and held most of the full-time jobs that were open to non-Russians. The nGanasans and Dolgans did not mingle easily with each other; an undercurrent of surpressed enmity often surfaced in bloody fights when they were drunk. Many of the male subjects (and some women) who came in for testing bore knife scars which had resulted from these fights. Neither the nGanasans or the Dolgans particularly liked the Russians. Both groups resented the Russians because of their economic and political power. The highest-paid and highest status jobs and the best housing were held by Russians. The "airport aristocracy" was one such priviledged group, made up of Aeroflot employees and maintenance staff. Other priviledged groups included the directors of the collective farm, teachers, mechanics, power-house operators and communication workers. Nevertheless, the Dolgans considered both the Russians and nGanasans as inferior and dirty. The nGanasans in turn looked upon both the Russians and Dolgans as temporary invaders, to be expelled from territory they regarded as rightfully theirs. In general, daily social interaction among the three groups was reasonably cordial and without conflict; however, frequent bouts of drinking often ended in violence either between or within groups.

A fourth distinct group in the village was the Russian army who were disliked by most of the villagers for various reasons. Other Russian residents disliked the military personnel because they were an economic drain on the local resources. Relative to the Russian civilians in the village, rations and other conditions for the enlisted men at the army base were bad and they often came into the village to purchase extra food and alcohol, depleting the stocks of scarce goods without adding anything substantial to the local economy. The Native men resented the soldiers for their constant attempts to seduce Native women, attempts that were often encouraged by the young females of the village. Legal supplies of gasoline and petroleum products were both scarce and expensive. However, the soldiers had large supplies of both, and many of the personnel exchanged these items for "services" and furs at exorbitant rates.

1.2.2 Transportation

The first hurdle for the investigators was reaching Volochanka with some 500 kg of equipment, supplies and food. Getting the Canadian equipment and supplies (about 150 kg) to Russia was relatively simple: a direct flight from Montreal to Moscow. Thereafter, matters became increasingly more difficult.

The Russian leader of the expedition (Dr. Pavel Vloshinsky) met Dr. Rode in Moscow, from where they continued by transcontinental train to Novosibirsk. In Novosibirsk they picked up additional Russian equipment and supplies and were joined by two more Russian scientists: a physiologist (Dr. Oleg Grishin) and a nutritionist (Dr. Svetlana Kisilova). From Novosibirsk the party continued by train east to Krasnoyarsk and then by air north to Norilsk.

In Norilsk they picked up more equipment from the Institute of Polar Medicine. Here the expedition was also issued with the ration coupons necessary to purchase such staple foods as pasta, rice, sugar, tea and butter in the Russian North. From Norlisk, they flew to Volochanka by chartered aircraft (a 1930s AN-2, a single engined biplane on skiis). The cost of the charter provides a good example of the uncertain and inflationary conditions affecting all Russian components of the investigation. The agreed cost of the outward flight from Norilsk to Volochanka was 12,000 rubles; the cost of the return trip, less than 3 months later, had increased to 230,000 rubles. Scheduled flights into Volachanka were infrequent (during the winter, one flight every 2-3 weeks) and the available aircraft could rarely take both passengers and freight on the same flight. Total travel time to and from the field work in Volochanka consumed close to 10 working days, a very high proportion of the total time spent in the field.

1.2.3 Local Transportation

Local transportation in Volochanka was limited to about 20 snowmobiles of Russian manufacture. By local standards these were very expensive and only the most successful hunters and trappers owned such equipment. Gasoline and oil was also expensive and spare parts were very difficult to get. Snowmobiles were used primarily for transportation to and from the best hunting grounds, about a day's travel from the village. On site, most hunting was done on foot or on skiis. Unlike the current situation in Igloolik, there were no privately owned cars, trucks, or all-terrain vehicles.

1.2.4 Working and Living Conditions in Volochanka

Working and living conditions for the research team in Volochanka were difficult at the best of times and were, to a large extent, responsible for the comparatively few (relative to the Igloolik sample) subjects that were seen and successfully tested in the Russian component of the study. Upon arrival in Volochanka we were assigned both quarters and working space at the local hospital. However, this proved to be unsatisfactory for either working or living. During our two-and-half months in Volochanka we lived in turn at the hospital, the school, the apartment of a teacher who was on temporary leave and finally in a small, unused barrack building controlled by the local military.

It was necessary to allocate a great deal of our time on site to finding and preparing food. Although we did have an electric hot plate for cooking it was rarely used, because often the voltage was so low that it took more than an hour to boil a small pot of water. This was particularly true in the early mornings and late evenings, when everyone in the community wanted to cook. As a result, we had to rely on a coal stove for all of our cooking and hot water needs and the stoking of this stove took a lot of time. Heating water for our laboratory and personal needs also required much time and attention. Shopping or bartering for food took an inordinately long time, since it had to be done immediately supplies became available rather than when items were needed. Store hours were unpredictable and short. Often work schedules were dictated or disrupted by the need to complete these everyday domestic tasks.

1.2.5 Laboratory Space in Volochanka

Eventually, we set up our laboratory in a small storage room at the local school, having tried the local "hospital" (which lacked sufficient electrical outlets and water) and similar room at the local airport (here conditions were better but it was too far from the village to attract subjects). Routine laboratory work was interrupted by frequent electrical power failures, which could last anywhere from a few minutes to several days. Maintaining a reasonable room temperature was another problem; indoor temperatures rarely exceeded 18°C and frequently were several degrees cooler. Often it was too cold (10-12°C) in the laboratory to allow subjects to strip to the waist for exercise testing and body composition measurements. We estimate that working time lost due to power failures, "brown-outs", and lack of heat amounted to at least 50% of the hours that we attempted to work in our makeshift laboratory.

We were fully prepared to handle the 220V, 50Hz electrical current that is the norm in Russia. Our Canadian instruments were equipped with both voltage stabilizers and converters and the most sensitive machines were dual voltage instruments. However, there was little that we could do about the frequent power failures or steep voltage drops that exceeded the effective range of our voltage regulators.

1.2.6 Communications

Telecommunications (telephone and telegraph) were limited to links with the regional centres of Dudinka and Norilsk, some 350 km distance. From there, messages had to be relayed by some third party to other parts of Russia. There were approximately 40-50 telephones in the village of Volochanka, judging from the single page of phone numbers posted at the local school. Out of town telephone calls had to be made by a personal visit to the local telephone exchange. Regular postal service was also limited to Russia.

Most homes had television sets. These received the two standard Moscow channels via satellite. There was no regional television or radio coverage, and no broadcasts in the Aboriginal languages of the region. Radio reception was limited to short wave broadcasts.

1.2.7 Housing

Most people lived in barracks-like, single-storey row houses consisting of 4-8 apartments per unit. A few buildings such as the schools, hospital and day-care centre had central heating (a coal-fired hot water system) but all other apartments were individually heated by the traditional Russian masonry stove which also served for cooking and heating water. None of the buildings had running water or toilets. In general, the apartments were greatly overcrowded with as many as 10-12 people living in a 2 room flat. However, there were a few exceptions - a number of Russian families occupied flats in a centrally heated building. Conditions here were much better, with families of 2-6 occupying apartments which comprised a living room, 2 bedrooms, a small kitchen, and a storage room. These units were part of the airport complex, occupied by families of Aeroflot employees, locally referred to as the "airport aristocracy". In contrast, the Mayor of Volochanka (a Russian), his wife, and two young children lived in the village in a one-room flat with a tiny kitchen.

Many of the buildings dated back to the 1930s and nearly all were badly in need of repair. Construction materials varied from logs in the older buildings, through stucco on wood, to metal sheeting. With the exception of the older log buildings, all seemed poorly insulated.

1.2.8 Schools

There were three schools in different parts of the village:

1. A kindergarten and day-care centre for children aged 5-6 years;

2. A primary school for children aged 7-10 years in a buiding called the "Internat". This place also served as a hostel for children whose parents were unable to care for them because of travel, work outside the community, illness, or family disruptions (alcoholism, violence, death); and

3. A secondary school for children aged 11-16 years. This school was the focus of academic, social and recreational activity in the village. In addition to 6 classrooms, it housed a library, an industrial arts workshop and a small gymnasium.

Instruction at all three schools was in Russian. The children were fluent in Russian. Most of the Aboriginal children could not speak their Native language and few of the young adults were fluent in either nGanasan or Dolgan.

1.2.9 Water Supply

None of the buildings in Volochanka had running water (either hot or cold) and other sources of water were in chronic short supply. Water delivery to the entire village of over 900 people was provided by a single, slow-moving bulldozer, hauling a 1000-litre, uninsulated, unheated tank on an open sledge. The water source was a hole cut into the river ice some 3 kilometers from the village. This source was apparently selected because it was the closest place to the village that a bulldozer could negotiate the river bank safely and the water was sufficiently deep at this point to prevent it from freezing all the way to the bottom of the river even during the winter months. The water was on/and off-loaded by bucket, making distribution a painfully slow and inefficient system. Homes often had no water and it was not unusual for the hospital and the school also to be deprived of water for several days. Blizzards, mechanical breakdowns and exceptionally cold days were all factors that could interrupt the meagre water supply of the entire community for days on end.

Water was stored in the houses in one or two 200-litre oil drums. The school had 8 such barrels and the hospital had about 12. Originally, these barrels had been painted, but many were now rusting with layers of scum on the bottom. At the school, children drank untreated and un-boiled water, sharing the same ladle-like cup. There was one "sink" in the entire school, consisting of a 3-litre container of water suspended above a regular sink which opened directly into a slop-bucket underneath. The hospital had a similar set-up, as did most houses.

1.2.10 Sanitation

There was no municipal sewage or garbage disposal system in Volochanka and there was no equivalent to the "honey-bucket" system that is somtimes still used in parts of the Canadian North. In homes people used a simple bucket for a toilet. The contents, together with any other garbage such as kitchen leftovers and cans were thrown onto the "street", a few meters from the door. Roving dogs eagerly awaited the contents of these slop buckets and devoured most of the organic matter in seconds. Nevertheless, the "streets" or spaces between multi-unit buildings were littered with inorganic garbage and frozen urine. Combustibles were burned in open heaps, wherever there happened to be enough material to start a fire. There was no evidence of any organized garbage collection or clean-up during the two months that we worked in the community.

The school had an outhouse, which consisted of a drafty, unheated, wooden shack raised on pilings to make room for 2 oil drums underneath. A hole in the floor above each barrel served as the toilet. Every person was responsible for providing his/her own "toilet paper". In theory the barrels were to be removed and emptied regularly, but in actuality they were completely full and frozen into an overflow of feces and urine. It was not unusual to find a "soldier" in the toilets at the school or the hospital. This was the local term for a frozen cone of feces and urine projecting above the floor in the toilet. This was chopped off only when squatting became impossible.

The hospital had a similar set-up, except that the outhouse was attached directly to the building and was accessible from inside the hospital through a door and a short hall.

1.2.11 Health Services

Health care delivery in Volochanka was limited to very basic medical needs, despite the fact that the village boasted a "hospital". The hospital had 4 rooms with a total 20 beds, but little in the way of equipment or facilities. It had a staff of 16 people, outnumbering hospitalized patients by a large margin for most of the time. There was a head nurse and 4 assistant "nurses", 5 cleaning women, 4 stokers and 2 cooks. When we arrived in Volochanka there was only one ambulatory patient, who was recovering from pnuemonia. During our stay, we never saw more than 2 hospitalized patients at any one time. Serious cases were evacuated by air as soon as possible. It appeared to us that the hospital admitted patients with even relatively minor ailments simply because the prognosis for recovery in the crowded living conditions at home was not very good. This was particularly true of women with small children; local social customs decreed that they had little respite from domestic chores even when they were ill. When a mother of pre-school children was admitted, her children were allowed to stay at the hospital with her.

Overall sanitary conditions at the hospital were poor but nevertheless were judged to be better than in most of the homes in the village. The hospital had central heating, but lacked running water. The toilet was a filthy outhouse attached to the hospital. One sink (over a slop bucket) served all ambulatory patients and visitors. As in the rest of the village, there was no system for garbage or sewage removal. The contents of bedpans and chamber pots, kitchen waste, grey water and clinkers and ashes from the furnace were dumped outside a few metres from the main entrance to the building.

There was a chronic shortage of water, even in the hospital. As everywhere else in the community, water was stored in 200-litre oil drums, some with covers and some without. The room that was used for storing water also served as the hospital laundry, the young children's chamber pot room, and the collection point for ward bedpans and chamber pots before the contents were dumped outside. Because of water shortages, large piles of soiled bedding, towels, gowns and unwashed chamber pots/bedpans often accumulated alongside the stored drinking water.

Physicians and other health care professionals rarely visited Volochanka. While we were there, one such visiting team (doctor, dentist, gynecologist, ophthamologist and psychiatrist) arrived by helicopter, staying for a total of 9 days. This was the first such team of doctors to visit Volochanka in three years. Serious medical cases or emergencies could usually be evacuated the 350 km to Dudinka (the administrative and medical centre serving Volochanka) by helicopter, but most residents rarely saw health care professionals other than in such emergency situations. The local nurse and assistants were fully occupied simply dealing with the day to day operation of the hospital and assorted out-patient emergencies. Time and resources for health education or preventive care were just not available.

1.2.12 Local Government

We did not see any evidence of self-government for the village as a whole. The language barrier prevented us from obtaining a detailed account of how the village was administered; however, the comparisons with Igloolik revealed some stark contrasts. Volochanka did not have anything comparable to the elected Hamlet Council in Igloolik. There were no organizations similar to the elected committees for health, education, or recreation that are found in Igloolik. There was no equivalent to the Igloolik Hunters and Trappers Association or the Igloolik Alcohol Education Committee. In Volochanka, adminstrative authority appeared to be concentrated in two men, both Russians: the Mayor and the Director of the Collective Farm. In comparison to Igloolik, the people of Volochanka appeared to have very little input in, or control over, municipal affairs.

1.2.13 Local Economy

Until the mid-1980s Volochanka was apparently a fairly "prosperous" village by Soviet standards with an economy based on organized reindeer herding and fur farming, plus private initiatives of hunting, trapping and fishing. The official economy was almost entirely controlled by the Volochanka collective farm, which was essentially identical to all other such collectives in the Soviet Union at that time. The collective managed and administered practically all aspects of civil life in Volochanka, including the allocation of employment and housing, and the administration of schools and municipal services. Funding was provided by the regional administration in Dudinka, in return for quotas of meat, fish and furs delivered from Volochanka.

About 5-6 years ago, the domestic herd of reindeer was destroyed, partly by disease (brucellosis), and partly by deliberate slaughter. This destroyed a large part of the economic base of the village. At the same time, fur farming practically disappeared, since the domestic foxes were dependent on the by-products from the processing of reindeer meat. A few foxes were still kept, but the manager of the fur farm said that he experienced great difficulty in obtaining sufficient fish or meat to feed the animals and he was on the verge of closing down operations. A tannery, boot factory and fur clothing shop were still struggling along, but were unable to get enough materials from the wild to maintain levels of production that had previously been sustained by the domestic reindeer herd.

Until very recently, the collective had maintained a small (10-12) herd of milk cows. These animals provided an invaluable source of fresh milk to the young children of the community. For reasons that were not made clear to us, the herd had been slaughtered about a month before we arrived.

Overall, the community gave a very strong impression of economic stagnation and decline. The one shop in the village had mostly empty shelves, with very few dry goods for sale. Only the most basic groceries such as bread (produced by the local bakery), pasta, flour, kasha, salt, tea, sugar and butter could be purchased. We did not see any supplies of fresh or canned meats, fish, vegetables, or fruit throughout our 8 week stay. However, as elswhere in Russia, if you had enough money or scarce goods to barter, you could obtain almost any food or commodity you wanted on the local black market.

2. METHODS

2.1 Data Collection

Due to financial and logistic restraints, our Russian colleagues were unable to include a Russian/English interpreter on the team for field work in Volochanka. This did not present any great problems as far as our laboratory work was concerned, since we had previously tested and practised all methods and procedures as a team in both Igloolik, Canada and Novosibirsk, Russia. In addition, our Russian colleagues spoke basic English and Dr. Rode understands and speaks some Russian. However, getting accurate additional information beyond the laboratory measurements proved to be very difficult and in most instances, impossible. Thus, many details of village life and conditions that would have put our laboratory findings in a broader context were simply not available to us because of the language barrier. All of the nGanasan and Dolgan spoke fluent Russian; the difficulty arose in translating the information that they provided into English.

2.2 Informed Consent

Only volunteers were tested in both Igloolik and Volochanka. The Canadian studies had followed a protocol approved by the Igloolik Hamlet Council and the University of Toronto Committee on Human Experimentation. All tests and procedures had been explained in Inuktitut and/or English (as preferred) and volunteers had been asked to sign consent forms (in Inuttitut or English as preferred) confirming that they had understood the proposed procedures and agreed to participate. In addition, Igloolik children had been required to get written permission from both parents before they were accepted for testing. In Volochanka we noted that the Russian scientists obtained verbal rather than written consent from adults and they did not seek formal parental consent before testing children. The Russian scientists on the team did not speak either nGanasan or Dolgan and no Natives were hired either as interpreters or assistants for our work in Volochanka. Thus all explanations of tests and procedures and all communication between the research team and the villagers was in Russian only. This was not a technical problem, since all villagers were fluent in Russian, but we believe that a lack of sensitivity to local participation and languages may have had a strong negative effect on volunteer recruitment. The relative numbers of volunteers recruited in Igloolik (151 subjects for blood lipids; 383 for fitness and other tests) and Volachanka (43 for lipids; 156 for fitness and other) substantiate that impression.

2.3 Questionnaire and Subject Identification

The questionnaire solicited information on:

a) Name, age, and date of birth, these details being checked against school, government, or local hospital records.

b) Health history, indicating whether subjects had experienced major illnesses or diseases. Answers to these questions were verified and amplified as necessary by comparison with available medical records held at the local hospital.

c) Occupation. All subjects were questioned as to occupation and physical activity patterns.

2.4 Body Composition

a) Height and Body Mass. Height and sitting height were measured to the nearest 0.5 cm, using a standard Russian combination height/sitting height scale especially designed for that purpose and found in most Russian schools. Body mass was measured to the nearest 0.5 kg, using a Russian-made bathroom scale calibrated against known standards.

b) Skinfold thickness was measured on the right side of the body, using a Lange skinfold caliper (Cambridge Scientific Instruments). The three sites recommended by the International Biological Programme Handbook(4) were measured:

- i) Triceps. This fold was measured over the triceps muscle, in line with the olecranon process, halfway along the length of the muscle.
- ii) Subscapular. This fold was measured beneath the tip of the right scapula, where the lines of Linn usually require the fold to be grasped in a diagonal plane, laterally and downwards.
- iii) Suprailiac. This fold was measured in the lateral line, above the iliac crest

c) Chest and Waist Circumferences. With the subjects standing, girths were measured to the nearest 0.5 cm; the observer crouched on the right side of the subject's body, using a cloth tape.

- i) Chest Girth. In males, the measurement was taken on the unclothed chest at the level of the nipples and at the end of a normal expiration.(5) In females the measurement was taken just above the breasts, again at the end of a normal expiration.

ii) Waist Girth. Measurements were made on the unclothed abdomen at the level of minimum girth for the females, and at the maximum girth for the males.[5]

2.5 Hand Grip and Leg Extension Force

The maximal hand grip force was measured using a Stoelting dynamometer individually adjusted for grip size. Quadriceps extension force was estimated using a cable tensiometer. A harness was placed around the widest diameter of the calf and the contraction began with the knee held at an angle of 120° as verified with a template.

2.6 Exercise Testing and Estimation of Aerobic Power

The maximal aerobic power was predicted from oxygen consumption and heart rate during the ascent of a double 23 cm step[6], using a computer solution[7] of the Astrand nomogram.[8] The electrocardiogram was monitored by standard exercise leads for 5 minutes prior to, during, and for 5 minutes after testing.

Oxygen consumption was measured by a standard open-circuit method, using a low resistance valve box and a 120 litre, broad-necked meteorological balloon.[1,9] In Igloolik, gas concentrations had been determined by paramagnetic and infrared gas analysers, calibrated against gases from cylinders tested by the Lloyd-Haldane method.

In the exercise tests, subjects climbed a double 23 cm step for 3 minutes at each of four rates (10,15, 20, and 25 ascents per minute for the men; and 8,12, 16, and 20 ascents for the women). Expired gas samples were collected in the final 30 seconds at each rate of ascent. In Igloolik gas volumes had been measured using a dry gas meter (Warren E. Collins Ltd.) calibrated against a 120 litre, chain compensated gasometer. The expired gas volumes in Volachanka were measured using a small mechanical gas turbine provided by our Russian colleagues. The output from this turbine was suspect from the beginning of our field work, and close inspection of the results (calculated oxygen consumptions, gas exhange ratios, and mechanical efficiencies) confirmed that in many cases the volume readings had been seriously under-estimated.

As a result of this setback, it was necessary to estimate the oxygen consumption (VO_2) in Volachanka, from the energy expenditure on the step test, assuming a mechanical efficiency of 16% for stepping and an oxygen equivalent of one litre of O_2 for an energy expenditure of 20.9 KJ/min (5 Kcal/min).

All of the Igloolik steptest data which we had collected in 1990 (in which the predicted maximal oxygen consumption results were based on the directly measured oxygen consumption at sub-maximal exercise loads) was recalculated as described above, in order to allow an appropriate comparison of predicted maximum oxygen consumptions values between the two groups based on the same systems of measurement and calculation.

In Volochanka, as in Igloolik, particular attention was given to the sterilization of mouthpieces, connecting tubing, and valve boxes. After each use, these were:

a) disassembled and rinsed;

b) submerged in a cold sterilizing solution for double the recommended period. The solution, a two-component system which remains inert until mixed, is effective against a range of viruses and bacteria, including gram-positive micro-organisms. The solution was discarded and replaced by fresh mixtures more frequently than recommended by the manufacturer; and

c) the items were rinsed and dried overnight.

Eight sets of valve boxes and connecting tubing were required to maintain a rotation which allowed the testing of 6-8 subjects a day.

2.7 Lung Function

In Igloolik, the one-second forced expiratory volume (FEV) and forced vital capacity (FVC) were measured using a 13.5 litre Stead-Wells spirometer, fitted with a lightweight bell. In Volochanka the FEV and FVC were measured using a 7.8 litre Vitalograph, model R, dry wedge bellows spirometer.

Seated subjects were allowed two practise attempts, followed by three definitive trials. Results were reported as the average of the three definitive trials.

Disposable mouthpieces and noseclips were used throughout and connecting tubing was sterilized as described above. As an additional precaution, active sterilizing agent was added to the water seal around the bell of the Stead-Wells spirometer. The equipment was routinely dismantled and cleaned, and the water seal was replaced at least once a week and more frequently when the testing schedule allowed.

2.8 Blood Pressure

Arterial blood pressures were measured using an aneroid sphygmomanometer with an adjustable cuff size. The standard WHO protocol[10] was used: after at least 10 minutes of rest, two measurements were taken with a standardized body position (sitting) and standardized rate of deflation. The mean of the two systolic readings and the two diastolic (5th phase) readings were recorded. The instrument was checked, before and after our field work, against a mercury sphygmomanometer. The same investigator used the same instrument to measure blood pressures in both Volochanka and Igloolik.

2.9 Blood Lipid Profiles

Two 10 ml samples (one for plasma, one for serum) were taken from a single venipuncture after an overnight fast. A disposable Vacutainer tube was used for blood collection. Samples were processed immediately after collection. Samples of serum and plasma were frozen and kept at -20°C or lower; frozen samples were later transported to the base laboratory, packed in dry ice. All lipid and free fatty acid analyses were performed under the direction of Dr. A.A. Kuksis at the Banting and Best Institute, University of Toronto using an automated high-temperature capillary gas choromatograph.

3. RESULTS

The age and sex composition of our Igloolik and Volachanka population samples is shown in the table below.

AGE GROUP (yr)	INUIT		nGANASAN	
	MALE	FEMALE	MALE	FEMALE
11-12	19	16	15	15
13-14	23	15	17	11
15-16	17	15	7	5
17-19	31	19	12	10
20-29	70	46	16	9
30-39	24	16	6	9
40-49	16	18	5	7
50-59	10	12	2	-
60-69	7	2	-	-
70-79	3	-	-	-
TOTALS	220	159	80	66

The population data for the Igloolik Inuit and the Volochanka nGanasan is summarized in Table A and illustrated in Fig. B. The Igloolik Inuit population has increased from 533 in 1970 to 930 in 1990:- a 74% increase in 20 years or an average increase of 3.7% per year. In comparison to the Iglulingmuit, the nGanasan population of Volochanka has increased only slightly, from 421 in 1976 to 457 in 1990:- an increase of 8.6% in 14 years, giving an average annual increment of 0.6%. The general shape of the population pyramid (Fig. B) appears similar for both Native populations; however, closer inspection shows that Igloolik has a higher proportion of people under the age of 30 years with values of 75 and 66% for Igloolik and Volochanka respectively.

3.1 Anthropometry, Strength and Fitness in Adults

Cross-sectional data for the adult Inuit of Igloolik and nGanasan of Volochanka are summarized in Tables 1 to 4. The results are shown graphically in Figures 1 to 10.

3.1.1 Body Composition

Height

The heights of both the Inuit and the nGanasan were at least 10 cm lower than in North American city-dwellers. However, we did not find any significant differences in the heights of adult men or women between the Inuit and the nGanasan for any of the adult age groupings 20-49 years (Fig. 1 & 2).

Body Mass

The two Native groups showed marked differences in body mass for both men (Fig. 3) and women (Fig. 4). On average, the Inuit men were heavier than their nGanasan counterparts by 6.6 (p=0.039), 6.4, and 15.2% at ages 20-29, 30-39, and 40-49 years respectively. A 2-way ANOVA of the mean weights (age*ethnic group) showed that the Inuit men were significantly heavier (p=0.004) than the nGanasan at all ages, with a significant effect of age (p=0.021) but no significant age*group interaction.

The Inuit women, however, were lighter than the nGanasan women by 11.4 (p=0.032), 7.5, and 2.5% at age 20-29, 30-39, and 40-49 years respectively (Fig. 4). As above, an ANOVA of the data for the 2 groups of women showed that the Inuit women were significantly lighter (p=0.032) than the nGanasan women, with a large age effect (p=0.001) but no significant age*group interaction.

Subcutaneous Fat

The Inuit men tested in 1990 had approximately the same average skinfolds as their peers in southern Canada. The nGanasan subjects were significantly thinner (ANOVA, p=0.001) than the Inuit males at all ages with values more typical of Igloolik in 1970 (Fig. 5). The total of the 3 skinfolds averaged 47.4 (p<0.001), 44.5, and 115.1% (p=0.016) greater than in the nGanasan men at ages 20-29, 30-39, and 40-49 years respectively.

Moreover,the Inuit men started to accumulate fat at an earlier age (13-14 years) and showed progressive increases into adulthood, with a large increase (43%) at age 40-49 years. The nGanasan men, in contrast, maintained relatively stable levels (21-22 mm) of subcutaneous fat throughout the adult age range. A 2-way ANOVA of the mean skinfold totals showed that the Inuit were significantly fatter at all ages (p=0.001), with no age effect or age*group interaction.

The Inuit adolescent females carried more subcutaneous fat than the nGanasan (Fig. 6) but perhaps as a reaction to TV images of "attractive" women, this trend was reversed in early adulthood. Both groups became fatter in middle age, with a larger increase in the Inuit than the nGanasan. Thus, at ages 20-29 and 30-39 years, the mean skinfold readings for Inuit women were lower by 20.1 and 13.6% respectively, but at age 40-49 years the readings were 13.9% higher in the Inuit women.

In the Inuit women the increase in subcutaneous fat began as early as at 15-16 years with a continuing trend of substantial increases to age 40-49 years. In the nGanasan women in contrast, increases in subcutaneous fat did not occur until age 20-29 years; then, as in the Inuit women, skinfolds continued to increase to age 40-49 years. A 2-way ANOVA did not reveal any significant differences between the two groups of women nor any age*group interaction but did show a significant (p=0.001) age effect.

Predicted Body Fat and Lean Body Mass

Equations developed by underwater weighing of Caucasian subjects[11] were used to predict total body fat and lean body mass. The results for Inuit and nGanasan men and women are shown in Table 4. While the application of these equations to the Inuit and nGanasan may not be accurate in absolute terms[12], it does provide a reasonable comparison of body composition in relative terms.

The Inuit men were fatter at all ages than their nGanasan counterparts with values for total body fat of 13.4, 13.4, 16.9, and 23.4% at ages 17-19, 20-29, 30-39, and 40-49 years respectively. The corresponding values for the nGanasan men were 9.0, 9.6, 13.0, and 13.5%. An ANOVA confirmed that the differences between the two groups of men were highly significant (p=0.000).

The lean body mass appeared essentially similar in both groups of men at all ages and an ANOVA confirmed this impresssion.

In the women there were no significant differences (ANOVA) between the Inuit and nGanasan in either total body fat or lean body mass. However, both the Inuit and the nGanasan women had subtantially more total body fat than the men of their group. In the Inuit women the total body fat was higher than in the men by 110, 98, 95, and 64% at ages 16-19, 20-29, 30-39, and 40-49 years respectively. The corresponding values in the nGanasan women were higher than in the nGanasan men by 158, 213, 170, and 178%. An ANOVA confirmed that these differences between the Inuit and nGanasan men and women were highly significant (p=0.001).

3.1.2 Strength

The grip strength was not remarkable in either population. However, Figure 7 shows that Inuit men had greater hand grip strength than did the nGanasan at all ages (20-49 years). At age 20-29, 30-39, and 40-49 years, the mean grip strength in the Inuit was significantly greater by margins of 10.7, 12.9, and 10.9% respectively. A 2-way ANOVA of the data for the two groups of men showed that the Inuit were significantly stronger ($p=0.019$) at all ages

However, the reverse was true for leg strength (Fig. 8). In the Inuit men of Igloolik, leg strength has decreased progressively over the past 20 years , and is now relatively low. In the nGanasan men, leg strength was significantly greater at ages 20-29, 30-39, and 40-49 years by margins of 34.1 ($p<0.001$), 12.2, and 2.1% respectively. The values at age 20-29 matched Igloolik men of 1980, but none were as high as those seen in Igloolik in 1970. A 2-way ANOVA of the mean values for the two groups of men showed that the leg strength was significantly higher ($p=0.019$) in the nGanasan.

In the women, the results for grip strength were poor in both communities (Fig. 9), with the adult nGanasan women showing a general trend (statistically not significant) to greater grip strength than the Inuit women. A 2-way ANOVA confirmed that there were no significant differences in grip strength between the two groups of women. However, in contrast to the data for men, leg strength in the Inuit women (Fig. 10) was superior to that of the nGanasan women. At age 20-29, 30-39, and 40-49 years leg strength in the Inuit women was significantly greater by 1.1, 43.0 ($p=0.002$), and 15.8% respectively. A 2-way ANOVA of the mean leg strengths showed that the Inuit women were significantly stronger ($p=0.007$) at ages 20-49 years.

Aerobic Power

Predictions of absolute and relative aerobic power based on measured oxygen consumption and work rate as estimated from step height, body mass, stepping rate, and an assumed mechanical efficiency of 16% for male and female Iglulingmuit are compared in Tables 5 and 6. Comparative values for absolute aerobic power are shown graphically in Figures 11 and 12.

A 2-way ANOVA did not reveal any significant differences in aerobic power between the two systems of measurement, either in male or in female subjects.

Cross-sectional comparisons of predicted absolute and relative aerobic power based on work rate between the Inuit and nGanasan populations are summarized in Tables 7 to 9; Figures 13 to 16 illustrate these comparisons.

Absolute aerobic power (Fig. 13) was significantly higher in Inuit men. Values for Inuit were 6.5, 8.4, and 17.6% higher for men aged 20-29, 30-39, and 40-49 years respectively; a 2-way ANOVA of the mean values showed that the Inuit men had significantly higher ($p=0.027$) readings at all ages 20-49 years. Relative aerobic power (ml/[Kg-min])in both communities was at the level anticipated for a moderately fit population (Fig. 14). Values were essentially similar for both groups of men. A 2-way ANOVA confirmed that there were no significant differences in relative aerobic power between the two groups of men.

In the women, (Fig. 15) there were no significant differences in absolute aerobic power between the Inuit and nGanasan at ages 20-29 or 30-39 years; however, at age 40-49, the absolute aerobic power in nGanasan was 19.6% higher ($p=0.032$) in the nGanasan than in the Inuit (Table 6).

Relative aerobic power (Fig. 16) showed a pattern similar to the absolute data but an ANOVA of the mean values for ages 20-29 and 30-39 showed that the Inuit women had significantly higher ($p=0.026$) values than the nGanasan women. Relative aerobic power was 17.3 ($p=0.018$) and 8.6% higher in the Inuit women at ages 20-29 and 30-39 years respectively. As with the absolute values, the nGanasan women at age 40-49 years had higher values (12.7%) for relative aerobic power than did the Inuit women, but the difference was not statistically significant.

3.1.3 Dynamic Lung Volumes

Cross-sectional data comparing the lung function of the Inuit and nGanasan men and women aged 20-49 years are summarized in Tables 7 to 9 and the results are shown graphically in Figures 17 to 20.

In the adults >20 years of age, sex-specific, multiple regression equations of the type:

$$\mathbf{FVC = a(AGE,yr) + b(HEIGHT) + c}$$

were fitted to the data for the prediction of forced vital capacity (FVC) and one-second forced expiratory volume (FEV). The equations for men and women are shown in Table 10, together with the calculated values at ages 20 and 60 years for a typical man and woman of height 165 and 155 cm respectively.

Lung Function in Men

In Inuit and nGanasan men aged 20-49 years, the average level of FEV and FVC (Figures 17 and 18) appeared to be essentially similar. An ANOVA confirmed that there were no statistically significant overall differences in lung volumes between the two groups, but there was a strong age*group interaction for both FEV ($p=0.018$) and FVC ($p=0.004$); in both cases, the lung volumes of the older subjects were better preserved in the nGanasan.

The regression equations in Table 10 show a greater ageing coefficient for lung volumes in the Inuit men. From age 20 to 60 years the Inuit men showed a loss in FVC and FEV of 51 and 52 ml/year respectively. The corresponding decreases in lung volumes in the nGanasan men were 46 and 24 ml/year.

Lung Function in Women

As in the men, there were no significant overall differences (ANOVA) in either the FEV or FVC between the Inuit and nGanasan women aged 20-49 years (Figures 19 and 20). Unlike the men, the two groups of women did not show any significant age*group interaction in lung volumes. However, like in the men, lung volumes appeared to age more rapidly in the Inuit than in the nGanasan women. Applying the regression equations in Table 10, we see that from age 20 to 60 years, the Inuit women show a decrease in FEV and FVC of 38 and 37 ml/year respectively. In the nGanasan women the corresponding decreases in FEV and FVC were 31 and 22 ml/year.

Table A. The 1990 age and sex distribution for the Igloolik Inuit and Volochanka nGanasan. Values shown are the number and percent.

Age Group	Igloolik Inuit				Volochanka nGanasan			
	Male		Female		Male		Female	
	No.	%	No.	%	No.	%	No.	%
80-89	2	0.22	1	0.11	3	0.66	0	0.00
70-79	6	0.65	6	0.64	7	1.53	3	0.66
60-69	7	0.76	7	0.75	7	1.53	6	1.31
50-59	23	2.47	21	2.26	16	3.50	10	2.19
40-49	34	3.66	31	3.33	13	2.84	25	5.47
30-39	54	5.80	39	4.20	34	7.44	30	6.56
20-29	96	10.33	81	8.71	47	10.28	31	6.78
10-19	121	13.01	133	14.30	56	12.25	50	10.94
0-9	142	15.27	126	13.55	60	13.13	59	12.91
Total	485	52.17	445	47.85	243	53.16	214	46.82

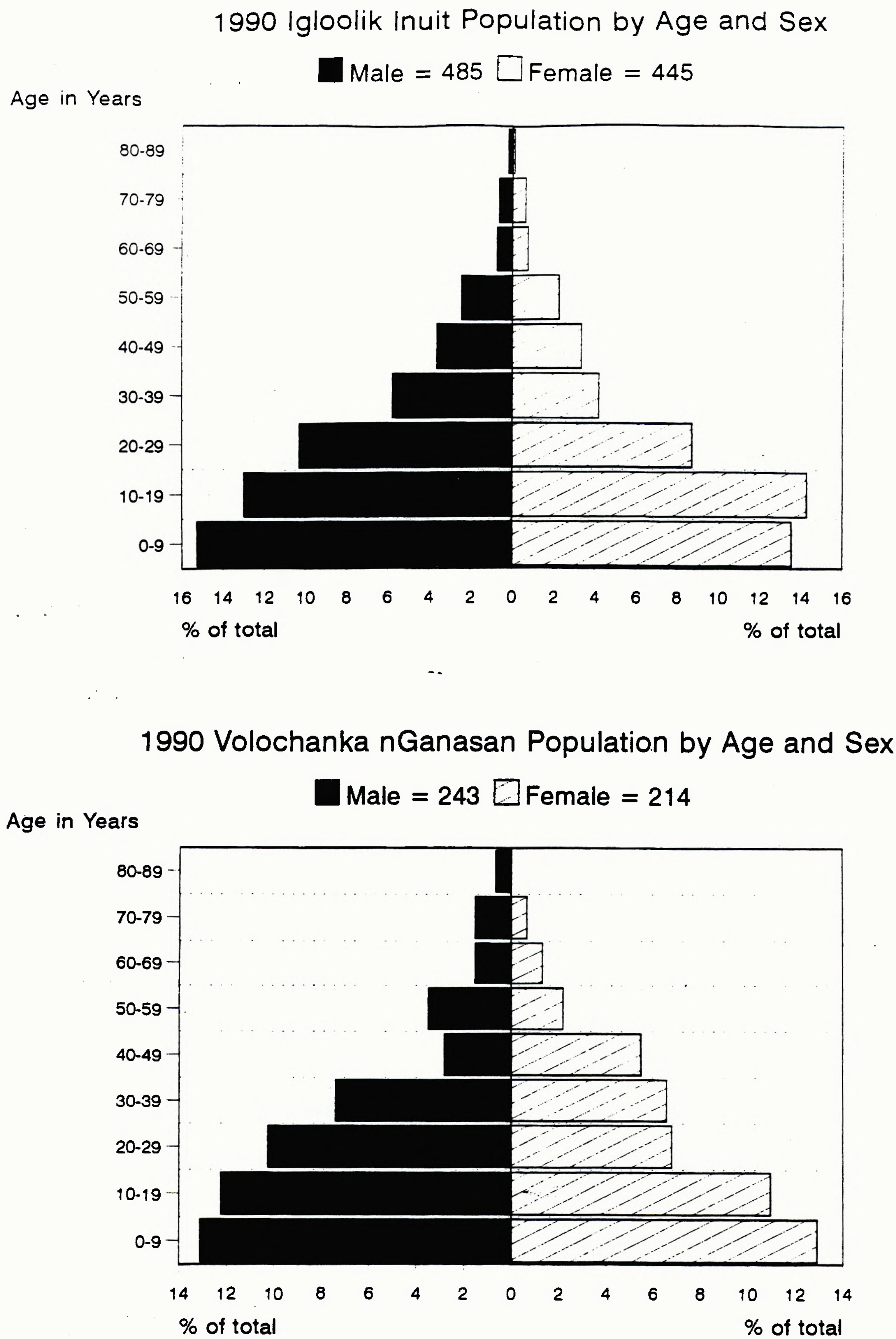


Fig. B. 1990 population pyramids for Igloolik and Volochanka.

Table 1. Anthropometry and strength in men and women aged 20-29 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	24.6 2.6 70	25.4 2.7 16	24.4 2.8 46	25.8 2.2 9
HEIGHT (cm)	164.3 5.0 70	163.6 5.0 16	153.2 5.7 46	153.1 5.7 9
BODY MASS (kg)	65.0 6.8 70	61.0 7.3 16	54.6 7.6 46	61.6 12.9 9
SUM 3 SKIN-FOLDS (mm)	31.1 15.7 69	21.1 7.0 16	45.2 18.8 46	56.6 23.3 9
HAND GRIP FORCE (Newtons)	455.5 79.2 70	411.4 56.1 16	229.1 58.9 46	254.0 57.7 9
LEG EXTENSION FORCE (Newtons)	556.4 148.1 69	746.2 174.2 16	391.3 90.0 45	387.0 106.7 9

Table 2. Anthropometry and strength in men and women aged 30-39 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	35.2 2.8 24	36.8 3.2 6	34.5 2.6 16	35.2 2.6 9
HEIGHT (cm)	163.7 5.8 24	161.1 4.6 6	153.8 5.5 16	150.2 3.2 9
BODY MASS (kg)	65.1 10.2 24	61.2 6.7 6	59.1 11.6 16	63.9 7.4 9
SUM 3 SKIN-FOLDS (mm)	32.8 18.2 24	22.7 14.6 6	64.3 26.4 16	74.4 25.2 9
HAND GRIP FORCE (Newtons)	417.3 82.0 24	369.5 26.1 6	226.2 48.4 16	222.4 41.3 9
LEG EXTENSION FORCE (Newtons)	539.2 146.3 24	605.0 108.3 6	402.2 83.0 15	281.2 72.4 9

Table 3. Anthropometry and strength in men and women aged 40-49 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	45.0 3.4 16	45.4 3.3 5	45.7 3.0 18	45.1 3.3 7
HEIGHT (cm)	162.7 4.1 16	166.3 6.2 5	152.8 5.8 18	152.5 4.3 7
BODY MASS (kg)	74.4 10.6 16	64.6 9.9 5	67.6 12.6 18	69.3 12.1 7
SUM 3 SKIN-FOLDS (mm)	46.9 30.9 16	21.8 12.0 5	85.4 40.6 18	75.0 27.8 7
HAND GRIP FORCE (Newtons)	441.5 92.1 16	398.3 52.6 5	209.8 62.0 18	236.8 41.0 7
LEG EXTENSION FORCE (Newtons)	599.7 123.2 16	612.1 263.1 5	379.8 110.3 18	327.9 70.0 7

Table 4. A comparison of total body fat (% of body mass) and lean body mass (LBM, kg) in Canadian Inuit and Siberian nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	INUIT MEN		nGANASAN MEN	
	% FAT	LBM	% FAT	LBM
17-19	13.4 3.7 31	54.5 4.5 31	9.0 3.6 11	52.7 5.0 11
20-29	13.4 5.3 70	56.1 4.8 70	9.6 3.7 16	55.0 5.3 16
30-39	16.9 6.0 24	53.6 5.6 24	13.0 6.1 6	52.9 2.5 6
40-49	23.4 8.3 16	56.4 4.0 16	13.5 7.3 5	55.5 5.9 5

AGE GROUP (yr)	INUIT WOMEN		nGANASAN WOMEN	
	% FAT	LBM	% FAT	LBM
16-19	28.2 4.8 27	39.0 4.0 27	23.2 5.0 14	38.6 4.3 14
20-29	26.5 6.5 46	39.8 3.7 46	30.0 6.1 9	42.6 6.0 9
30-39	32.9 5.7 16	39.2 5.3 16	35.1 5.2 9	41.2 2.6 9
40-49	38.3 7.6 18	40.9 4.5 18	37.5 5.6 7	42.8 4.6 7

Table 5. A comparison of the predicted maximum aerobic power in Inuit males as determined from heart rate and VO_2 (O_2 Scale) and heart rate and estimated work rate on steps (Work Scale). Values shown are the mean, SD, and N of the absolute (ABS) and relative (REL) aerobic power in L/min and ML/[kg-min] STPD respectively.

Age Group (yr)	Oxygen Scale (A)		Work Scale (B)		(B) - (A)	
	ABS	REL	ABS	REL	ABS	REL
11-12	2.28 0.30 19	58.7 7.1 19	2.31 0.28 19	59.2 5.6 19	0.03 0.15 19	0.55 4.00 19
13-14	2.71 0.56 23	55.0 8.1 23	2.78 0.60 23	56.5 9.5 23	0.07 0.23 23	1.50 4.77 23
15-16	3.30 0.74 17	57.5 10.4 17	3.32 0.62 17	57.8 8.1 17	0.02 0.38 17	0.26 6.50 17
17-19	3.51 0.65 31	55.7 9.0 31	3.54 0.66 31	56.2 9.1 31	0.03 0.38 31	0.46 5.90 31
20-29	3.31 0.56 69	51.1 8.9 69	3.10 0.51 70	47.9 7.8 70	-0.21 0.34 69	-3.31 5.48 69
30-39	3.00 0.56 23	46.0 7.2 23	2.85 0.62 24	43.8 6.4 24	-0.13 0.32 23	-2.34 5.22 23
40-49	3.06 0.46 16	41.5 6.4 16	2.94 0.34 16	40.0 5.8 16	-0.12 0.28 16	-1.46 3.67 16
50-59	2.41 0.37 9	35.2 6.2 9	2.34 0.39 9	34.7 8.7 9	-0.06 0.24 9	-0.50 3.35 9
60-69	2.34 0.56 6	33.9 5.0 6	2.51 0.63 7	36.1 6.8 7	0.00 0.22 6	0.12 3.11 6
70-79	2.15 0.61 3	32.9 9.8 3	2.16 0.60 3	33.2 10.7 3	0.01 0.23 3	0.33 3.34 3

Table 6. A comparison of the predicted maximum aerobic power in Inuit females as determined from heart rate and VO_2 (O_2 Scale) and heart rate and estimated work rate on steps (Work Scale). Values shown are the mean, SD, and N of the absolute (ABS) and relative (REL) aerobic power in L/min and ML/[kg-min] STPD respectively.

Age Group (yr)	Oxygen Scale (A)		Work Scale (B)		(B) - (A)	
	ABS	REL	ABS	REL	ABS	REL
11-12	1.87 0.32 15	46.6 9.9 15	1.99 0.30 15	50.0 10.8 15	0.12 0.19 15	3.37 4.56 15
13-14	2.10 0.46 15	45.4 7.6 15	2.21 0.43 15	48.1 9.1 15	0.11 0.21 15	2.72 4.81 15
15-16	2.26 0.37 15	41.9 4.5 15	2.48 0.39 15	45.9 5.2 15	0.22 0.18 15	3.96 3.75 15
17-19	2.30 0.55 19	42.0 7.8 19	2.46 0.60 19	45.0 8.5 19	0.16 0.25 19	2.95 4.08 19
20-29	2.24 0.44 46	41.0 6.5 46	2.43 0.48 46	44.7 7.4 46	0.19 0.27 46	3.69 4.87 46
30-39	2.06 0.50 16	32.0 6.8 16	2.15 0.60 16	36.6 7.7 16	0.09 0.25 16	1.37 4.20 16
40-49	2.11 0.31 18	31.0 4.6 18	2.19 0.40 19	33.0 6.2 19	0.11 0.23 18	1.53 3.98 18
50-59	1.95 0.56 12	27.7 6.7 12	1.91 0.47 12	27.5 6.9 12	-0.04 0.23 12	-0.19 3.03 12
60-69	2.09 0.13 2	34.0 2.9 2	1.82 0.29 2	29.5 0.3 2	-0.27 0.15 2	-4.54 3.15 2

Table 7. Lung function and predicted aerobic power (VO2max) in men and women aged 20-29 years. Values shown are the mean, SD, and N.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	4.43 0.56 69	4.36 0.55 16	3.25 0.45 46	3.30 0.55 9
FORCED VITAL CAPACITY (L,BTPS)	5.36 0.63 69	4.94 0.55 16	3.86 0.47 46	3.64 0.57 9
FEV/FVC (%)	82.8 4.8 69	88.4 4.9 16	84.2 5.4 46	90.6 4.0 9
AEROBIC POWER (Predicted VO2max, l/min, STPD)	3.10 0.51 70	2.91 0.49 16	2.43 0.48 46	2.36 0.70 9
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	47.9 7.8 70	47.8 5.8 16	44.7 7.4 46	38.1 7.3 9

Table 8. Lung function and predicted aerobic power (VO2max) in men and women aged 30-39 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	4.00 0.60 24	3.53 0.44 5	3.12 0.55 16	2.91 0.35 9
FORCED VITAL CAPACITY (L,BTPS)	4.80 0.75 24	4.14 0.35 5	3.66 0.52 16	3.33 0.42 9
FEV/FVC (%)	83.4 3.7 24	85.0 4.0 5	85.0 5.6 16	87.7 5.1 9
AEROBIC POWER (Predicted VO2max, l/min, STPD)	2.85 0.62 24	2.63 0.23 6	2.15 0.60 16	2.10 0.38 8
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	43.8 6.4 24	43.1 3.6 6	36.6 7.7 16	33.7 6.9 8

Table 9. Lung function and predicted aerobic power (VO2max) in men and women aged 40-49 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	3.34 0.61 16	4.02 0.60 5	2.52 0.55 18	2.73 0.57 7
FORCED VITAL CAPACITY (L,BTPS)	4.12 0.56 16	4.81 0.47 5	3.16 0.61 18	3.33 0.48 7
FEV/FVC (%)	81.0 6.7 16	83.6 9.4 5	79.2 5.3 18	81.4 10.0 7
AEROBIC POWER (Predicted VO2max, l/min, STPD)	2.94 0.34 16	2.50 0.76 5	2.19 0.40 19	2.62* 0.41 6
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	40.0 5.8 16	38.3 6.6 5	33.0 6.2 19	37.2 8.9 6

Table 10. Equations for the prediction of $FEV_{1.0}$ and FVC in Inuit and nGanasan men and women from age (A) and height (H) as calculated by multiple regression analysis, showing typical volumes (L, BTPS) for height = 165 cm and 155 cm in men and women respectively

GROUP AND REGRESSION EQUATIONS	TYPICAL VOLUMES	
	AGE 20	AGE 60
INUIT MEN, N=119		
FEV = -1.8999 - 0.0511A + 0.0462H	4.71	2.66
FVC = -2.5398 - 0.0524A + 0.0558H	5.62	3.53
GANASSAN MEN, N=26		
FEV = -7.8070 - 0.0461A + 0.0820H	4.80	2.96
FVC = -8.3612 - 0.0241A + 0.0850H	5.18	4.22
INUIT WOMEN, N=92		
FEV = -2.3092 - 0.0379A + 0.0426H	3.54	2.02
FVC = -3.2281 - 0.0365A + 0.0523H	4.14	2.68
GANASSAN WOMEN, N=25		
FEV = -5.4349 - 0.0311A + 0.0626H	3.65	2.40
FVC = -6.5319 - 0.0223A + 0.0706H	3.97	3.07

HEIGHT IN MALES

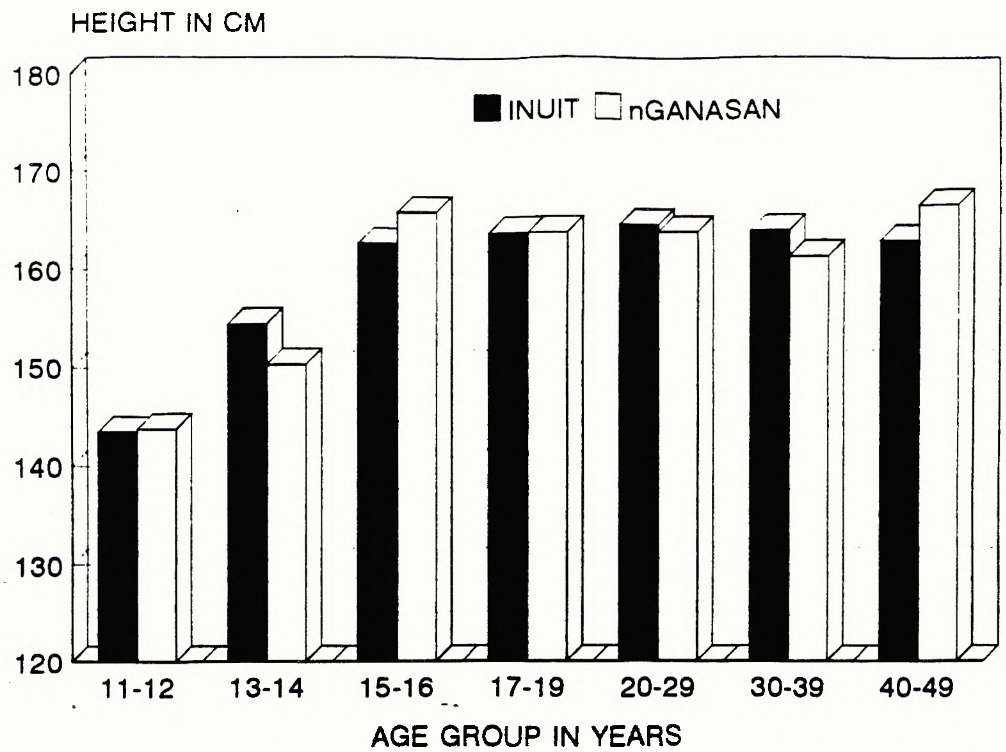


Figure 1. Height comparisons in males aged 11 -49 years.

HEIGHT IN FEMALES

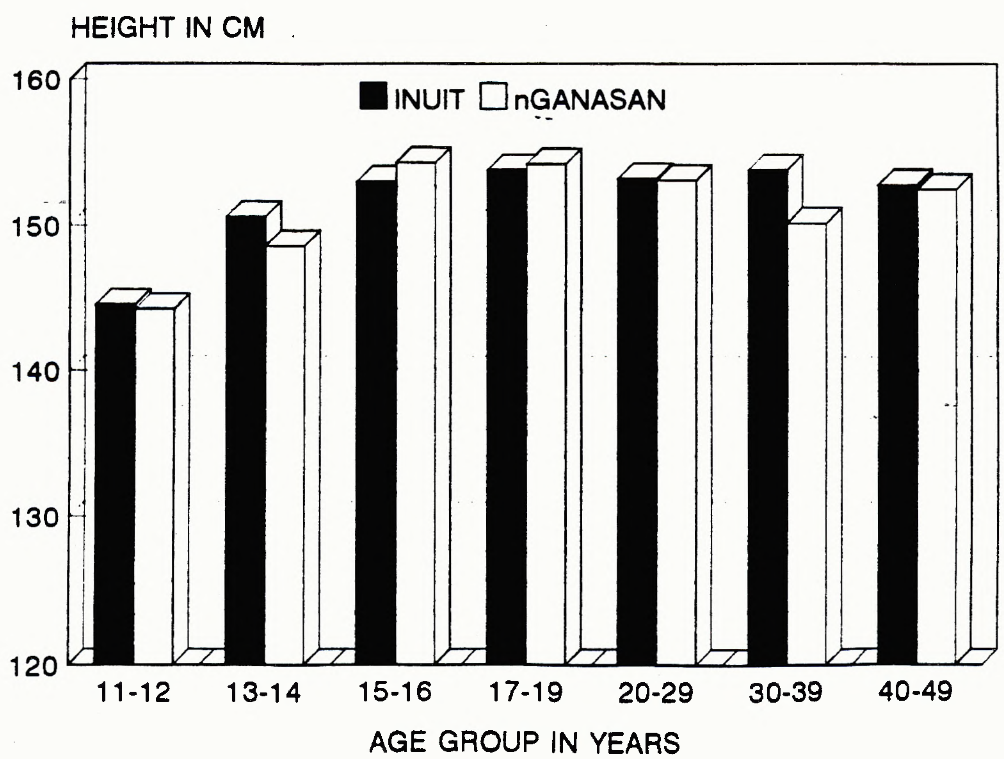


Figure 2. Height comparisons in females aged 11 - 49.

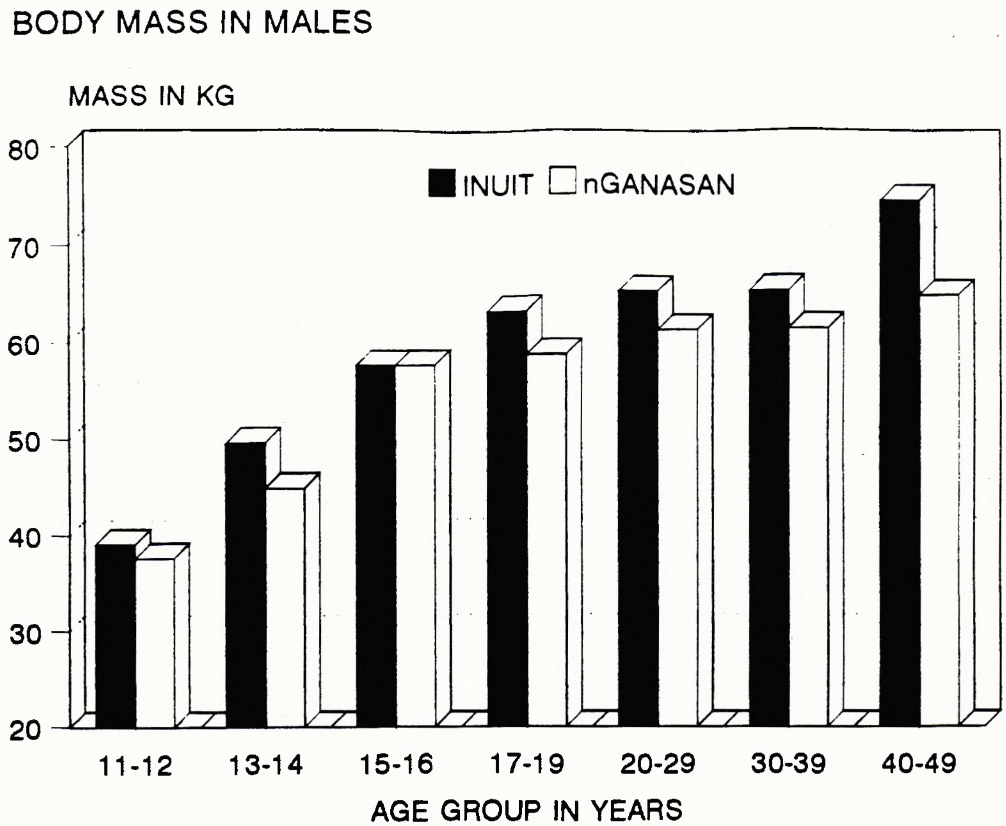


Figure 3. Body mass comparisons in males aged 11-49 years.

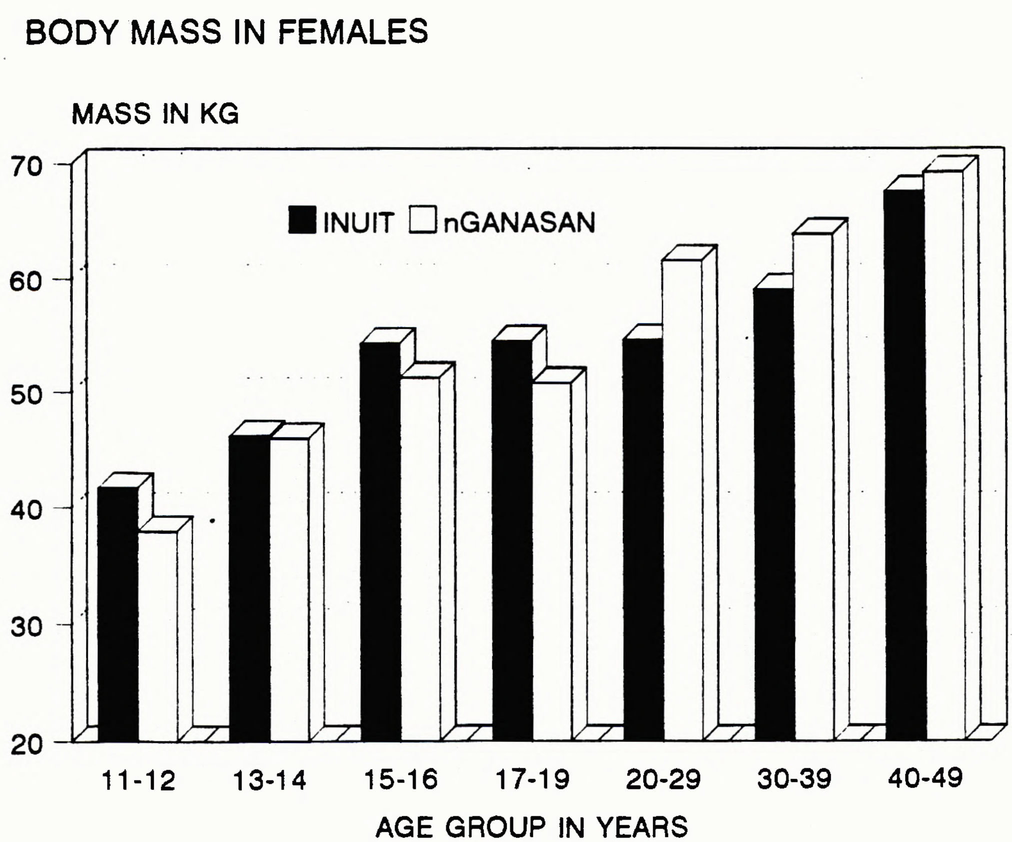


Figure 4. Body mass comparisons in females aged 11-49 years.

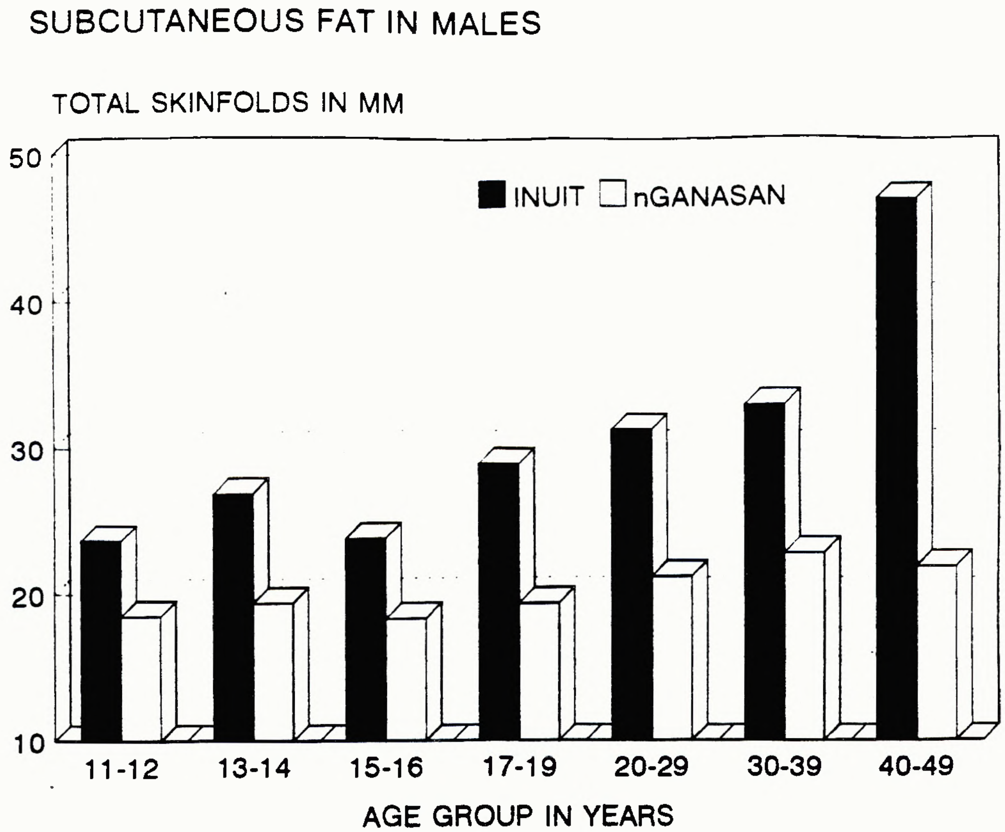


Figure 5. Subcutaneous fat comparisons in males aged 11 - 49 years.

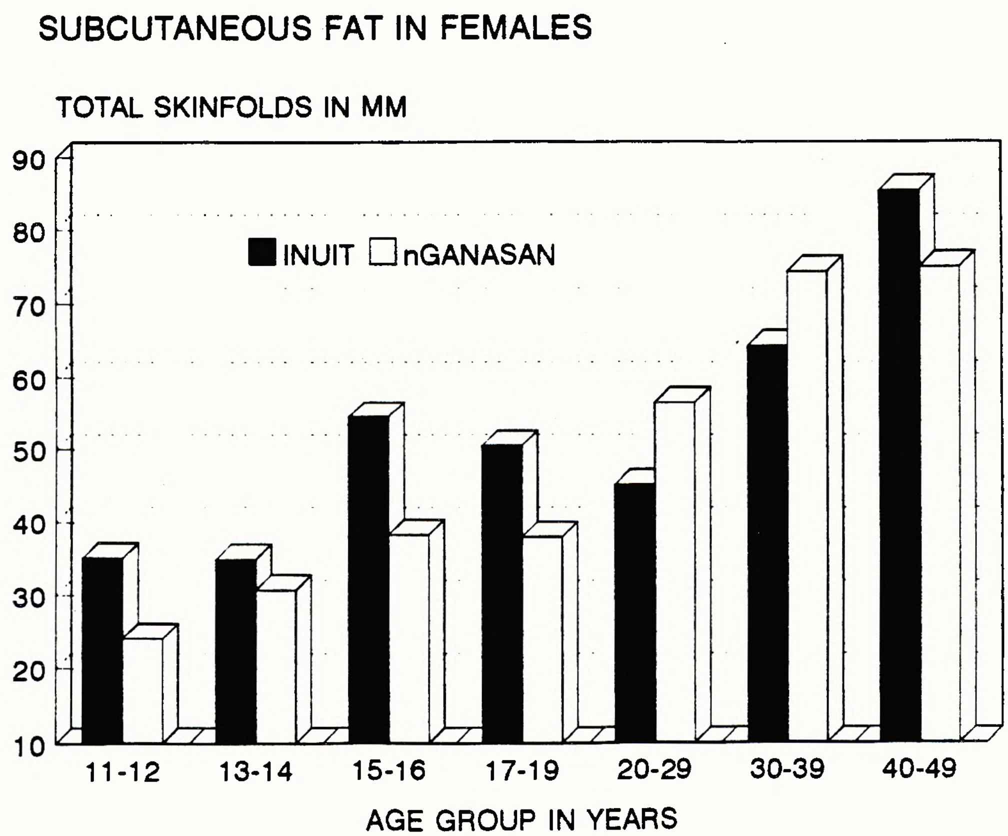


Figure 6. Subcutaneous fat comparisons in females aged 11 - 49 years.

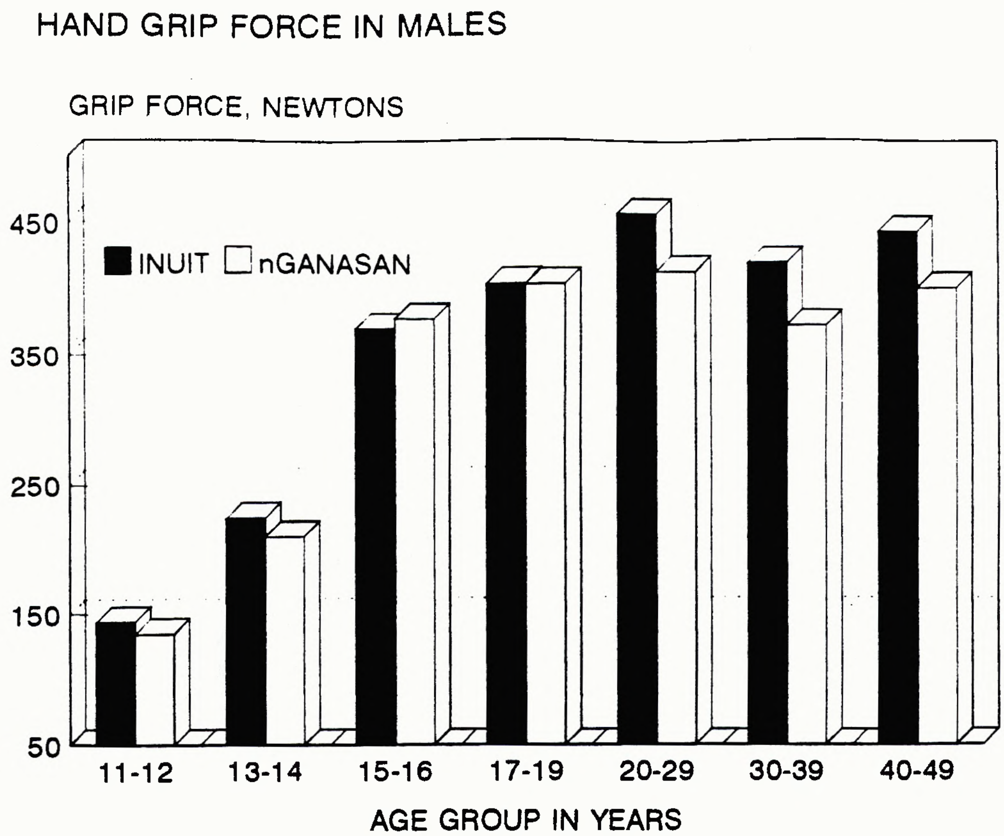


Figure 7. Dominant grip strength comparisons in males aged 11-49 years.

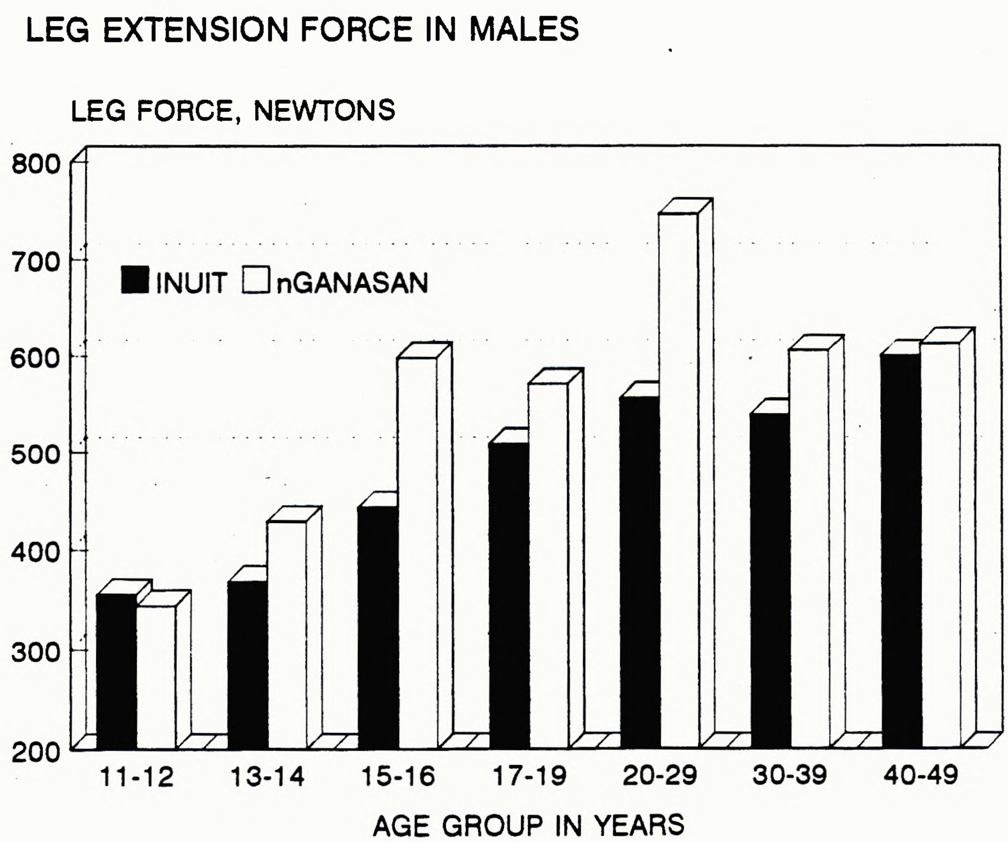


Figure 8. Leg strength comparisons in males aged 11-49 years.

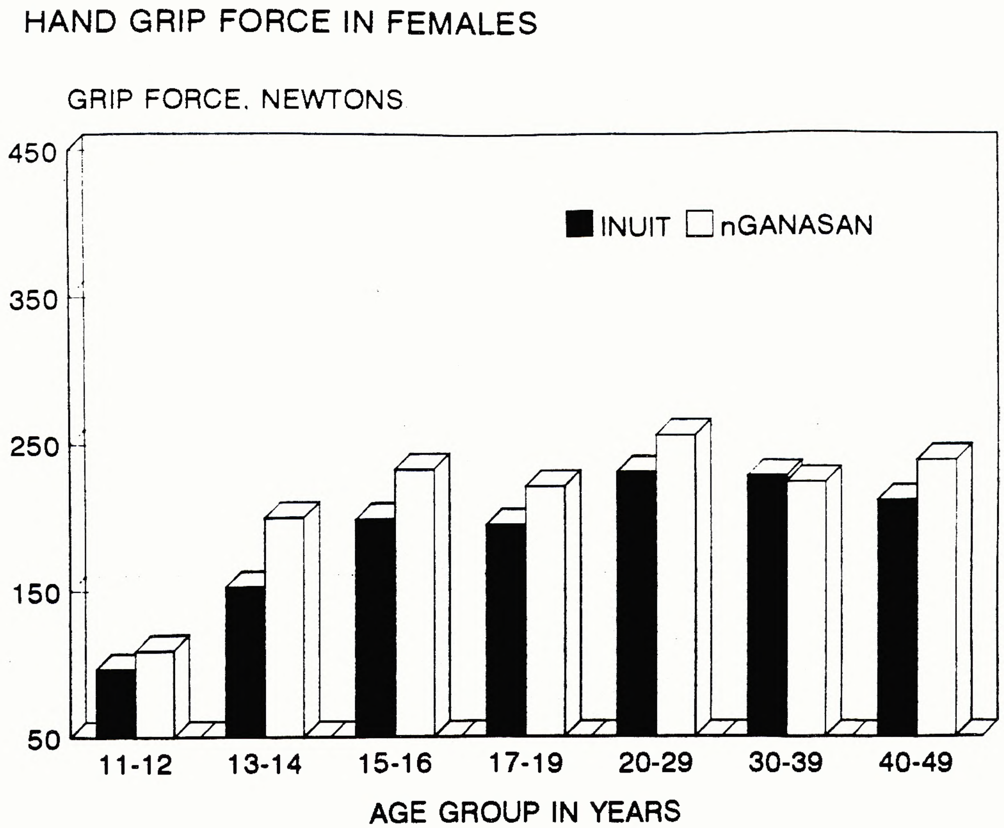


Figure 9. Dominant grip strength comparisons in females aged 11-49 years.

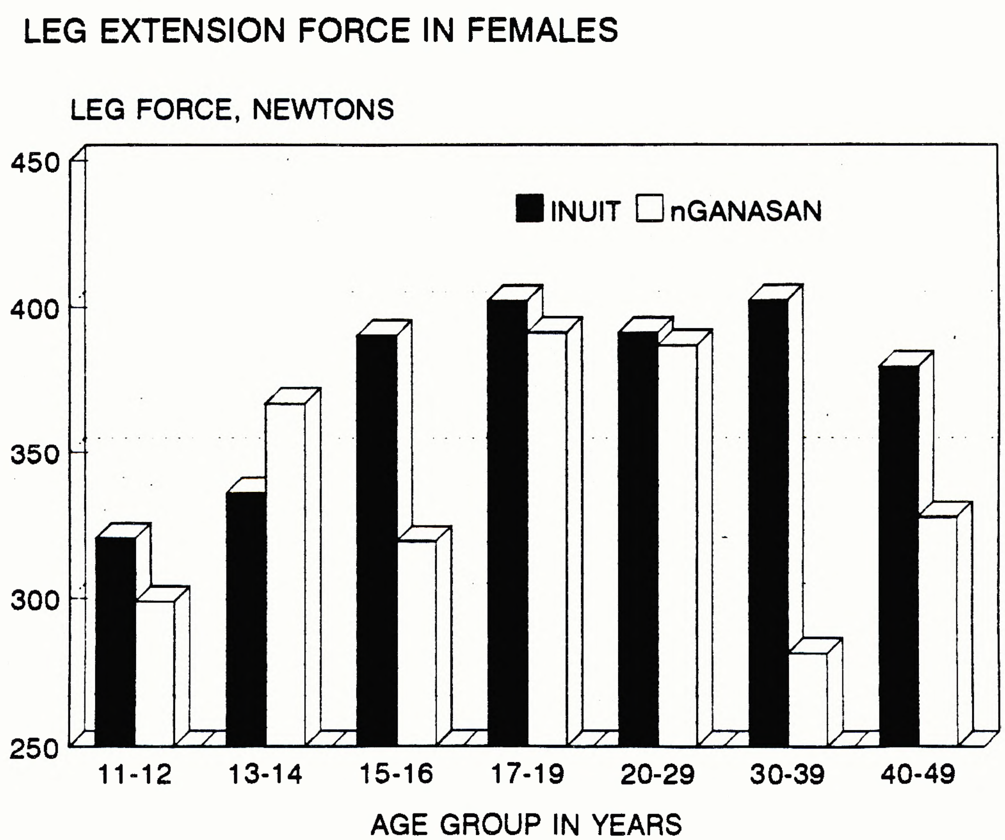


Figure 10. Leg strength comparisons in females aged 11-49 years.

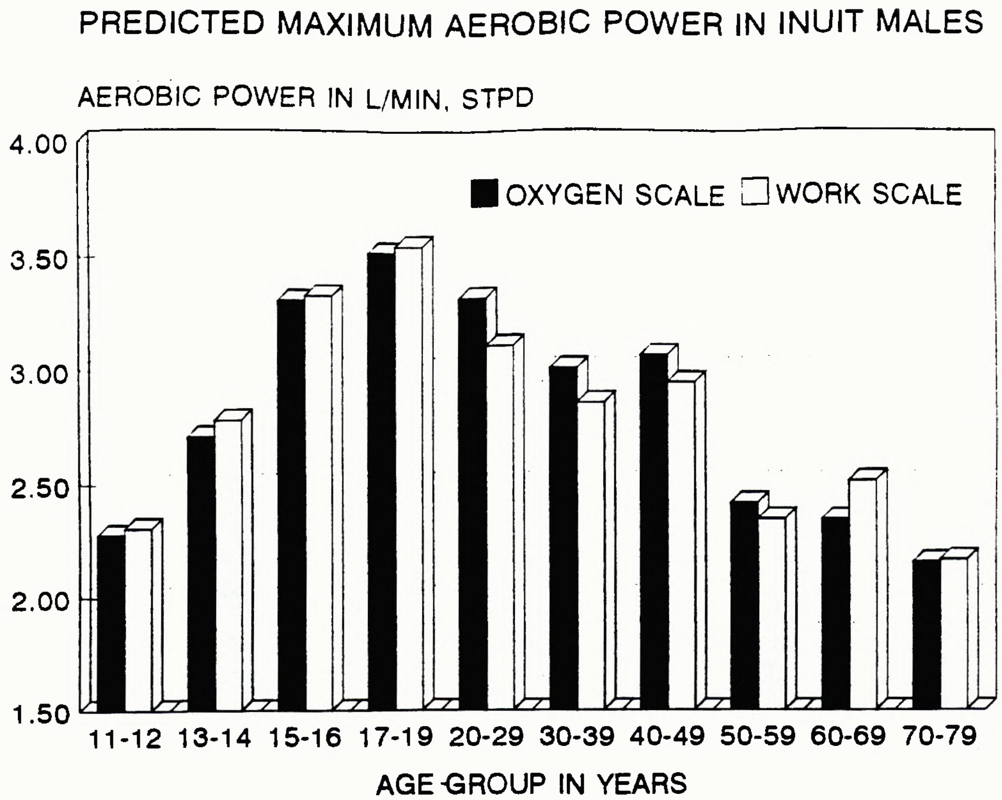


Figure 11. A comparison of absolute aerobic power predictions in Inuit males based on measured oxygen consumption and work rate.

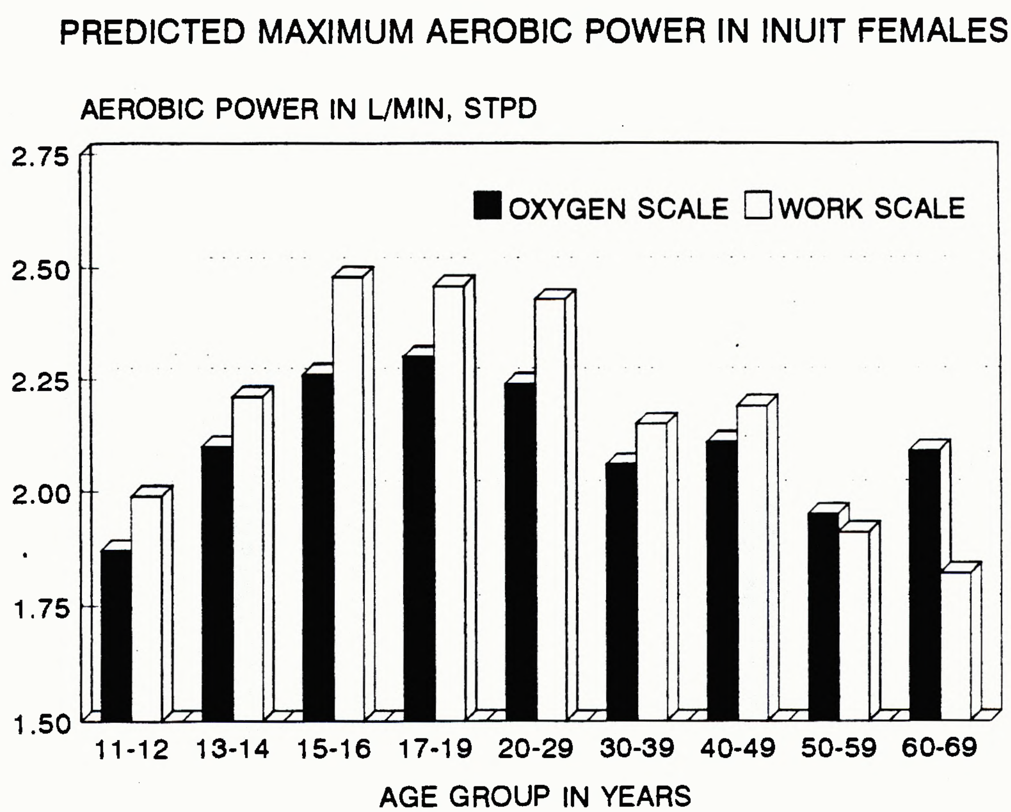


Figure 12. A comparison of absolute aerobic power predictions in Inuit females based on measured oxygen consumption and work rate.

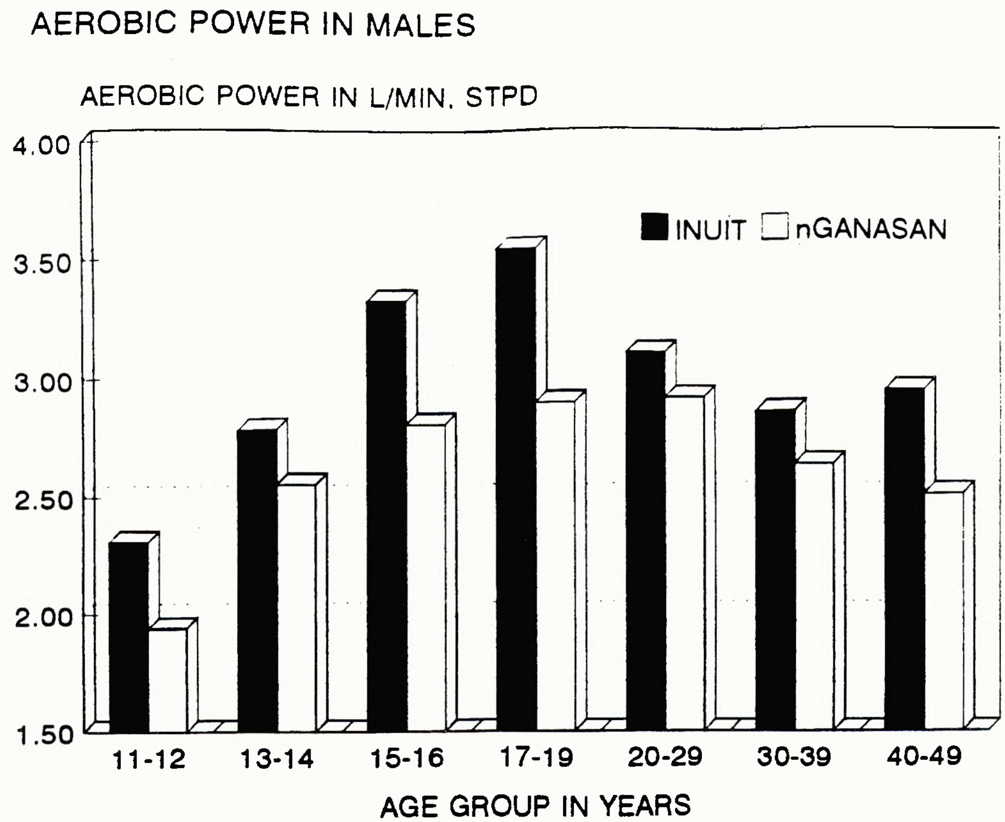


Figure 13. Absolute aerobic power comparisons in males aged 11 - 49 years.

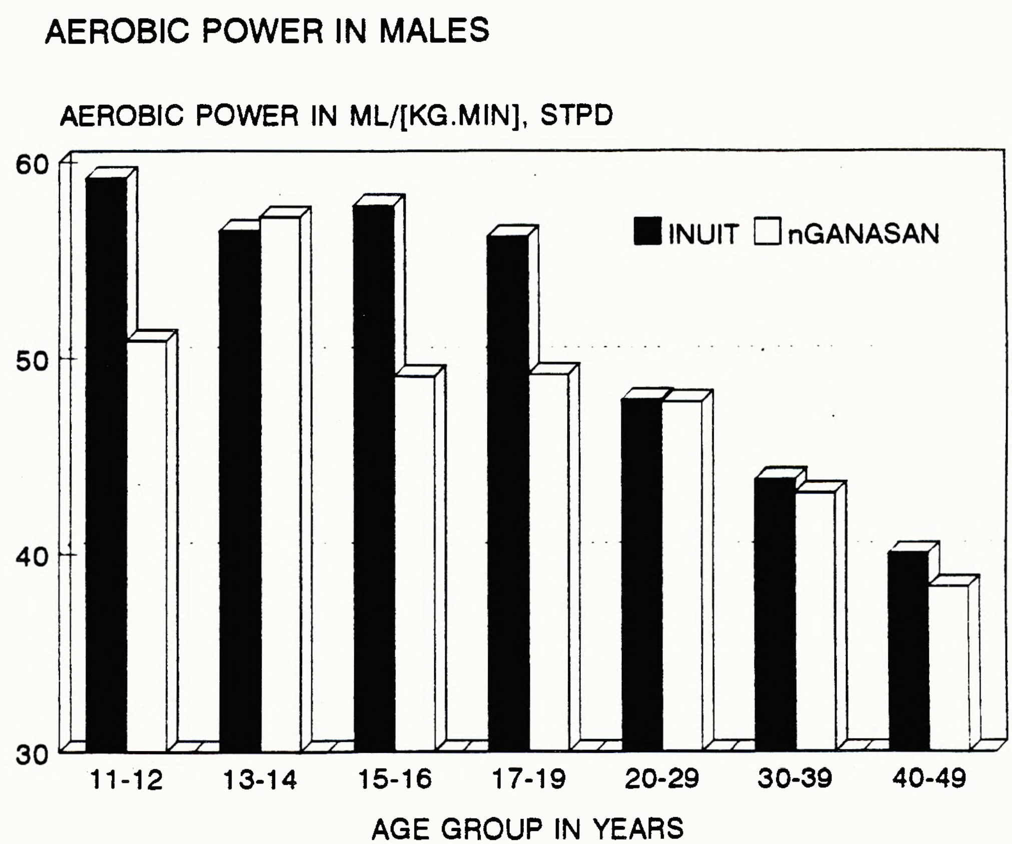


Figure 14. Relative aerobic power comparisons in males aged 11-49 years.

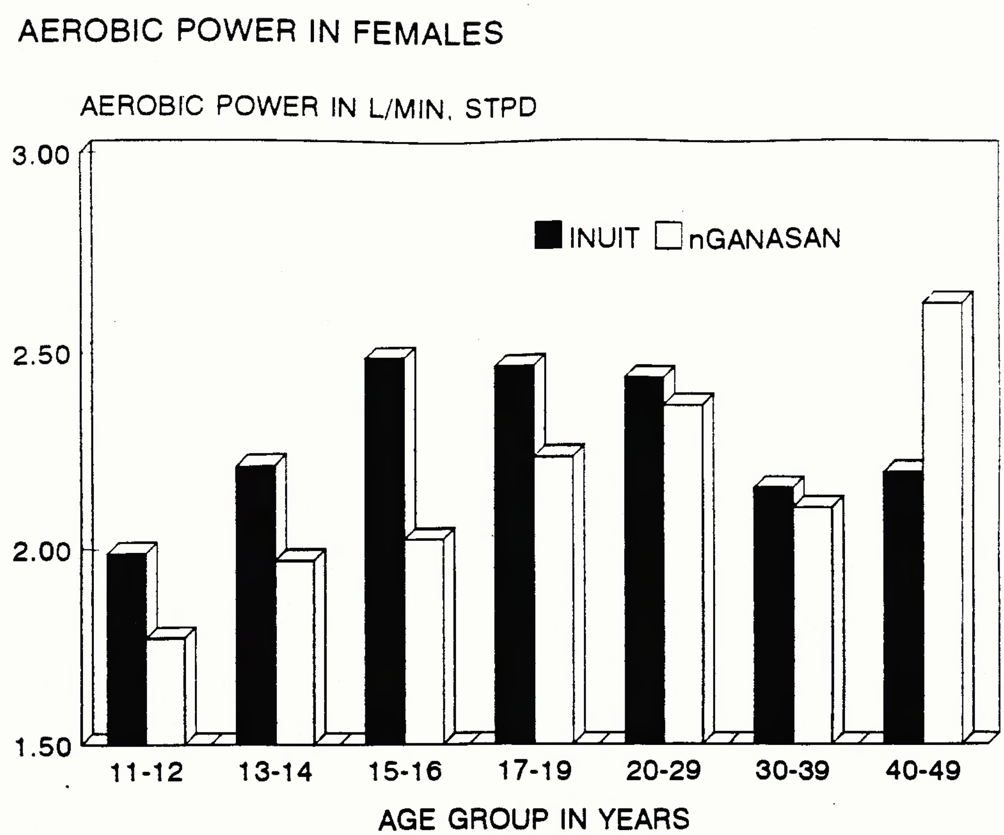


Figure 15. Absolute aerobic power comparisons in females aged 11 - 49 years.

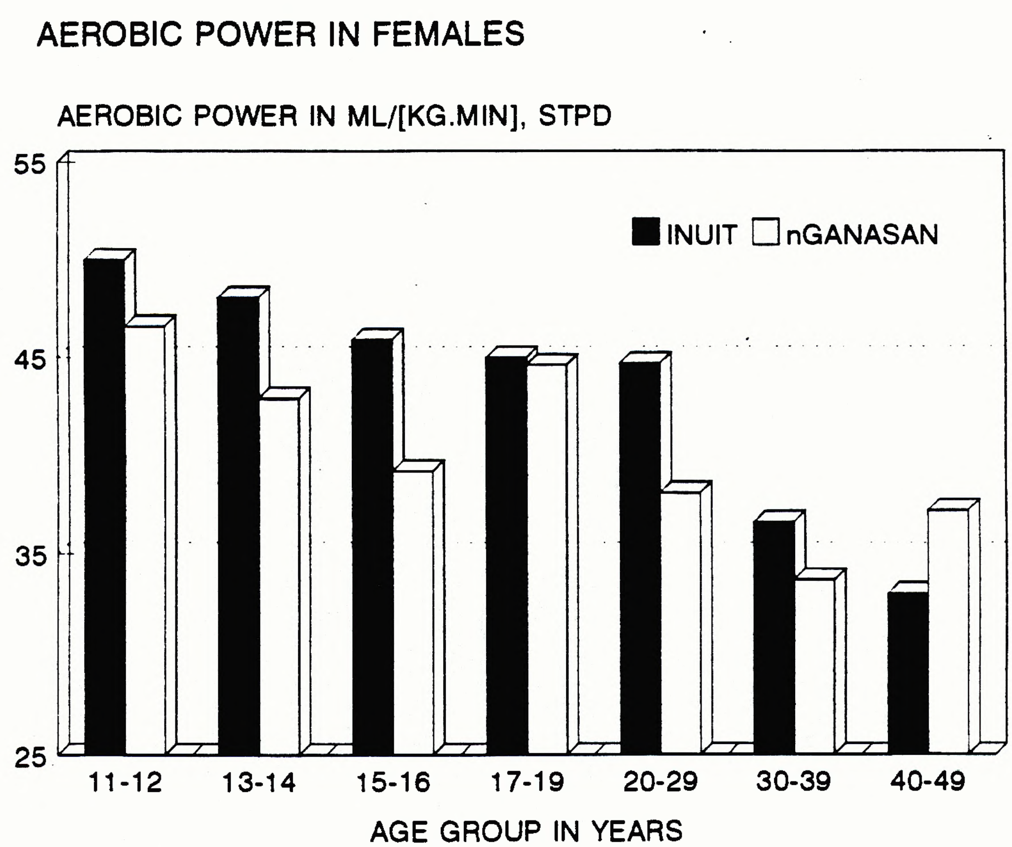


Figure 16. Relative aerobic power comparisons in females aged 11-49 years.

LUNG FUNCTION IN MALES

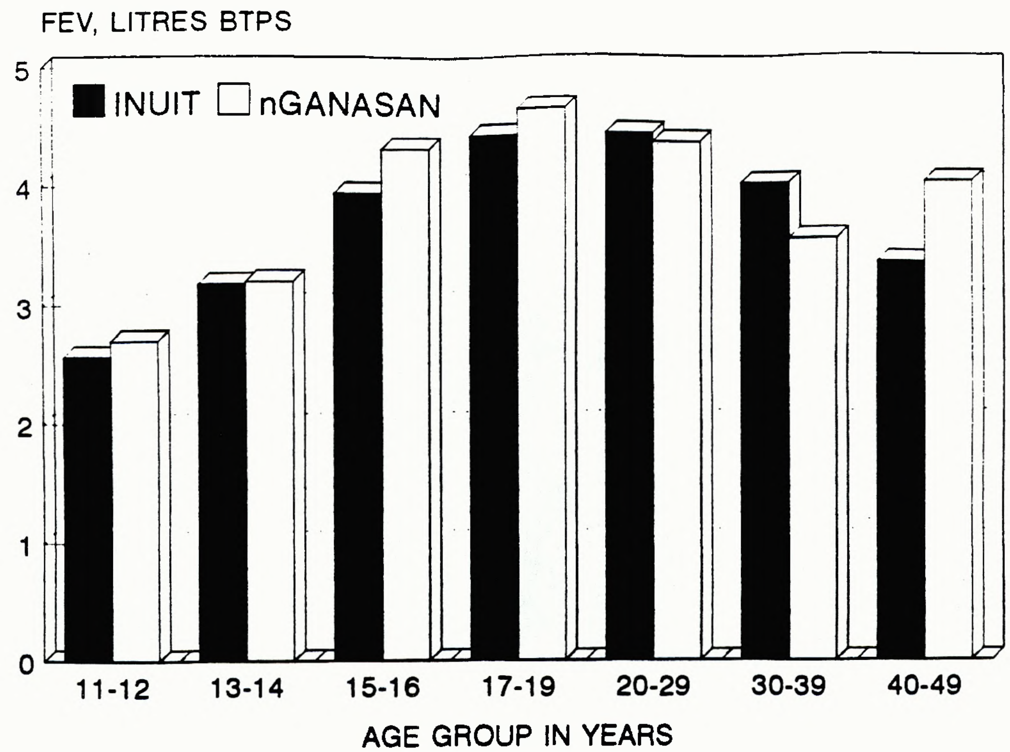


Figure 17. One-second forced expiratory volume in males aged 11-49 years.

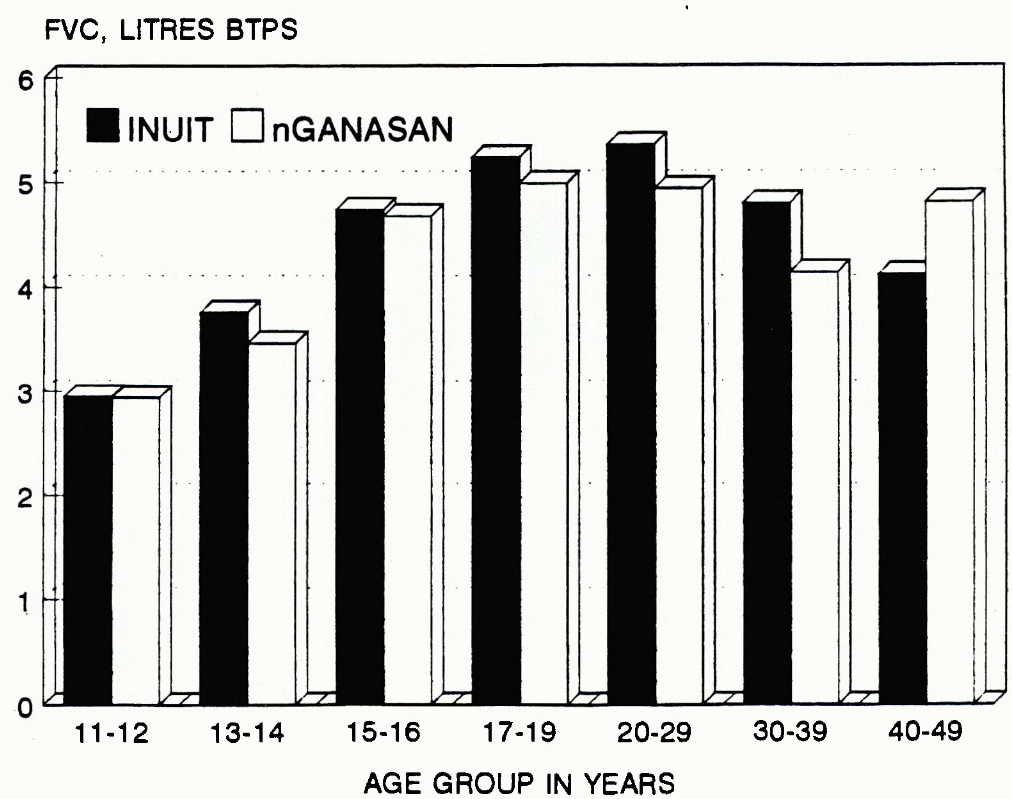


Figure 18. Forced vital capacity in males aged 11-49 years.

LUNG FUNCTION IN FEMALES

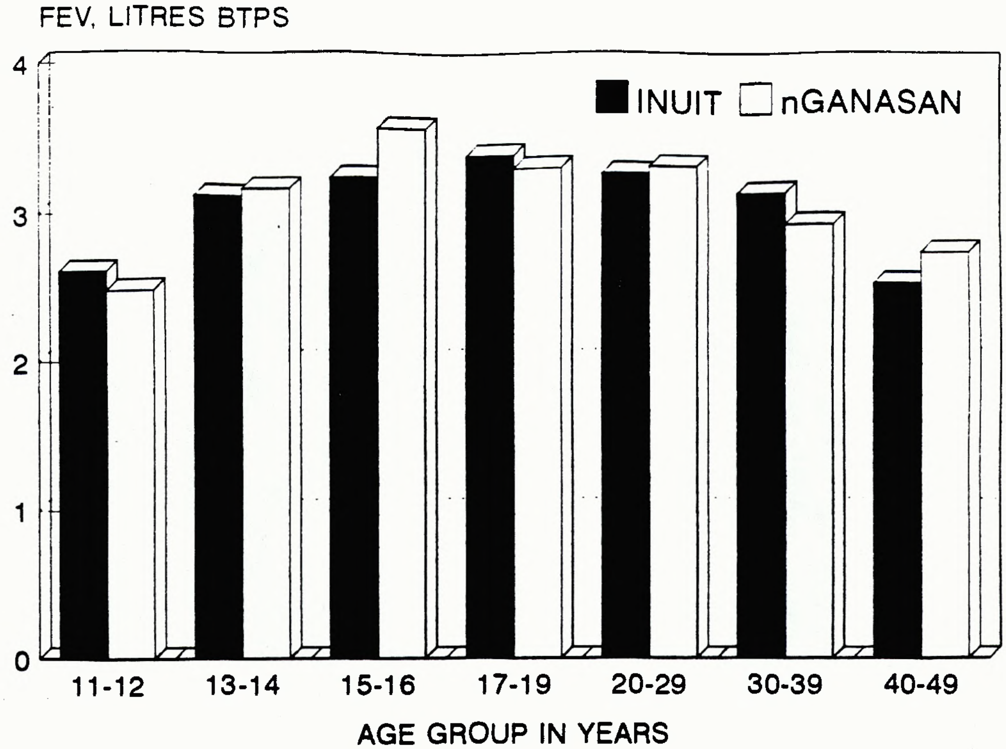


Figure 19. One-second forced expiratory volume in females aged 11-49 years.

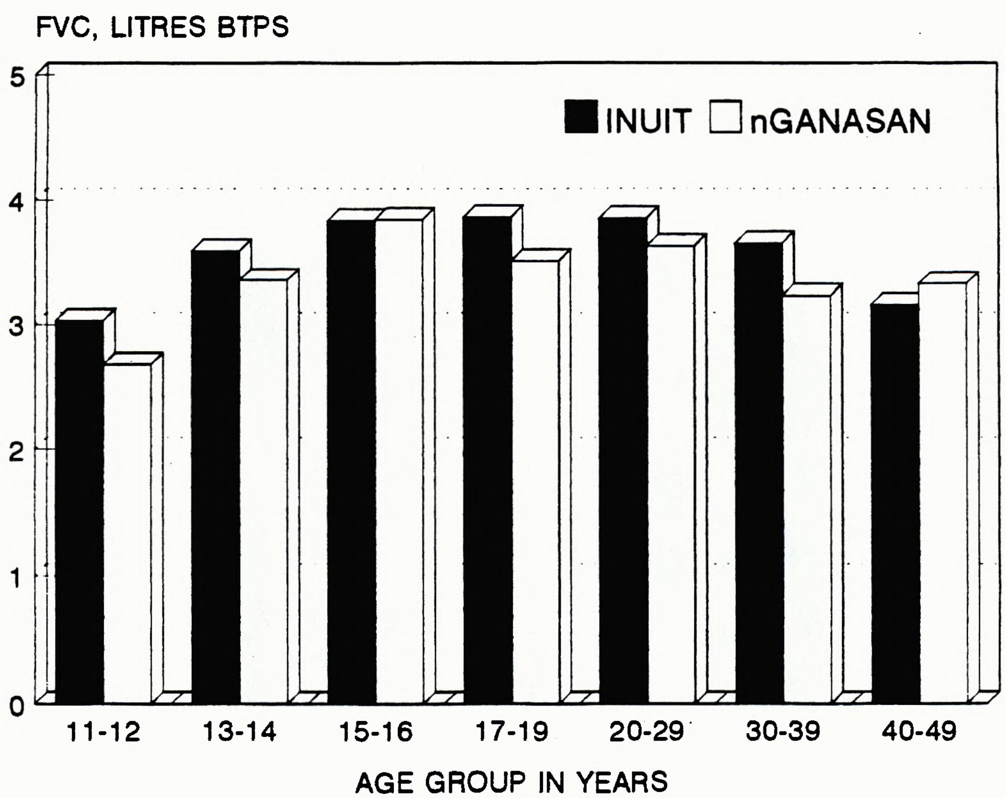


Figure 20. Forced vital capacity in females aged 11-49 years.

3.2 Anthropometry, Strength and Fitness in Children

Cross-sectional, age-grouped data for children aged 11-19 years are summerized in Tables 11 to 19. The results are illustrated in Figures 1 to 20, together with the data for adults.

3.2.1 Results for Boys Aged 11-19 Years

Height

Both the Inuit and nGanasan boys were shorter than their urban peers. Figure 1 shows that there are no apparent differences in standing height between the Inuit and the nGanasan boys at any given age. An ANOVA (age group * ethnic group) verified that there were, in fact, no significant differences between the two groups of boys attributable to either age group or (age group * ethnic group) interaction.

Body Mass

At age 15-16 years, the Inuit and nGanasan boys had an identical mean body mass, but in all other age groups the Inuit boys were heavier (Fig. 3) than the nGanasan boys by margins of 4.0, 10.2, and 7,7% (p=0,047) at ages 11-12, 13-14, and 17-19 years respectively. An ANOVA confirmed that the Inuit were significantly heavier (p=0.049) than the nGanasan boys, although there was no significant (age group * ethnic group) interaction.

Subcutaneous Fat

The skinfold readings of the older Inuit boys are now approaching the levels found in Southern Canada (Fig. 5). At all ages, they are markedly fatter relative to their nGanasan peers, the skinfold totals being greater by 28.1, 38.7 (p=0.017), 30.1, and 49% (p=0.001) at ages 11-12, 13-14, 15-16,and 17-19 years respectively. An ANOVA verified that the Inuit boys were significantly fatter than the nGanasan (p=0.000), although there was no significant (age group * ethnic group) interaction.

Strength

The hand grip values were not outstanding in either population. Figure 7 shows that the grip strength was essentially similar at all ages in the two groups of boys.

The leg extension force was also relatively low in older Inuit boys, and with the exception of the 11-12 year age group, leg strength was significantly higher in the nGanasan boys at all ages (Fig. 8). At age 11-12 years, the Inuit boys had a slight advantage in leg strength (+3.2%), but at ages 13-14, 15-16, and 17-19 years the nGanasan were stronger by margins of 16.6, 34,7 ($p=0.054$), and 12.0% respectively. An ANOVA of the data showed that as a group, the nGanasan boys had significantly higher ($p=0.005$) leg strength than the Inuit; however, the (age group * ethnic group) interaction was not significant.

Predicted Aerobic Power

The young Inuit boys retained a relatively high predicted maximal oxygen intake. Figure 13 shows that the absolute aerobic power was higher at all ages in the Inuit boys than in the nGanasan. At ages 11-12, 13-14, 15-16, and 17-19 years, the Inuit boys had an advantage of 19.1 ($p=0.008$), 9.0, 18.6, and 22.5% ($p=0.003$) respectively. An ANOVA confirmed that the differences between the two groups were highly significant ($p=0.000$).

The results for relative aerobic power (Fig. 14) were similar to the absolute data, above. With the exception of the 13-14 year old sample, the Inuit boys had a higher relative aerobic power in all age groups. At age 13-14 years the nGanasan showed a 9.0% advantage in aerobic power; however, at ages 11-12, 15-16, and 17-19 years the Inuit boys showed an advantage of 16.3 ($p<0.001$), 18.6, and 14.2% ($p=0.001$) respectively. An ANOVA showed that the differences between the two groups of boys were highly significant ($p=0.000$), with a small (age group * ethnic group) interaction.

3.2.2 Results for Girls Aged 11-19 Years

Height

Figure 2 indicates that, as with the boys, there were no apparent differences in standing height between the Inuit and nGanasan girls. An ANOVA confirmed this impression.

Body Mass

As with the boys, the Inuit girls tended to be heavier than the nGanasan at all ages (Fig. 4). At ages 11-12, 13-14, 15-16, and 17-19 the average values for the Inuit Girls were heavier by margins of 10.0, 0.4, 5.9, and 7.3% respectively. However, an ANOVA showed that these differences in body mass ($p=0.1$) did not reach the conventional level of statistical significance.

Subcutaneous Fat

Like the boys, subcutaneous fat readings of the Inuit girls were as high as in sedentary city-dwellers. They were markedly fatter at all ages than the nGanasan children (Fig. 6), the Inuit skinfold totals being greater by 45.6 (p=0.061), 13.7, 62.2 (p=0.05), and 32.9% at ages 11-12, 13-14, 15-16, and 17-19 years respectively. An ANOVA showed that the differences in body fat between the two groups of girls were highly significant (p=0.000).

Strength

The grip strength was relatively poor in both populations. However, in contrast to the boys, the nGanasan girls had a greater grip strength than the the Inuit girls at all ages (Fig. 9). The nGanasan girls were stronger by margins of 12.7, 30.6, 16.8, and 13.2% at ages 11-12, 13-14, 15-16, and 17-19 years respectively. An ANOVA showed these differences to be highly significant (p=0.005).

The results for leg strength were less consistent (Fig. 10), and a formal ANOVA did not show any significant differences in leg strength between the two groups of girls. The Inuit girls tended to a 7.3% advantage at age 11-12 years; whereas, the nGanasan had an advantage of 9.3% at age 13-14 years. However, thereafter, at ages 15-16 and 17-19 years the Inuit girls showed respective advantages of 22.1 and 2.8% - their advantage being maintained in the older females through to age 40-49 years. The overall trend to greater leg strength in the older adolescent and adult Inuit women is probably due to their tradition of carrying young children on their backs in the "amauti", a practice not adopted in Volochanka.

Predicted Aerobic Power

Figure 15 shows that at all ages the Inuit girls retained a good average level of aerobic power relative to developed societies. They had a higher absolute aerobic power than the nGanasan girls; at ages 11-12, 13-14, 15-16, and 17-19 years, their respective advantages were 12,4, 12.2, 22.8(p=0.023), and 10.3%. An ANOVA showed that differences between the two groups of girls were highly significant (p=0.003).

Relative aerobic power (Fig 16) in the two groups of girls followed a pattern similar to the absolute values above. At ages 11-12, 13-14, 15-16 and 17-19 years, the Inuit girls had a respective advantage of 7.3, 12.1, 17.1, and 0.90%. An ANOVA showed that the differences were significant (p=0.024); however, unlike the boys, there was no significant (age group * ethnic group) interaction.

3.2.3 Lung Volumes in Children and Young Adults

Cross-sectional, age-grouped data for the one-second forced expiratory volume (FEV) and forced vital capacity (FVC) for Inuit and nGanasan boys and girls aged 11-19 years are shown in Tables 15 to 18. The results are shown graphically together with the data for adults in Figures 17 and 18 for the boys and Figures 19 and 20 for the girls.

Lung function continues to develop in the Inuit and nGanasan until they reach an age in the early twenties. Accordingly, regression equations of the type: **FVC = a(HEIGHT, cm)^b** were fitted logarithmically for the prediction of FVC and FEV for subjects aged 11-19 years. The results for Inuit and nGanasan children are shown in Table 19.

Lung Volumes in Boys

From Figure 17 and 18 we can see that Inuit and nGanasan boys have essentially similar volumes for both FEV and FVC. An ANOVA confirmed that there were no significant differences in lung volumes between the 2 groups of boys.

Lung Volumes in Girls

The FEV was very similar in both the Inuit and nGanasan girls (Fig. 19) and an ANOVA confirmed that there were no significant differences in FEV between the two groups of girls. However, the FVC (Fig. 20) was significantly (ANOVA, $p=0.016$) higher in the Inuit girls. The values in the Inuit girls were higher by 13.0% ($p=0.01$), 7.0%, and 9.9% ($p=0.05$) for girls aged 11-12, 13-14, and 17-19 years respectively. For girls aged 15-16 years, the FVC was practically identical for the Inuit and nGanasan girls at 3.84 and 3.85 litres respectively.

Table 11. Anthropometry and strength in boys and girls aged 11-12 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	12.2 0.3 19	12.0 0.6 15	12.1 0.7 16	12.2 0.5 15
HEIGHT (cm)	143.5 4.9 19	143.8 7.7 15	144.6 5.4 16	144.3 4.3 15
BODY MASS (kg)	39.1 4.5 19	37.6 6.4 15	41.7 8.5 16	37.9 4.6 15
SUM 3 SKIN-FOLDS (mm)	23.7 11.4 19	18.5 3.6 15	35.1 20.6 16	24.1 7.9 15
HAND GRIP FORCE (Newtons)	144.0 37.7 19	134.7 56.9 15	96.9 34.1 16	109.2 41.3 15
LEG EXTENSION FORCE (Newtons)	354.7 103.9 19	343.7 94.0 15	320.7 90.8 16	298.9 63.5 15

Table 12. Anthropometry and strength in boys and girls aged 13-14 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	13.8 0.6 23	14.1 0.6 17	13.8 0.5 15	13.6 0.5 11
HEIGHT (cm)	154.3 7.2 23	150.3 9.9 17	150.6 5.5 15	148.6 4.9 11
BODY MASS (kg)	49.5 7.4 23	44.9 8.8 17	46.2 6.5 15	46.0 7.9 11
SUM 3 SKIN-FOLDS (mm)	26.9 12.6 23	9.4 5.8 17	34.9 8.5 15	30.7 12.3 11
HAND GRIP FORCE (Newtons)	224.4 80.8 23	210.1 71.7 17	153.0 60.0 15	199.8 58.3 11
LEG EXTENSION FORCE (Newtons)	368.1 120.1 23	429.3 150.8 17	336.2 92.7 15	367.4 91.7 11

Table 13. Anthropometry and strength in boys and girls aged 15-16 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	15.9 0.6 17	15.9 0.5 7	16.1 0.5 15	16.3 0.5 5
HEIGHT (cm)	162.5 4.9 17	165.7 7.4 7	153.0 5.1 15	154.3 3.8 5
BODY MASS (kg)	57.4 6.2 17	57.4 9.3 7	54.3 9.0 15	51.3 5.7 5
SUM 3 SKIN-FOLDS (mm)	23.8 11.2 17	18.3 4.1 7	54.5 19.6 15	33.6 2.4 5
HAND GRIP FORCE (Newtons)	367.6 71.9 17	375.6 124.6 7	198.2 51.3 15	231.5 42.0 5
LEG EXTENSION FORCE (Newtons)	443.8 88.6 17	597.7 166.6 7	390.4 100.4 15	319.8 113.7 5

Table 14. Anthropometry and strength in boys and girls aged 17-19 years. Values shown are the mean, standard deviation, and sample size.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
AGE (yr)	18.4 0.8 31	17.7 0.7 12	18.4 0.9 19	18.3 0.8 10
HEIGHT (cm)	163.5 5.1 31	163.5 6.6 12	153.8 4.4 19	154.2 4.3 10
BODY MASS (kg)	63.0 6.5 31	58.5 6.4 12	54.5 5.6 19	50.8 10.0 10
SUM 3 SKIN-FOLDS (mm)	28.8 11.6 31	19.3 6.2 12	50.5 15.9 19	38.0 19.7 10
HAND GRIP FORCE (Newtons)	402.2 60.3 31	401.4 60.8 12	194.1 46.0 19	219.8 51.1 10
LEG EXTENSION FORCE (Newtons)	509.1 131.8 31	570.6 190.3 12	402.2 55.6 19	391.4 100.9 10

Table 15. Lung function and predicted aerobic power (VO2max) in boys and girls aged 11-12 years. Values shown are the mean, SD, and N.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	2.57 0.34 19	2.70 0.34 14	2.61 0.35 16	2.48 0.35 15
FORCED VITAL CAPACITY (L,BTPS)	2.95 0.36 19	2.94 0.34 14	3.03 0.38 16	2.68 0.32 15
FEV/FVC (%)	87.3 3.5 19	91.8 3.2 14	86.3 5.1 16	92.6 6.0 15
AEROBIC POWER (Predicted VO2max, l/min, STPD)	2.31 0.28 19	1.94 0.41 14	1.99 0.30 15	1.77 0.36 15
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	59.2 2.3 19	50.9 6.5 14	50.0 10.8 15	46.6 6.5 15

Table 16. Lung function and predicted aerobic power (VO2max) in boys and girls aged 13-14 years. Values shown are the mean, SD, and N.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	3.17 0.56 23	3.19 0.76 17	3.11 0.46 15	3.16 0.56 11
FORCED VITAL CAPACITY (L,BTPS)	3.76 0.61 23	3.47 0.81 17	3.60 0.45 15	3.36 0.60 11
FEV/FVC (%)	84.4 5.2 23	91.9 3.4 17	86.2 5.4 15	94.2 3.1 11
AEROBIC POWER (Predicted VO2max, l/min, STPD)	2.78 0.60 23	2.55 0.52 17	2.21 0.43 15	1.97 0.46 11
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	56.5 9.5 23	57.2 8.3 17	48.1 9.1 15	42.9 7.3 11

Table 17. Lung function and predicted aerobic power (VO2max) in boys and girls aged 15-16 years. Values shown are the mean, SD, and N.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	3.93 0.59 17	4.31 0.74 6	3.23 0.39 15	3.56 0.54 4
FORCED VITAL CAPACITY (L,BTPS)	4.74 0.65 17	4.68 0.61 6	3.84 0.47 15	3.85 0.60 4
FEV/FVC (%)	82.9 4.7 17	92.0 5.5 6	84.3 6.9 15	95.2 4 .2 4
AEROBIC POWER (Predicted VO2max, l/min, STPD)	3.32 0.62 17	2.80 0.49 7	2.48 0.39 15	2.02 0.47 5
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	57.8 8.1 17	49.1 5.8 7	45.9 5.2 15	39.2 7.3 5

Table 18. Lung function and predicted aerobic power (VO2max) in boys and girls aged 17-19 years. Values shown are the mean, SD, and N.

MEASUREMENT	MALE		FEMALE	
	INUIT	nGANASAN	INUIT	nGANASAN
FORCED EXPIRATORY VOLUME (L,BTPS)	4.42 0.51 31	4.64 0.59 11	3.38 0.37 19	3.29 0.39 10
FORCED VITAL CAPACITY (L,BTPS)	5.24 0.61 31	4.99 0.57 11	3.87 0.41 19	3.52 0.37 10
FEV/FVC (%)	84.5 5.4 31	92.9 3.2 11	87.3 4.7 19	93.5 3.6 10
AEROBIC POWER (Predicted VO2max, l/min, STPD)	3.54 0.66 31	2.89 0.48 12	2.46 0.60 19	2.23 0.39 10
AEROBIC POWER (Predicted VO2max, ml/[kg.min], STPD)	56.2 9.1 31	49.2 4.1 12	45.0 8.5 19	44.6 7.3 10

Table 19. Equations for the prediction of $FEV_{1.0}$, FVC, from height in Inuit (I) and nGanasan (G) boys aged 9-19 years as calculated by a log-log regression analysis of lung volumes against height, showing predicted volumes for H=150 cm.

LUNG FUNCTION AND ETHNIC GROUP		EQUATION	PREDICTED VOLUME
MALES			
FEV (I)	N = 92	$6.62 \times 10^{-8} H^{3.52}$	3.03
FEV (G)	N = 48	$2.43 \times 10^{-7} H^{3.27}$	3.17
FVC (I)	N = 92	$2.56 \times 10^{-8} H^{3.74}$	3.52
FVC (G)	N = 48	$3.23 \times 10^{-7} H^{3.23}$	3.45
FEMALES			
FEV (I)	N = 65	$2.51 \times 10^{-5} H^{2.34}$	3.10
FEV (G)	N = 41	$9.82 \times 10^{-9} H^{3.90}$	3.01
FVC (I)	N = 65	$9.35 \times 10^{-6} H^{2.56}$	3.48
FVC (G)	N = 41	$1.29 \times 10^{-8} H^{3.86}$	3.24

3.3 Plasma Lipids, Fatty Acids and Cardiovascular Risk Factors

Data on 12 blood lipids, 17 fatty acids, and 5 other cardiovascular risk factors (blood pressure, body composition, and cigarette smoking) were measured on a sub-sample of 151 Inuit (89M, 62F) and 43 nGanasan (30M, 11F). The results are summarized in Tables 20 to 32 and illustrated in Figures 21 to 46. The table below shows the sample size, age, and sex distribution of the Inuit and nGanasan who volunteered for the blood studies.

AGE GROUP (yr)	INUIT		nGANASAN	
	MALE	FEMALE	MALE	FEMALE
18-29	30	22	16	7
30-39	18	16	7	2
40-49	17	8	4	2
50-59	17	13	3	-
60-69	4	3	-	-
70-79	3	-	-	-

Because of the missing data sets seen in some of the age groupings above, we have analysed and presented our data in two sets:

a) an analysis of the data for Inuit men and women aged 18-69 years; and

b) a comparison of the data for Inuit and nGanasan men and women for ages 18-59 and 18-49 years respectively.

3.3.1 Plasma Lipids in Inuit Men and Women

We used a 2-way ANOVA to compare the mean plasma lipid profiles of Inuit men and women aged 18-29, 30-39, 40-49, 50-59 and 60-69 years. We looked for sex differences, the effects of age, and age*sex interaction. Unless otherwise specified, all references to an ANOVA in the following sections conform to the above format.

1. **Total Lipids (Table 20, Figure 21)**

The ANOVA did not reveal any significant differences between men and women, and there were no age effects or sex*age interaction. The mean total lipid levels for all men and women aged 18-69 years were 432 ± 122 and 466 ± 113 mg% respectively; the 7.8% difference was not statistically significant.

Values in the 3 men aged 70-79 years (542 mg%) were 25.5% higher (NS) than the average 432 mg% for men aged 18-69 years.

2. **Total Cholesterol (Table 21, Fig. 22)**

Figure 22 indicates that at all ages the total cholesterol levels tended to be higher in the women than in the men. The ANOVA revealed a marginally significant (p=0.063) sex difference, but no age effect or sex*age interaction. An inspection of the data by individual age groups showed that the only significant change with age was seen in the men who had a 15.7% (p=0.041) increase in total cholesterol from age 18-29 to 30-39 years.

The mean values for all men and women aged 18-69 years were 148 ± 40 and 161 ± 41 mg% respectively; the 8.7% difference was marginally significant (p=0.063).

The values for the 3 men aged 70-79 years (203 mg%) were significantly higher (+37.2%, p=0.021) than the 148 mg% average for all men aged 18-69 years.

3. **Triacylglycerol (Table 22, Fig. 23)**

Figure 23 suggests a trend to a decrease of plasma triacylglycerol with age in both men and women. However, the ANOVA did not reveal any sex differences, age effect, or sex*age interaction. The mean values for all men and women age 18-69 years were both very low at 53 ± 39 and 51 ± 25 mg% respectively.

Values in the men aged 70-79 years (35mg%) were significantly lower (-34%, p=0.024) than the 53 mg% average for all men aged 18-69 years.

4. **Free Cholesterol (Table 23, Fig. 24)**

Figure 24 shows that at all ages the free cholesterol levels appear to be higher in the women than in the men. The ANOVA confirmed that there was a significant sex difference (p=0.017), but there was no age effect or sex*age interaction. At ages 18-29, 30-39, 40-49, 50-59 and 60-69 years the free cholesterol levels in the women were higher by 13.1, 4.4, 2.4, 11.9 and 37.5% ($p=0.001$) respectively.

There was a significant 9.8% difference ($p=0.041$) between the mean values for all men (41 ± 11) and all women (45 ± 11) mg% aged 18-69 years.

The free cholesterol levels (55 mg%) in the 3 men aged 70-79 years were significantly higher (+34.2%, $p=0.033$) than the 41 mg% average for men aged 18-69 years.

5. Phosphatidyl Choline (Table 24, Fig. 25)

Figure 25 shows a marked decline of phosphatidyl choline levels with age for both men and women from age 18-29 to 50-59 years. Levels in the women appear to be higher than in the men at all ages. The ANOVA revealed a marginally significant sex difference ($p=0.080$), a strong age effect ($p=0.001$), and no sex*age interaction. A one-way ANOVA of the data for men aged 18-59 years showed a significant decrease ($p=0.024$) of phosphatidyl choline with age; a similar analysis for the women of the same age also revealed a marginally significant ($p=0.057$) decrease with age.

The mean values for all men and women aged 18-69 years were 105 ± 37 and 118 ± 35 mg% respectively, with a significant 12.4% ($p=0.041$) difference between the men and women.

Values for the 70-79 year old men (125 mg%) were 19.1% higher (NS) than the average 105mg% for all men aged 18-69 years.

6. The Phosphatidyl Choline/Free Cholesterol Ratio (PC/FC)(Table 25, Fig. 26)

Figure 26 shows a decrease of the PC/FC ratio with age in both men (18-29 to 50-59 years) and women (18-29 to 60-69 years). The ANOVA revealed that there were no significant sex differences, but there was a strong age effect ($p=0.002$). There was no sex*age interaction. A one-way ANOVA of the data for the men aged 18-59 years confirmed that there was a significant decrease ($p=0.037$) in the PC/FC ratio with age. Men aged 18-29, 30-39, 40-49, and 50-59 years had respective ratios of 1.75, 1.32, 1.19, and 0.97. A similar analysis for the women aged 18-69 years also showed a highly significant decrease ($p=0.000$) of the PC/FC ratio with age. Women aged 18-29, 30-39, 40-49, 50-59,and 60-69 years had respective ratios of 1.54, 1.31, 1.26, 1.05 and 0.88.

The mean PC/FC ratios for all men and women aged 18-69 years were 1.37 ± 0.88 and 1.31 ± 0.30, respectively; the 4.6% difference was not statistically significant.

The PC/FC ratio (1.18) in the 70-79 year old men was 13.9% lower (NS) than the mean value (1.37) for all men aged 18-69.

7. Monoglycerides (Table 26, Fig. 27)

The ANOVA did not reveal any sex differences, age effects, or sex*age interaction. Figure 27 suggests that there were some marked differences between specific age groups, but the t-test of individual age-group means did not confirm this impression.

The mean monoglyceride levels for all men and women aged 18-69 years were 1.76 ± 1.30 and 1.54 ± 1.06 mg%, respectively; the 14.3% difference was not statistically significant.

The monoglyceride level in 70-79 year old men (1.39 mg%) was 21.0% lower (NS) than the norm (1.76 mg%) for all men aged 18-69 years.

8. Total Fatty Acids (Table 27, Fig. 28)

The ANOVA did not show a sex difference, age effect, or sex*age interaction. Figure 28 suggests a trend to differences within and between some age groups, but individual t-tests of age-grouped means did not reveal any significant differences.

The mean total fatty acid levels for all men and women aged 18-69 years were 6.45 ± 4.43 and 7.62 ± 4.23 mg%, respectively; the 18% difference was not statistically significant.

In the men, there was a general trend to a decrease of fatty acid concentrations with age. The 4.56 mg% found in the 70-79 year old men was 38% less than the 7.35 mg% seen in the 18-29 year old men; however, the difference was not statistically significant. The results for women were inconsistent, and the 60-69 year old women had values (7.71 mg%) that were essentially the same as those seen in the 18-29 year old females (7.80 mg%).

9. Cholesterol Esters (Table 28, Fig. 29)

The ANOVA of cholesterol ester concentrations did not reveal any sex difference, age effect, or sex*age interaction. However, a t-test showed that there was a significant (p=0.041) 30.7% difference between the men (179 mg%) and women (234 mg%) aged 60-69 years. In addition, the cholesterol ester levels in the 3 men aged 70-79 years (247 mg%) were significantly higher (p=0.029) than the 179 mg% average for all men aged 18-69 years.

The mean cholesterol ester levels in all men and women aged 18-69 years were 179 ± 52 and 195 ± 51 mg% respectively; the 7.8% difference was not statistically significant.

Values in the men aged 70-79 years (247mg%) were significantly higher (+38%, p=0.023) than the average of 179mg% for all men aged 18-69 years.

10. Esterified Cholesterol (Table 29, Fig. 30)

The plasma esterified cholesterol concentrations showed a similar pattern to the cholesterol ester distribution seen above. The ANOVA did not show a significant sex difference, age effect, or sex*age interaction. However, a t-test showed that there was a significant 30.6% difference in esterified cholesterol levels between the 60-69 year old men (108 mg%) and women (141 mg%). Furthermore, levels in the 3 men aged 70-79 years (148 mg%) were significantly higher (38%, p=0.031) than the 107 mg% average for all men aged 18-69 years.

The mean esterified cholesterol concentrations for all men and women aged 18-69 years were 107 ± 31 and 116 ± 31 mg%, respectively; the 8.4% difference was not statistically significant.

11. Diglyceride + Ceramide (Table 30, Fig. 31)

The diglyceride + ceramide concentrations were higher in the women than in the men at all ages with the exception of the 40-49 year old group, where the levels were slightly higher (4%) in the men. The readings were higher in the women by 16.1 (p=0.039), 9.0, 11.4, and 37.1% (p=0.076) at ages 18-29, 30-39, 50-59, and 60-69 years, respectively. The ANOVA confirmed that there was a significant sex difference (p=0.036), but no age effect or sex*age interaction.

Levels in the 3 men aged 70-79 years (160 mg%) were 29% higher (NS) than the 124 mg% average for men aged 18-69 years.

The mean diglyceride + ceramide concentrations for all men and women aged 18-69 years were 124 ± 38 and 138 ± 35 mg%, respectively; the 11.3% difference was significant (p=0.019).

12. Total Phospholipids (Table 31, Fig. 32)

The total phospholipid concentrations were higher in the women at all ages with the exception of the 40-49 year old group, where the levels were slightly (3.8%) higher in the men. At ages 18-29, 30-39, 50-59, and 60-69 years the levels were higher in the women by 16.6 ($p=0.035$), 8.7, 11.4 and 37% ($p=0.079$) respectively. The ANOVA confirmed that there was a significant sex difference ($p=0.036$), with no age effect or sex*age interaction.

There was a significant 12% difference ($p=0.019$) between the mean values for all men (158 $\pm$ 48 mg%) and women (177 $\pm$ 45 mg%) aged 18-69 years.

Values in the 3 men aged 70-79 years (205 $\pm$ 29 mg%) were 29.8% higher ($p=0.097$) than the 158 mg% average for all men aged 18-69 years.

13. Sphingomyelin (Table 32, Fig. 33)

Figure 33 shows that sphingomyelin concentrations were higher in women at all ages except at age 40-49 years, when they were essentially similar to those found in the men. At ages 18-29, 30-39, 50-59 and 60-69 years, values in the women were higher by 19 ($p=0.019$), 6.5, 6.8, and 41.4% ($p=0.015$) respectively. The ANOVA confirmed a significant sex difference ($p=0.013$), a strong age effect ($p=0.002$), but no sex*age interaction.

There was a significant 10.9 % difference ($p=0.025$) between the mean values for all men (24.8 $\pm$ 7.1)mg% and women (27.5 $\pm$ 6.7)mg% aged 18-69 years.

Values in the 3 men aged 70-79 years (39.0 $\pm$ 4.3)mg% were 57.3% higher ($p=0.001$) than the 24.8 mg% average for all men aged 18-69.

Table 20. Total plasma lipids (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	424 117 30	385 101 16	462 118 22	368 114 7
30-39	470 88 18	464 105 7	483 129 16	575 37 2
40-49	428 99 17	510 100 4	428 80 8	422 127 2
50-59	418 181 17	377 4 3	459 111 13	
60-69	394 63 4		535 92 3	
70-79	542 75 3			

Table 21. Total cholesterol levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	140 38 30	126 21 16	156 39 22	131 35 7
30-39	162 33 18	159 35 7	165 47 16	195 33 2
40-49	149 36 17	159 21 4	156 30 8	147 37 2
50-59	149 58 17	135 9 3	162 46 13	
60-69	148 18 4		196 17 3	
70-79	203 31 3			

Table 22. Triacyglycerol levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	65 50 30	51 45 16	56 31 22	37 34 7
30-39	58 25 18	44 25 7	52 21 16	66 39 2
40-49	43 16 17	86 35 4	40 10 8	27 3 2
50-59	40 44 17	26 9 3	45 18 13	
60-69	39 12 4		61 53 3	
70-79	35 8 3			

Table 23. Free cholesterol levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	38 12 30	36 5 16	43 10 22	36 8 7
30-39	45 8 18	45 9 7	47 12 16	56 7 2
40-49	42 8 17	43 2 4	43 9 8	41 9 2
50-59	42 13 17	39 1 3	47 12 13	
60-69	40 3 4		55 2 3	
70-79	55 10 3			

Table 24. Phosphatidyl choline levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	115 34 30	99 28 16	131 27 22	95 25 7
30-39	118 36 18	129 35 7	124 47 16	153 14 2
40-49	100 32 17	128 30 4	110 30 8	113 63 2
50-59	81 39 17	95 21 3	97 26 13	
60-69	92 31 4		96 12 3	
70-79	125 33 3			

Table 25. PC/FC ratio in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	1.75 1.35 30	1.37 0.25 16	1.54 0.21 22	1.31 0.17 7
30-39	1.32 0.32 18	1.43 0.17 7	1.31 0.31 16	1.36 0.04 2
40-49	1.19 0.25 17	1.48 0.30 4	1.26 0.13 8	1.32 0.46 2
50-59	0.97 0.29 17	1.24 0.31 3	1.05 0.20 13	
60-69	1.14 0.34 4		0.88 0.11 3	
70-79	1.18 0.48 3			

Table 26. Plasma monoglycerides (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	1.59 0.72 30	1.76 0.54 16	1.30 0.64 22	0.98 0.35 7
30-39	2.09 1.98 18	1.62 0.43 7	1.78 1.43 16	1.89 0.41 2
40-49	1.70 0.80 17	2.23 1.07 4	1.66 1.31 8	1.59 1.77 2
50-59	1.94 1.67 17	1.08 0.20 3	1.47 1.07 13	
60-69	1.05 0.46 4		1.92 0.80 3	
70-79	1.39 0.44 3			

Table 27. Plasma fatty acid levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	7.35 5.99 30	2.58 2.07 16	7.80 3.81 22	2.74 2.17 7
30-39	5.76 3.13 18	1.11 0.81 7	8.89 5.98 16	2.35 0.29 2
40-49	6.53 3.43 17	0.64 0.57 4	6.41 2.82 8	1.44 2.03 2
50-59	5.90 3.38 17	2.28 1.13 3	6.48 2.97 13	
60-69	4.91 3.65 4		7.71 4.29 3	
70-79	4.56 3.02 3			

Table 28. Plasma cholesterol esters (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	170 46 30	151 28 16	187 48 22	157 46 7
30-39	195 42 18	189 44 7	197 60 16	232 44 2
40-49	179 46 17	194 32 4	188 36 8	177 46 2
50-59	178 75 17	161 13 3	192 57 13	
60-69	179 25 4		234 28 3	
70-79	247 35 3			

Table 29. Plasma esterified cholesterols (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	102 28 30	90 17 16	112 29 22	94 27 7
30-39	117 25 18	114 27 7	118 36 16	139 26 2
40-49	108 28 17	116 19 4	113 21 8	106 27 2
50-59	107 45 17	97 8 3	115 34 13	
60-69	108 15 4		141 17 3	
70-79	148 21 3			

Table 30. Plasma diglyceride + ceramide levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	118 32 30	115 27 16	137 32 22	107 29 7
30-39	134 29 18	145 30 7	146 45 16	172 19 2
40-49	128 35 17	147 28 4	123 26 8	138 58 2
50-59	123 56 17	118 14 3	137 35 13	
60-69	105 26 4		144 17 3	
70-79	160 22 3			

Table 31. Total plasma phospholipid levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	151 41 30	147 35 16	176 41 22	137 38 7
30-39	172 36 18	186 38 7	187 57 16	220 24 2
40-49	164 45 17	188 36 4	158 34 8	176 74 2
50-59	158 71 17	151 18 3	176 45 13	
60-69	135 34 4		185 22 3	
70-79	205 29 3			

Table 32. Plasma sphingomyelin levels (mg%) in Inuit and nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	21.1 6.1 30	19.6 3.9 16	25.1 5.6 22	19.7 5.3 7
30-39	26.3 5.4 18	25.2 4.6 7	28.0 7.3 16	32.0 6.1 2
40-49	26.4 5.8 17	25.0 3.8 4	26.2 5.8 8	27.7 9.0 2
50-59	28.1 9.5 17	22.7 2.1 3	30.0 7.4 13	
60-69	24.9 4.0 4		35.2 3.3 3	
70-79	39.0 4.3 3			

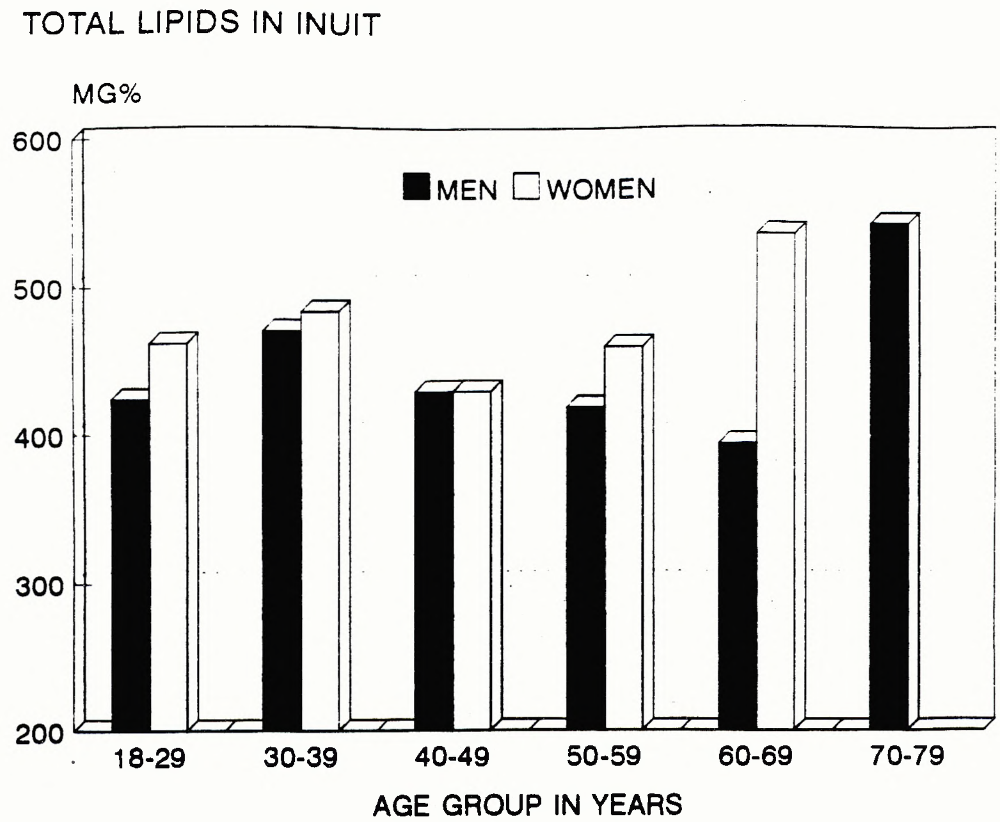


Figure 21. Total lipids in Inuit men and women aged 18-79 years.

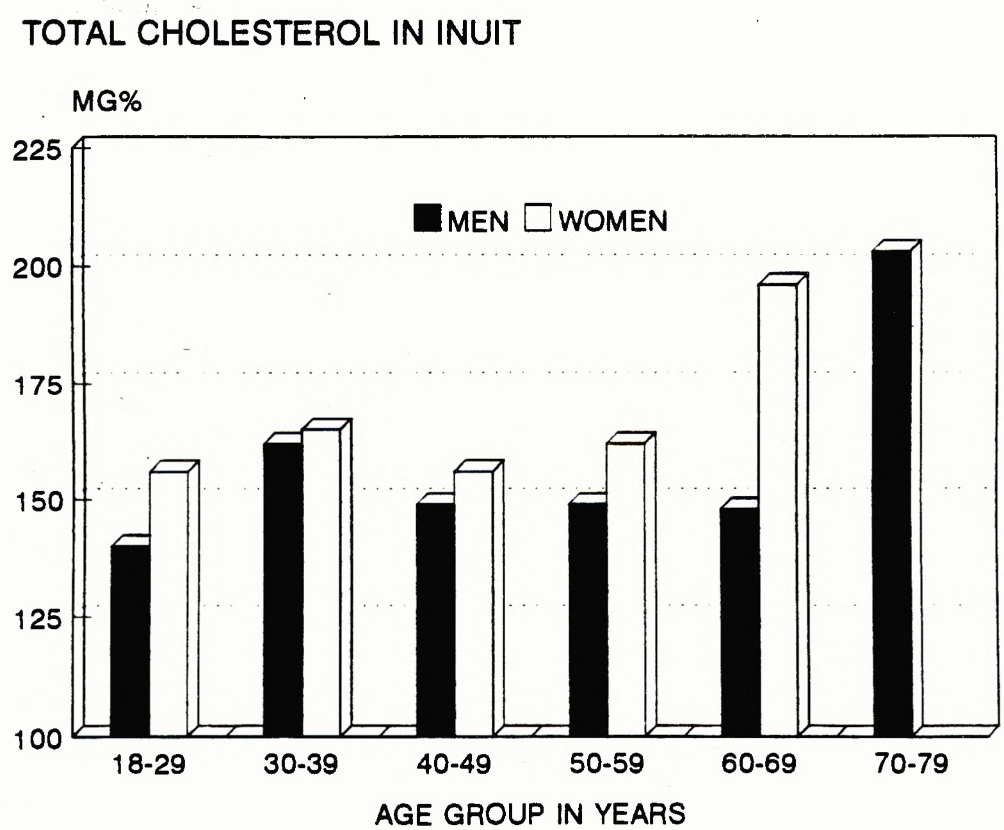


Figure 22. Total plasma cholesterol in Inuit men and women aged 18-79 years.

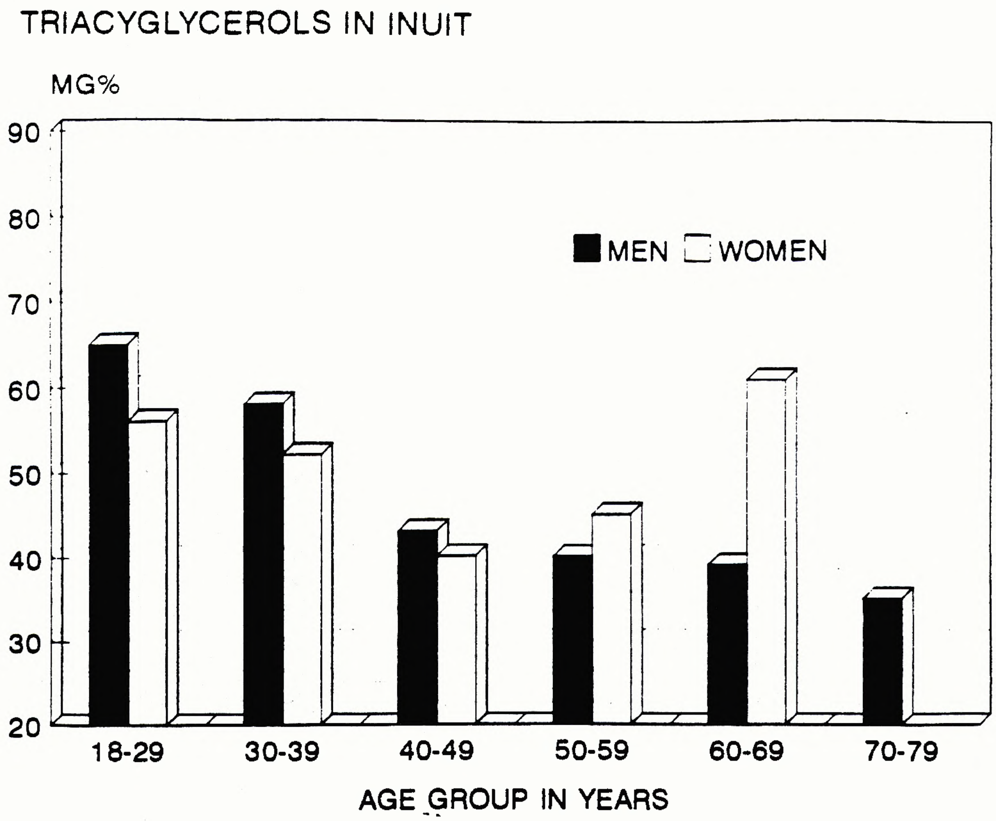


Figure 23. Triacylglycerols in Inuit men and women aged 18-79 years.

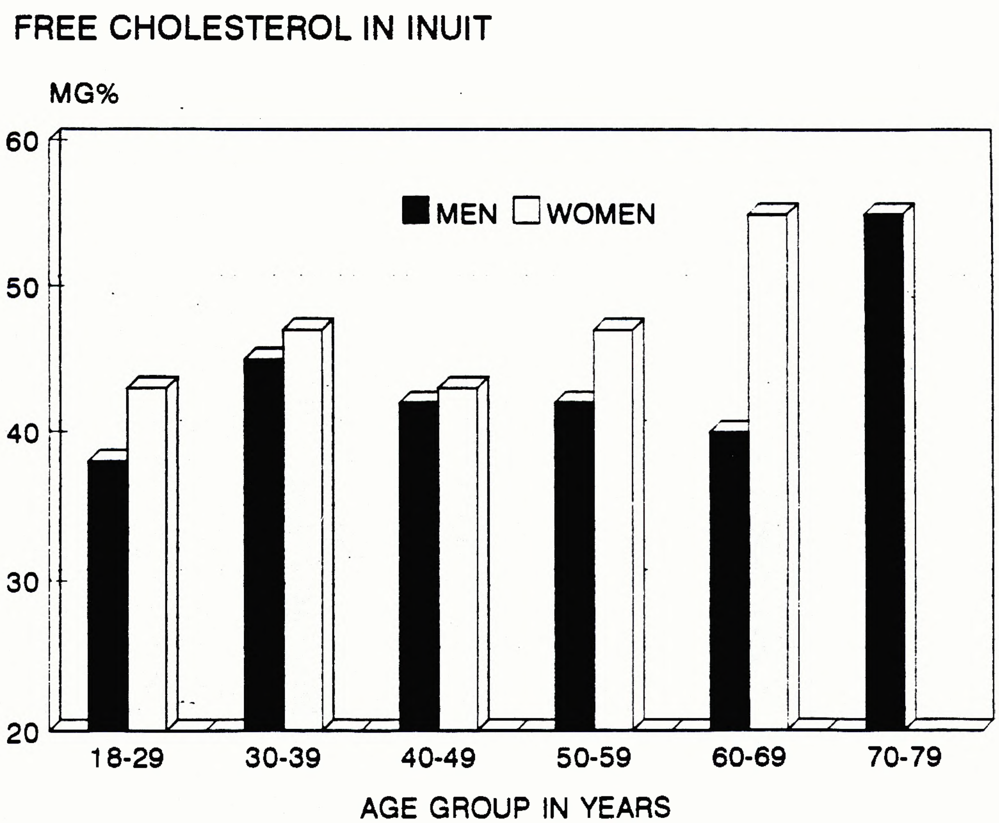


Figure 24. Free cholesterol in Inuit men and women aged 18-79 years.

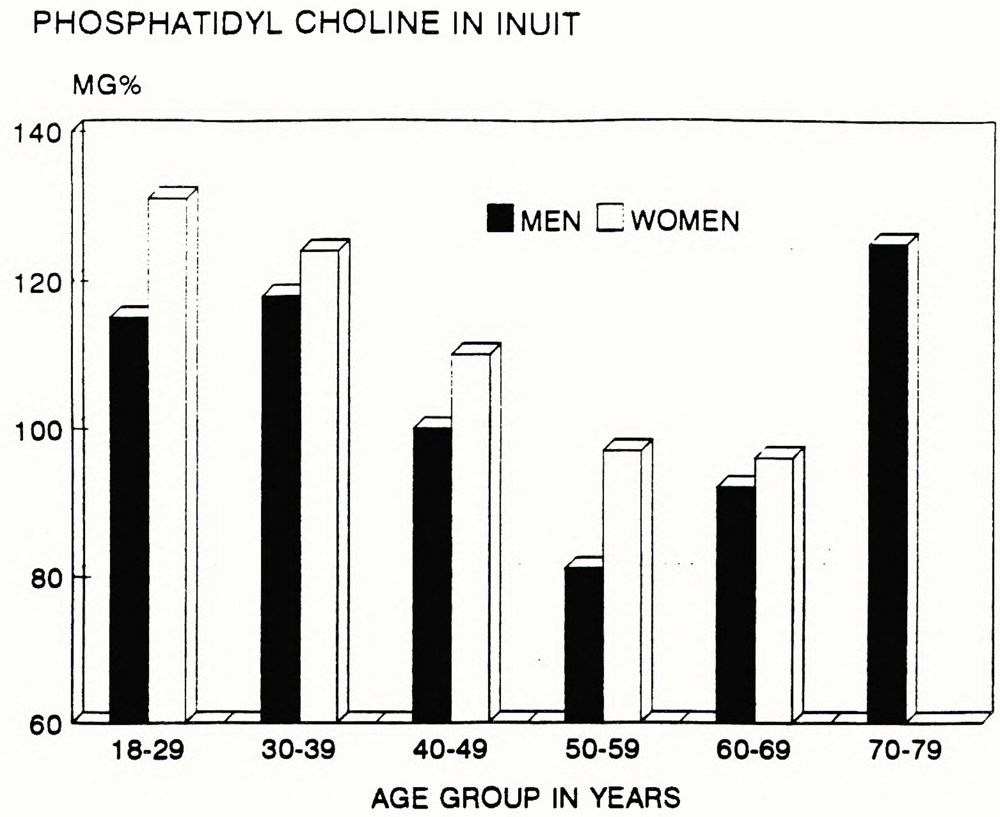


Figure 25. Phosphatidyl choline in Inuit men and women aged 18-79 years.

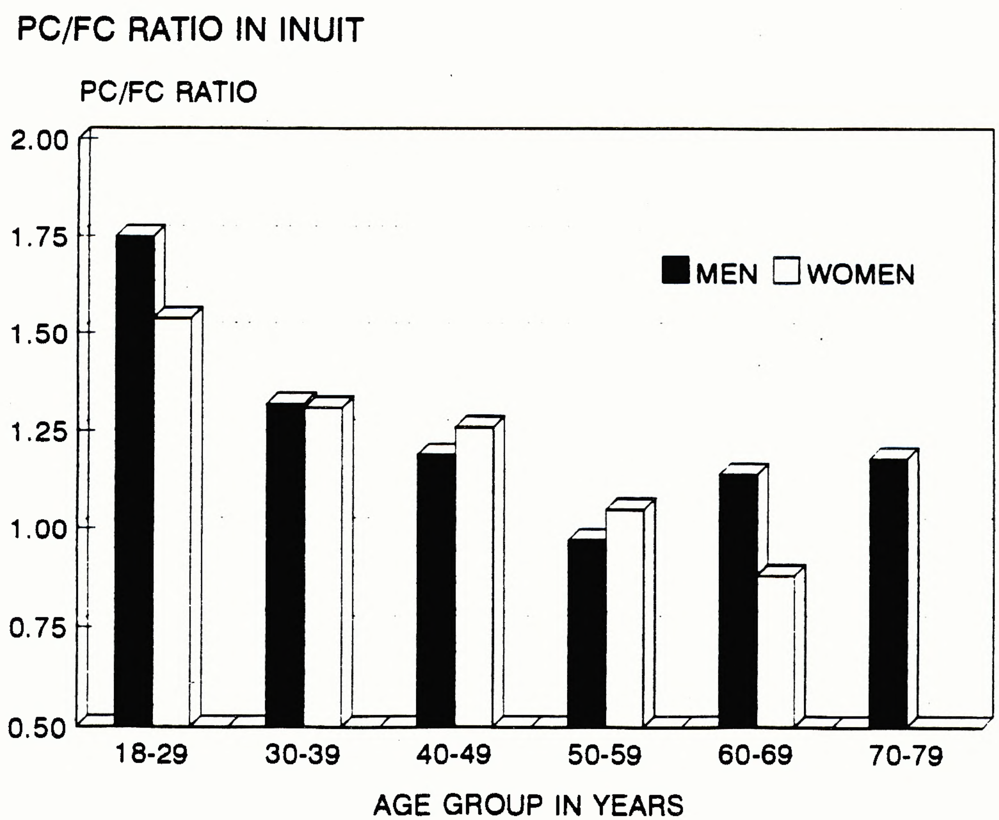


Figure 26. PC/FC ratio in Inuit men and women aged 18-79 years.

MONOGLYCERIDE IN INUIT

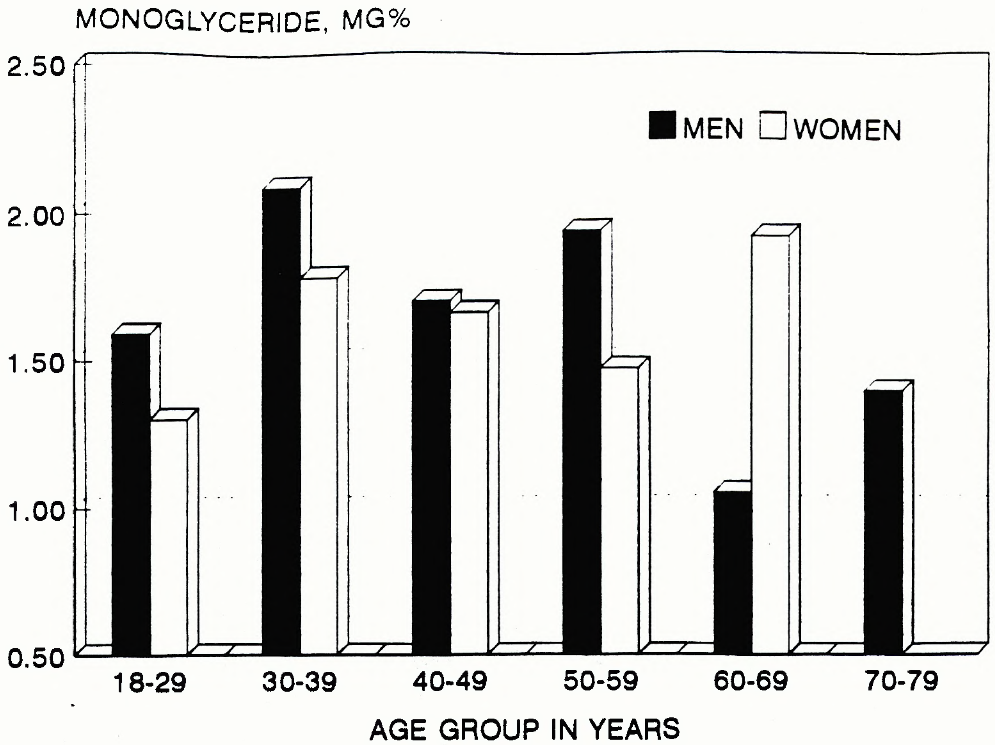


Figure 27. Plasma monoglyceride levels in Inuit men and women aged 18-79 years.

FATTY ACIDS IN INUIT

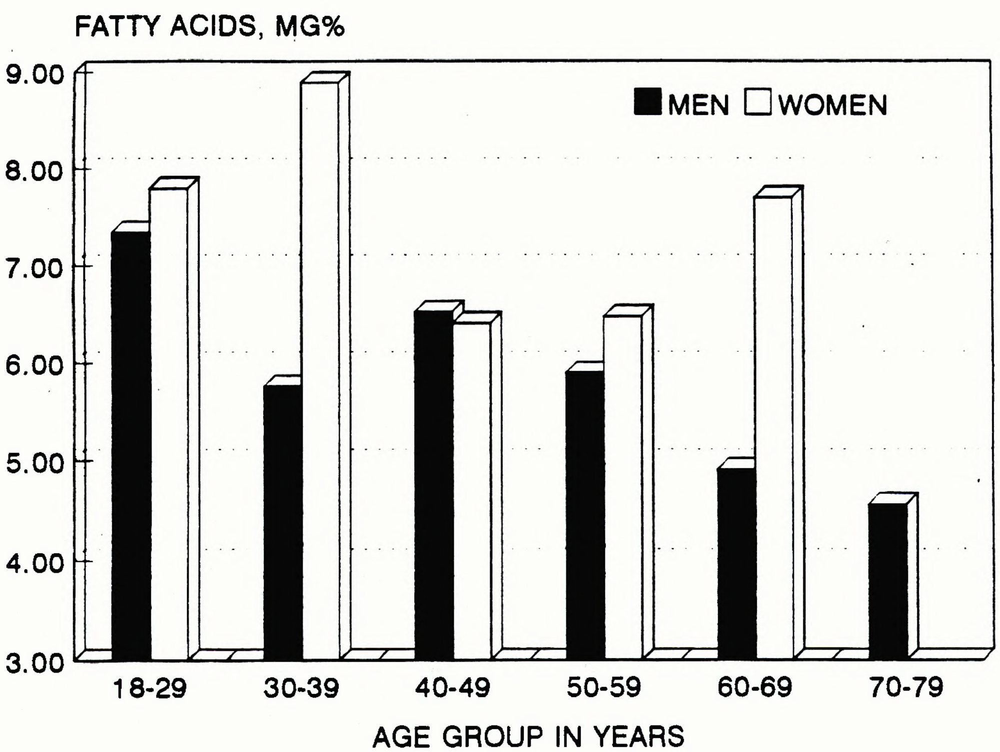


Figure 28. Plasma fatty acid levels in Inuit men women aged 18-79 years.

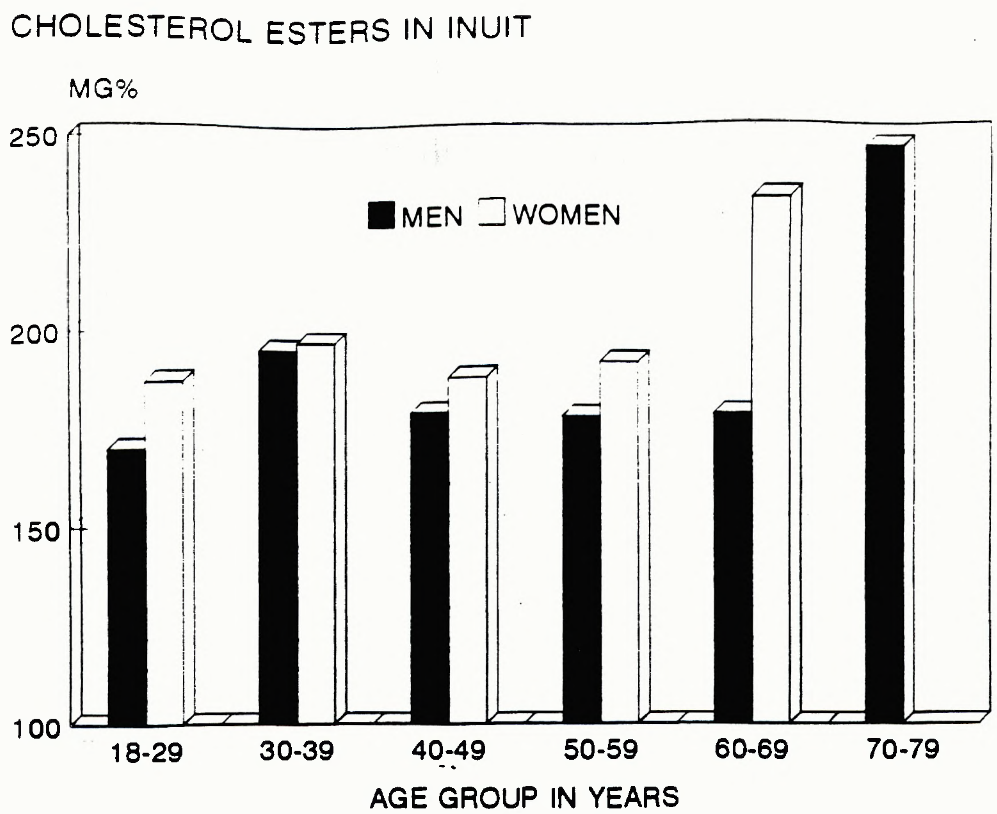


Figure 29. Plasma cholesterol ester levels in Inuit men and women aged 18-79 years.

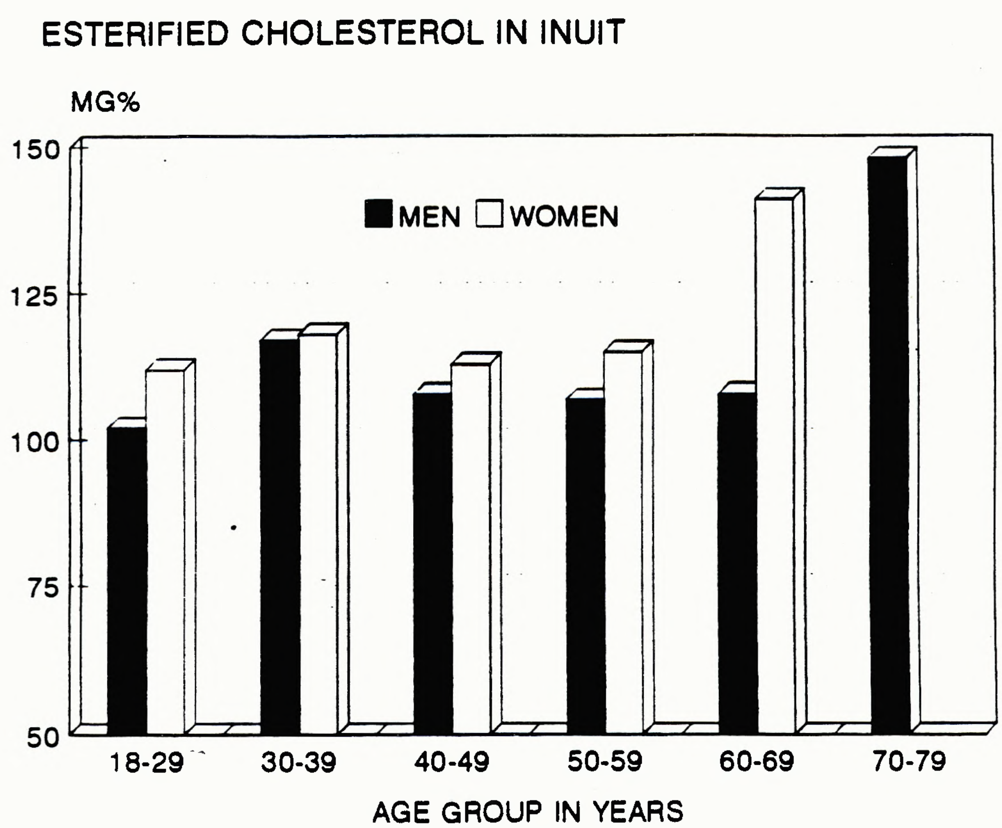


Figure 30. Plasma esterified cholesterol levels in Inuit men and women aged 18-79 years.

DIGLYCERIDE + CERAMIDE IN INUIT

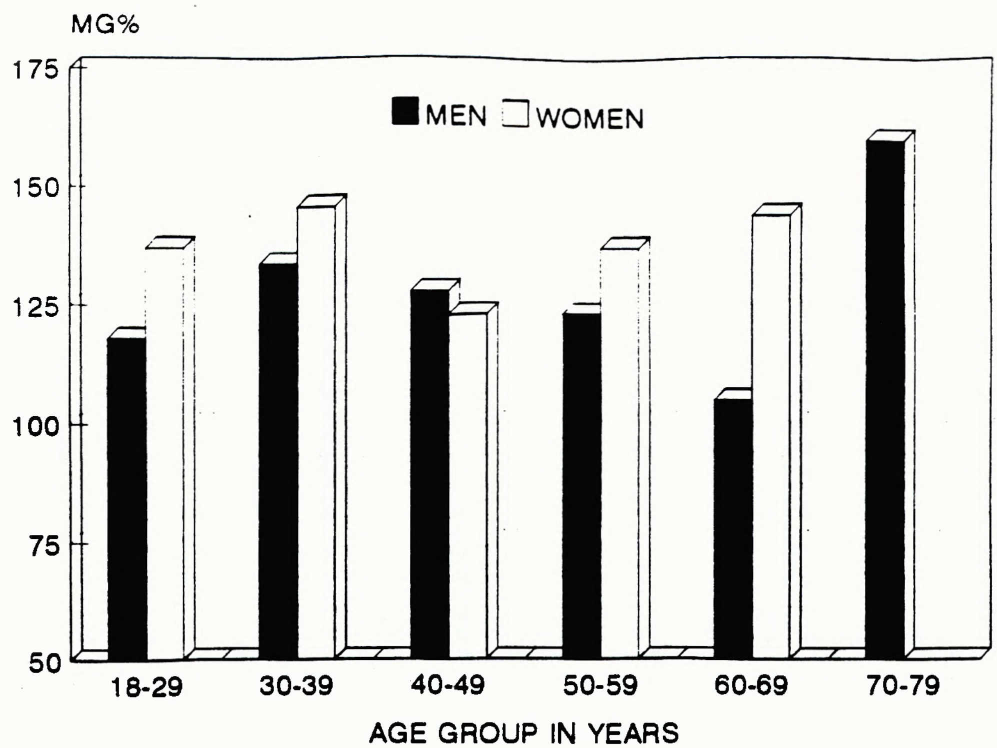


Figure 31. Plasma diglyceride + ceramide levels in Inuit men and women aged 18-79 years.

TOTAL PHOSPHOLIPIDS IN INUIT

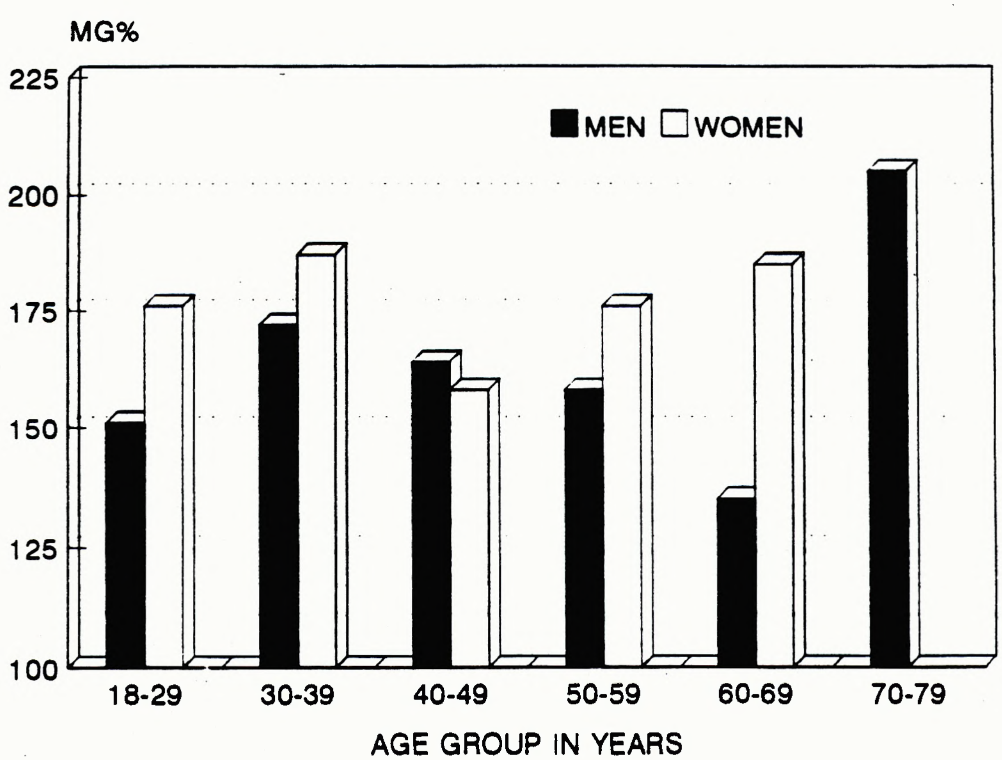


Figure 32. Total plasma phospholipid levels in Inuit men and women aged 18-79 years.

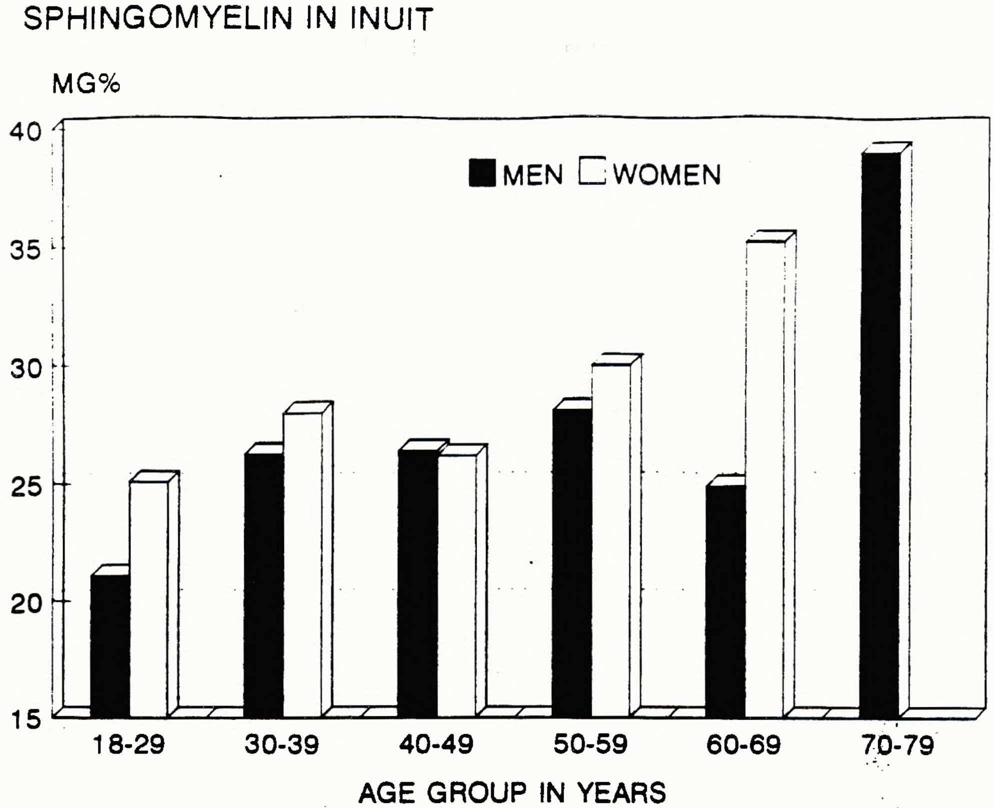


Figure 33. Plasma sphingomyelin levels in Inuit men and women aged 18-79 years.

3.3.2 Comparison of Plasma Lipids in Inuit and nGanasan

a) **Results for Men**. A 2-way ANOVA was used to compare the mean lipid profiles of the Inuit and nGanasan men aged 18-29, 30-39, 40-49 and 50-59 years, these being the age categories that were common to both groups of men. The analysis looked for group differences, the effect of age, and group*age interaction. Unless stated otherwise, all references to an ANOVA in this section conform to the above format.

b) **Results for Women**. Data was analysed as for the men above but the ANOVA was based on the 3 age groups common to both Inuit and nGanasan women, 18-29, 30-39 and 40-49 years.

1. Total Lipids (Table 20, Fig. 34)

a) **Men**. Total plasma lipids were similar in the Inuit and nGanasan, showing little change with age. The ANOVA confirmed that there were no significant differences between the two groups of men. The mean total lipid concentrations for all Inuit and nGanasan men aged 18-59 years were (434±124) and (417±104)mg% respectively; the 4.8% difference was not statistically significant.

b) **Women**. As in the men, the ANOVA did not reveal any significant differences between the two groups of women. The mean values for all Inuit and nGanasan women aged 18-49 years were (464±116) and (415±127)mg%, respectively; the 11.8% difference was not statistically significant.

2. Total Cholesterol (Table 21, Fig. 35)

a) **Men**. The ANOVA did not show any significant differences between the 2 groups. However, from age 18-29 to 30-39 years both the Inuit and nGanasan men showed significant increases in total cholesterol of 15.7% ($p=0.041$) and 26% ($p=0.052$) respectively. The 7.2% difference in the mean values for all Inuit (149±41)mg% and nGanasan (139±27)mg% men aged 18-59 years was not statistically significant.

b) **Women**. As in the men, there were no significant differences (ANOVA) in the total cholesterol levels between the two groups of women. The 9.7% difference in the mean levels for all Inuit (159±40)mg% and nGanasan (145±41)mg% women aged 18-49 years was not statistically significant.

3. **Triacylglycerol (Table 22, Fig. 36)**

a) **Men**. The ANOVA did not reveal any significant differences between the Inuit and nGanasan men. The 5.6% difference in the values for all Inuit (54±40)mg% and nGanasan (51±39)mg% men aged 18-59 years was not statistically significant.

b) **Women**. As in the men, there were no significant differences (ANOVA) in the triacylglycerol concentrations between the 2 groups. The 30% difference in the values for all Inuit (52±25)mg% and nGanasan (40±32)mg% women aged 18-49 years was not statistically significant.

4. **Free Cholesterol (Table 23, Fig. 37)**

a) **Men**. The ANOVA revealed a significant age effect (p=0.043), but there was no significant group difference or group*age interaction. From age 18-29 to 30-39 years both the Inuit and nGanasan showed significant increases in free cholesterol levels of 18% (p=0.015) and 25% (p=0.029), with a statistically insignificant trend to decreases thereafter to age 50-59 years. The mean values for all Inuit (41±11)mg% and nGanasan (39±7)mg% men aged 18-59 years were essentially similar.

b) **Women**. The ANOVA did not reveal any significant differences in free cholesterol between the 2 groups of women. However, as in the men, both the Inuit and nGanasan women tended to increases of 9.3% (NS) and 55.6% (NS) from age 18-29 to 30-39 years, with subsequent decreases to age 40-49 years. The 7% difference in mean free cholesterol values between all Inuit (44±10)mg% and all nGanasan (41±11)mg% women aged 18-49 years was not statistically significant.

5. **Phosphatidyl Choline (Table 24, Fig. 38)**

a) **Men**. The ANOVA did not show any significant inter-group differences, age effect, or group*age interaction. The marginally significant age effect (p=0.073) was due to the significant decrease of phosphatidyl choline with age in the Inuit men, as described on page 62. The nGanasan, in contrast, showed a sharp 29% increase (p=0.026) from age 18-29 to 30-39 years, no change at 40-49 years, followed by a trend to a 25% (NS) decrease at age 50-59 years.

The mean concentrations of phosphadityl choline for all Inuit and nGanasan men aged 18-59 years were essentially similar, with respective values of (106±37) and (109±29)mg%.

b) **Women.** The ANOVA did not reveal any significant differences of phosphatidyl choline between the two groups. However, the nGanasan women, like the nGanasan men, showed a steep and statistically significant (61%, p=0.019) increase from age 18-29 to 30-39 years, followed by a trend to a 26% (NS) decrease at age 40-49 years. For the Inuit women aged 18-49 years, Fig.38 suggests there was a progressive decrease of phosphatidyl choline levels with age. This trend was marginally significant (p=0.057) for Inuit women aged 18-59 years, as seen on page 62.

The 14.7% difference in values between all Inuit (125±36)mg% and all nGanasan (109±36)mg% women aged 18-49 years was not statistically significant.

6. The Phosphatidyl Choline/Free Cholesterol Ratio (PC/FC) (Table 25, Fig. 39)

a) **Men.** The ANOVA showed no significant differences in the PC/FC ratio between the Inuit and nGanasan men. The progressive decrease of the PC/FC ratio with age in the Inuit men suggested in Fig. 39 is discussed on page 62. There was no difference in the PC/FC ratios between all Inuit (1.38±0.89) and all nGanasan (1.38±0.24) men aged 18-59 years.

b) Women. As in the men, the ANOVA did not reveal any significant inter-group difference, age effect, or age*group interaction. However, as in the men, the Inuit women showed a progressive decrease in the PC/FC ratio with age, also discussed more fully on page 62. The mean PC/FC ratios for all Inuit and nGanasan women were (1.41±0.27) and (1.32±0.20), respectively; the 6.8% difference was not statistically significant.

7. Monoglycerides (Table 26, Fig. 40)

a) **Men.** The ANOVA did not show any significant differences between the two groups. The 3.5% difference between the mean values between all Inuit (1.80±1.31)mg% and all nGanasan (1.74±0.62)mg% men aged 18-59 years was not statistically significant.

b) **Women.** As in the men, there were no significant differences in the monoglyceride levels between the two groups of women. The mean values for all Inuit and nGanasan women aged 18-49 years were (1.53±1.09) and (1.26±0.75)mg%, respectively; the 21% difference was not statistically significant.

8. Total Fatty Acids (Table 27, Fig. 41)

a) **Men.** Figure 41 shows that at all ages, the Inuit men had markedly higher total fatty acid levels than their nGanasan peers. The ANOVA confirmed that the differences between the two groups were highly significant ($p=0.000$), with no age effect, or group*age interaction.

The levels were higher in the Inuit, by 185 ($p<0.001$), 419 ($p<0.001$), 920 ($p<0.001$), and 111% ($p=0.006$) at ages 18-29, 30-39, 40-49, and 50-59 years respectively.

The mean total fatty acid concentrations for all Inuit and all nGanasan men aged 18-59 years were (6.53 ± 4.47) and (2.03 ± 1.80)mg%, respectively; the 222% difference was highly significant ($p<0.001$).

b) **Women.** The overall pattern of fatty acids in the women was similar to that seen in the men, above. The ANOVA showed a highly significant difference ($p=0.004$) between the 2 groups of women, with no age effect or group*age interaction. The levels were higher in the Inuit women by 185 ($p<0.001$), 278 ($p<0.001$), and 345% ($p=0.051$) at ages 18-29, 30-39, and 40-49 years respectively.

The mean total fatty acid concentrations for all Inuit and all nGanasan women ageg 18-49 years were (7.93 ± 4.54) and (2.43 ± 1.88)mg%, respectively; the 226% difference was highly significant ($p<0.001$).

9. Cholesterol Esters (Table 28, Fig. 42)

a) **Men.** Figure 42 shows that from age 18-29 to 30-39 years, both the Inuit and nGanasan men had marginally significant increases in cholesterol esters, with respective increases of 15 ($p=0.066$) and 25% ($p=0.068$). However, the ANOVA did not reveal any significant overall differences between the 2 groups of men.

The 7.8% difference in cholesterol ester levels for all Inuit (179 ± 53)mg% and all nGanasan (166 ± 35)mg% men aged 18-59 years was not statistically significant.

b) **Women.** The ANOVA did not reveal any significant differences between the two groups. The 9.1% difference in the mean values for all Inuit (191 ± 50)mg% and all nGanasan (175 ± 50)mg% women aged 18-49 years was not statistically significant.

10. Esterified Cholesterol (Table 29, Fig. 43)

a) **Men.** Inspection of the data indicated that the esterified cholesterol concentrations were essentially similar in both groups, with no significant inter-group differences in any of the age groups. The ANOVA confirmed this initial analysis. The 8.0% difference in the mean values for all Inuit (108±32)mg% and all nGanasan (100±21)mg% men aged 18-59 years was not statistically significant.

b) **Women.** The ANOVA did not reveal any significant differences between the two groups. The 8.6% difference in the mean values for all Inuit (114±30)mg% and all nGanasan (105±30)mg% women aged 18-49 years was not statistically significant.

11. Diglyceride + Ceramide (Table 30, Fig. 44)

a) **Men.** The ANOVA did not show any significant differences between the two groups. The mean (diglyceride + ceramide) values for all Inuit and nGanasan men aged 18-59 years were essentially the same at (125±38)mg% and (126±30)mg% respectively.

b) **Women.** The ANOVA did not reveal any significant overall differences between the two groups, but the nGanasan women showed a significant 61% ($p=0.022$) increase in (diglyceride + ceramide) concentrations from age 18-29 to 30-39 years. The 10.4% difference in the mean values for all Inuit (138±36)mg% and all nGanasan (125±40)mg% women aged 18-49 years was not statistically significant.

12. Total Phospholipid (Table 31, Fig. 45)

a) **Men.** Figure 45 indicates that there was a substantial change in total phospholipid from age 18-29 to 30-39 years in both the Inuit and nGanasan, with respective increases of 13.9 ($p=0.079$) and 26.5% ($p=0.026$). However, the ANOVA did not reveal any significant overall differences between the two groups of men. The mean total phospholipid levels for all Inuit and all nGanasan men aged 18-59 years were practically the same at (160±49) and (161±38)mg% respectively.

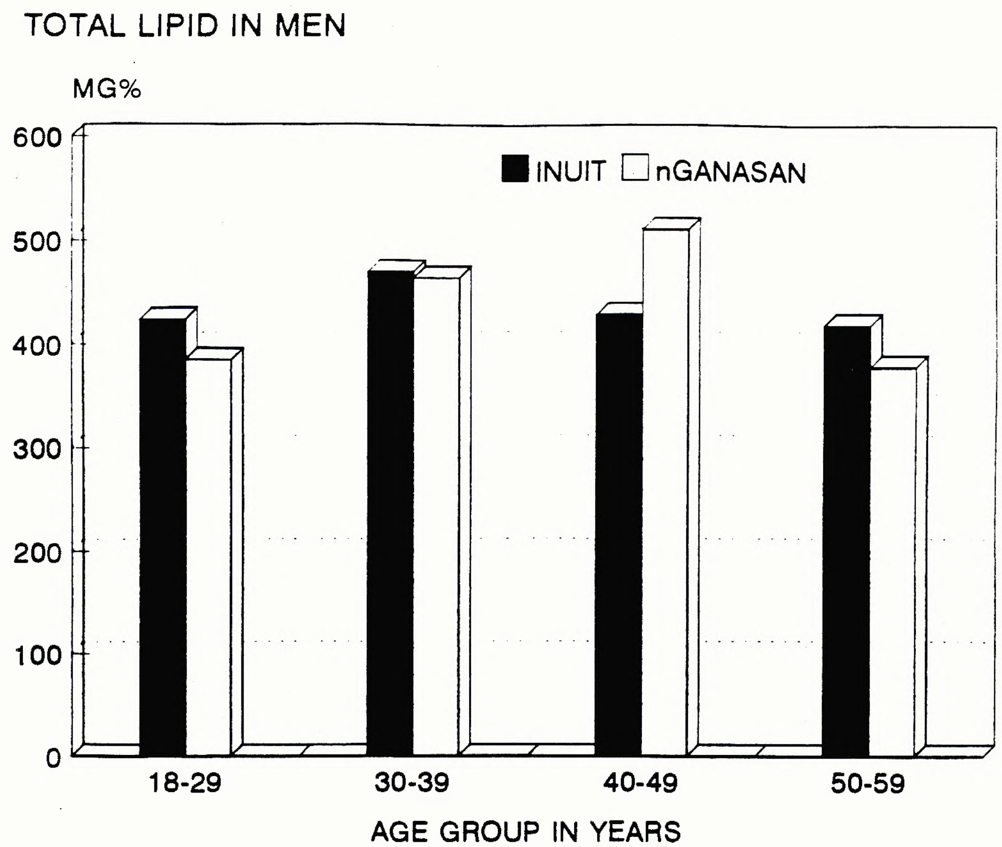
b) **Women.** The results for women were similar to those seen in the men above. From age 18-29 to 30-39 years both the Inuit and nGanasan women showed increases in total phospholipids of 6.3% (NS) and 61% ($p=0.025$) respectively. However, the ANOVA did not reveal any significant differences between the 2 groups of women. The 10.6% difference in the mean values for all Inuit (177±46)mg% and all nGanasan (160±51)mg% women aged 18-49 years was not statistically significant.

13. Sphingomyelin (Table 32, Fig. 46)

a) **Men**. Figure 46 shows that the sphingomyelin concentrations were higher in the Inuit than in the nGanasan men at all ages. From age 18-29 to 30-39 years, both the Inuit and nGanasan men showed significant increases of 24.6 ($p=0.005$) and 28.6% ($p=0.007$) respectively. The ANOVA did not show any inter-group differences or group*age interaction, but there was a highly significant age effect ($p=0.007$).

There was a significant 13.2% ($p=0.012$) difference in the mean values for all Inuit (24.8 ± 7.2)mg% and all nGanasan (21.9 ± 4.5)mg% men aged 18-59 years.

b) **Women**. The ANOVA did not show a group difference, or group*age interaction but there was a marginally significant age effect ($p=0.058$). From age 18-29 to 30-39 years both the Inuit and nGanasan women showed increases in sphingomyelin levels of 11.6 (NS) and 62% ($p=0.025$), respectively. The 12.4% difference in the mean values for all Inuit (26.3 ± 6.3)mg% and all nGanasan (23.4 ± 7.5)mg% women aged 18-49 years was not statistically significant.



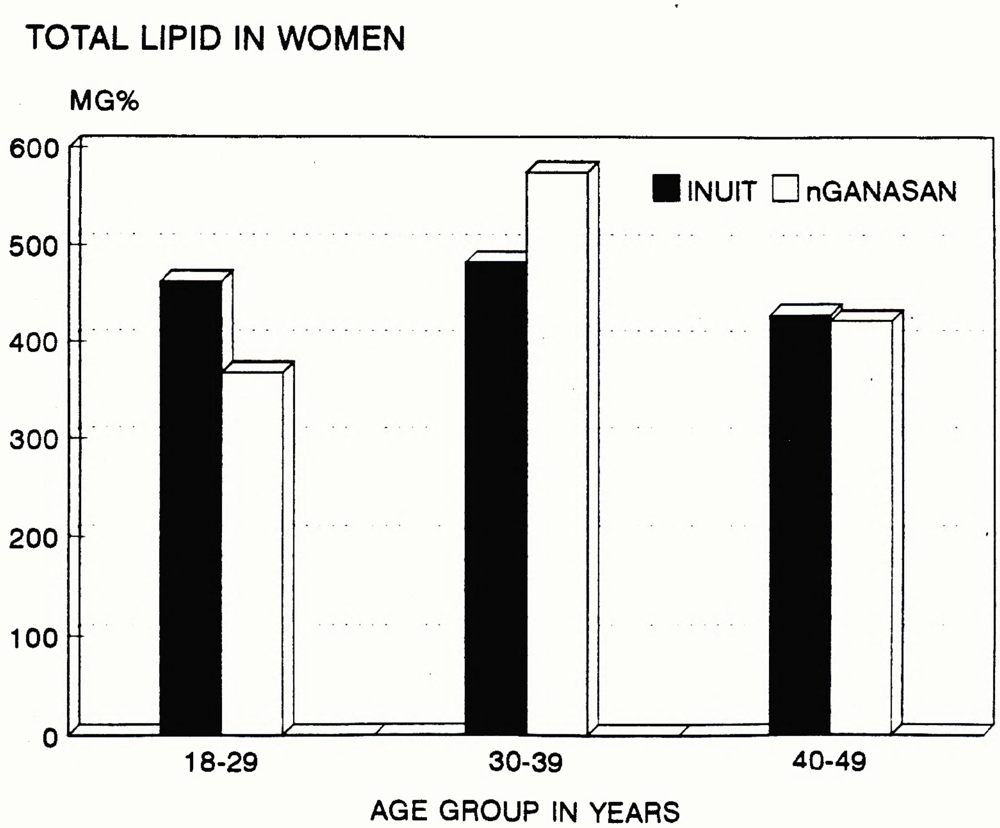


Figure 34. Total lipids in Inuit and nGanasan men and women.

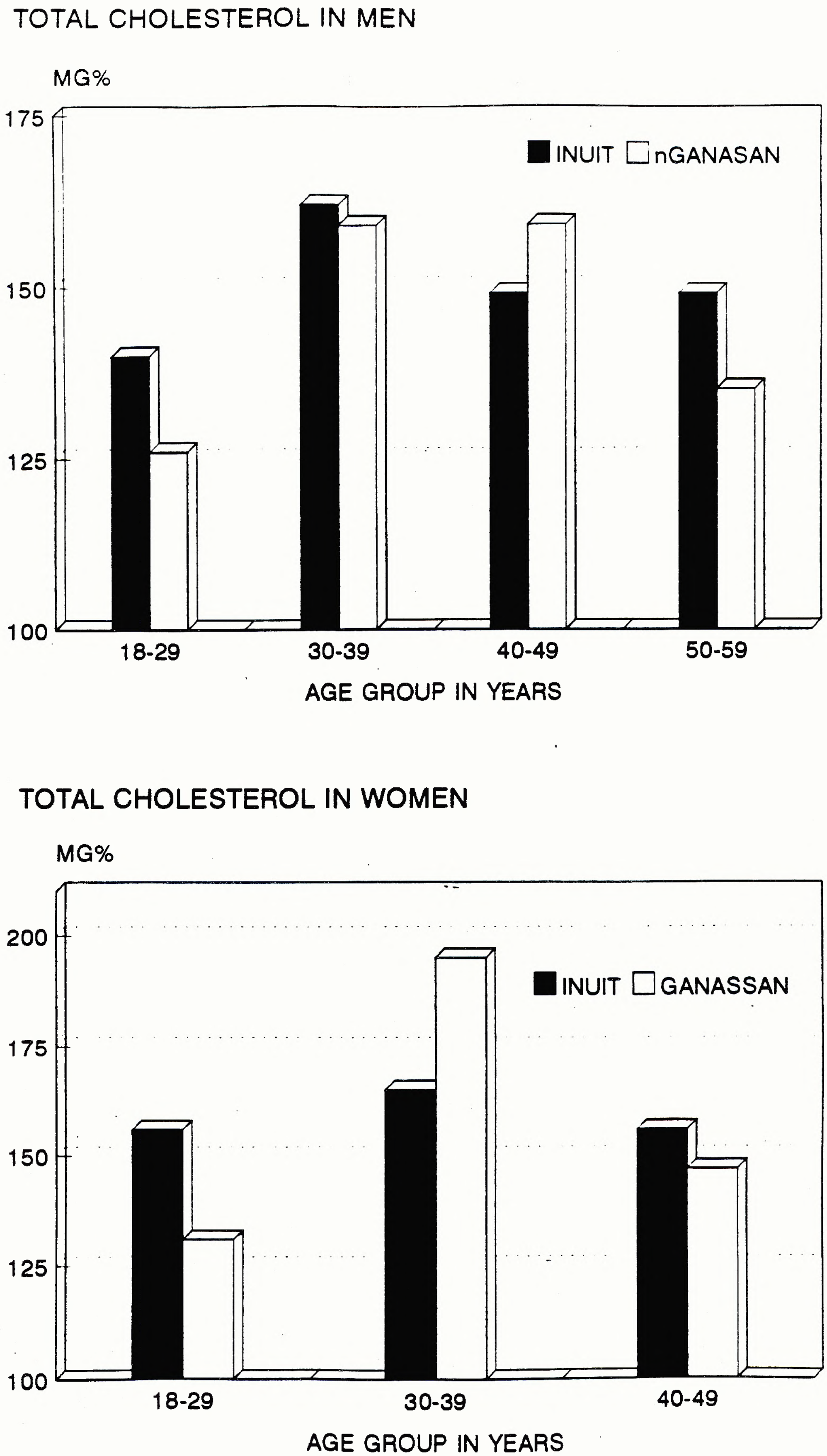
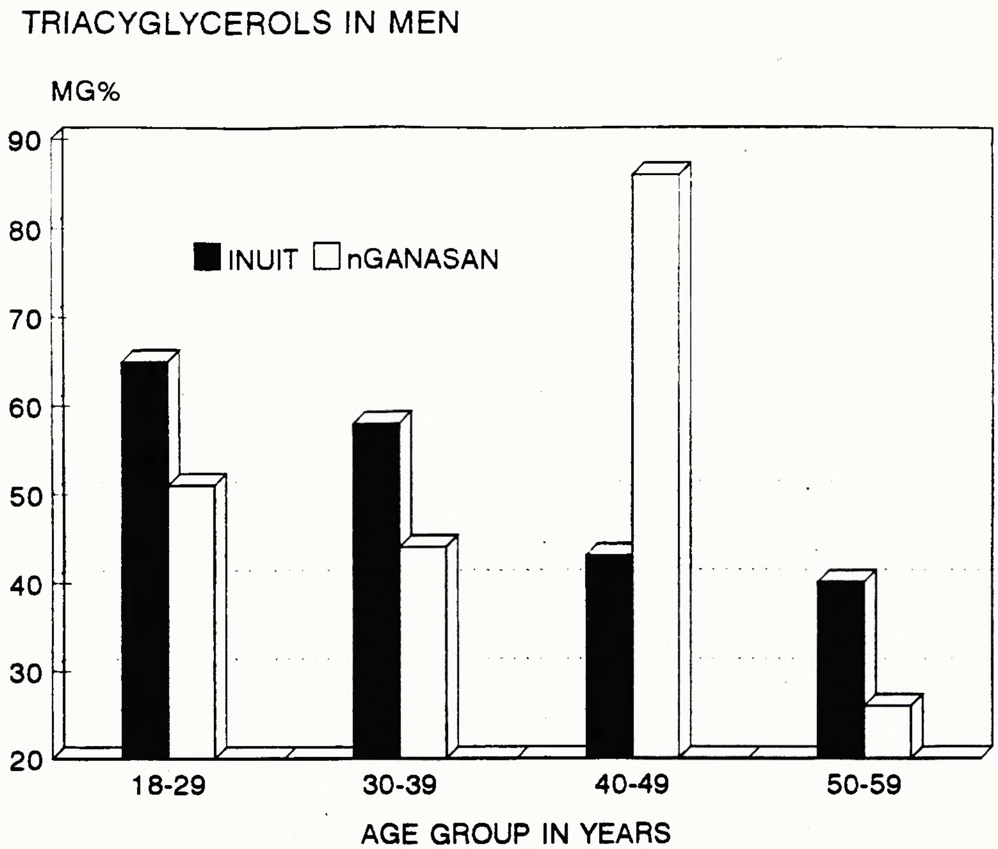


Figure 35. Total cholesterol in Inuit and nGanasan men and women.



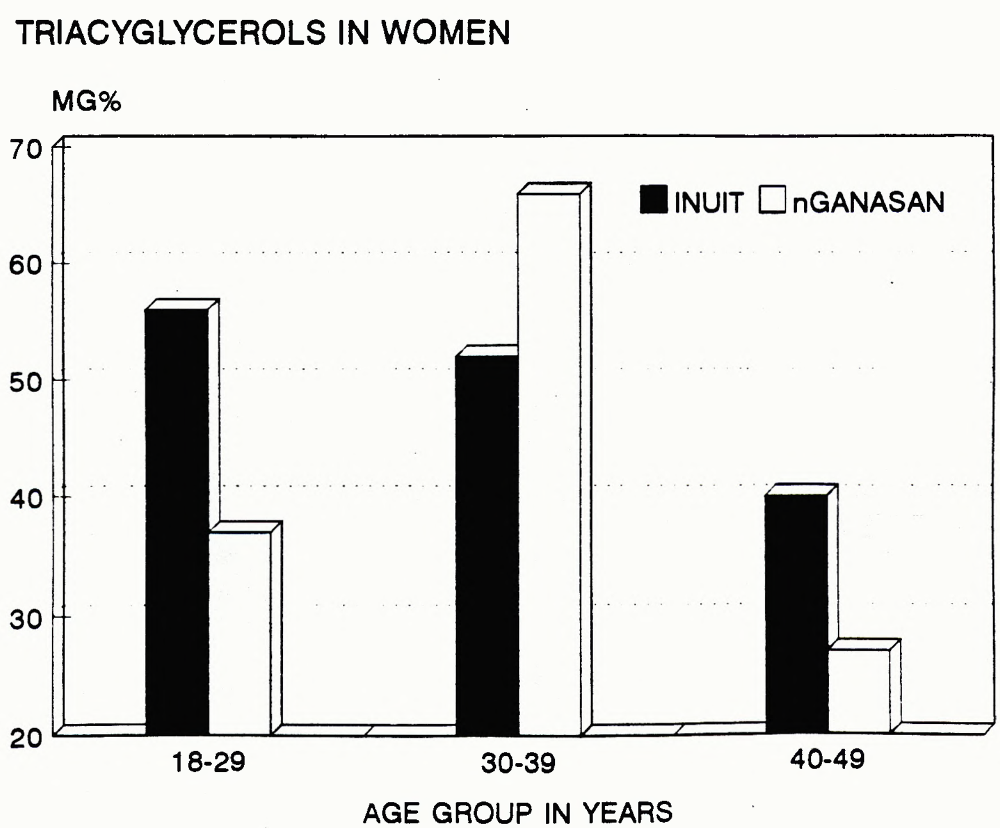
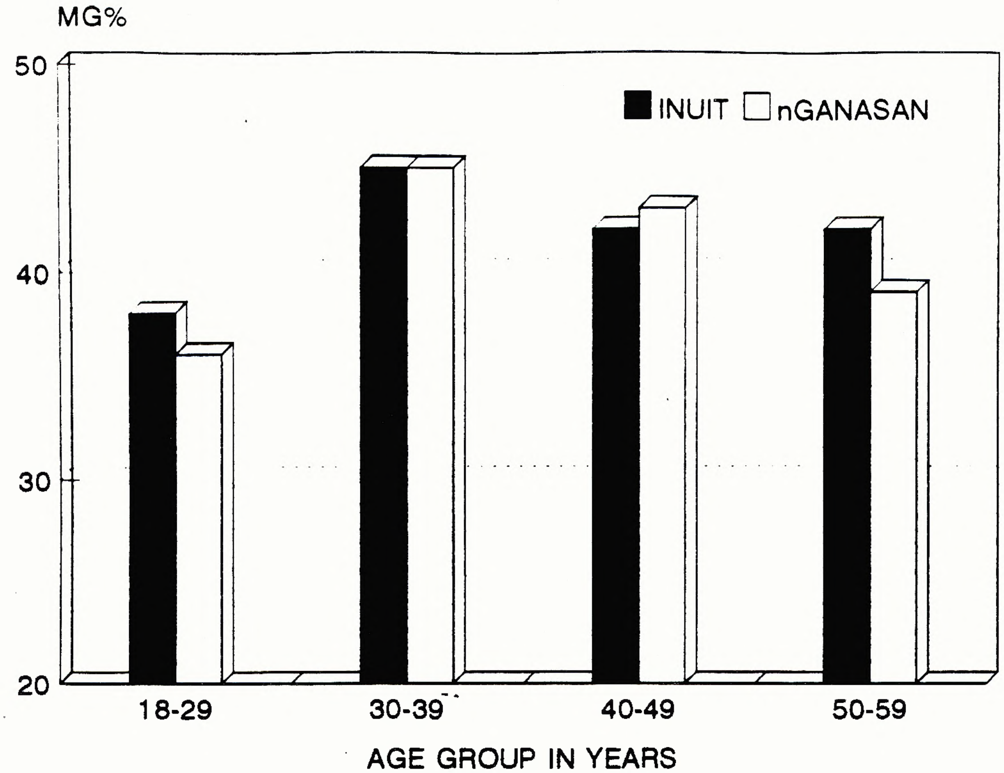


Figure 36. Triacylglycerols in Inuit and nGanasan men and women.

FREE CHOLESTEROL IN MEN



FREE CHOLESTEROL IN WOMEN

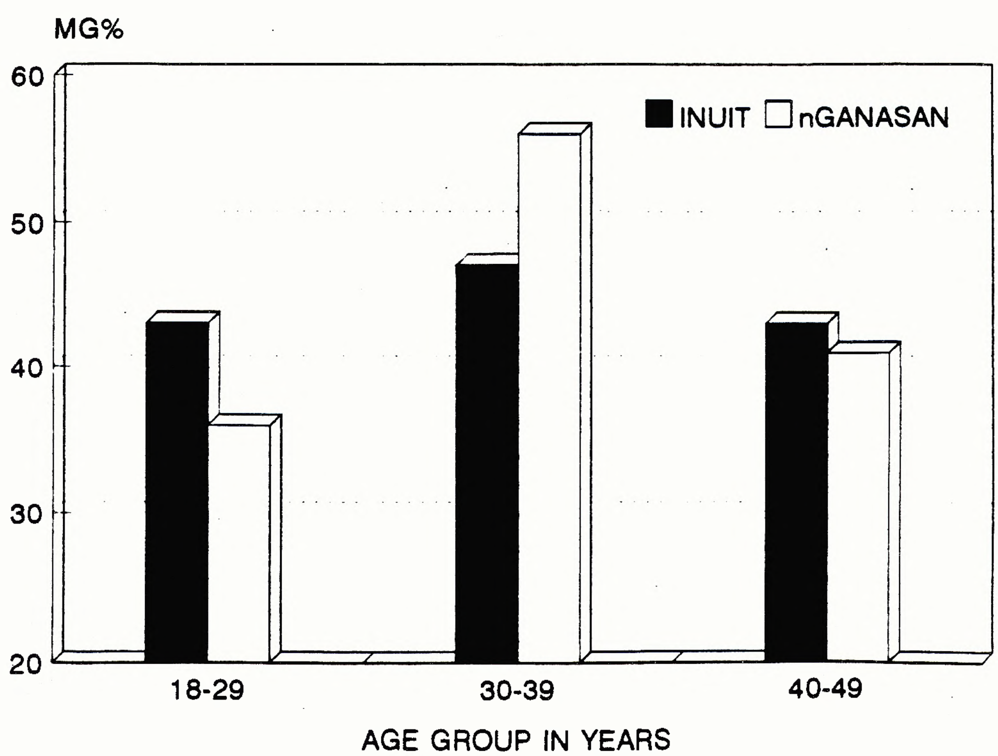
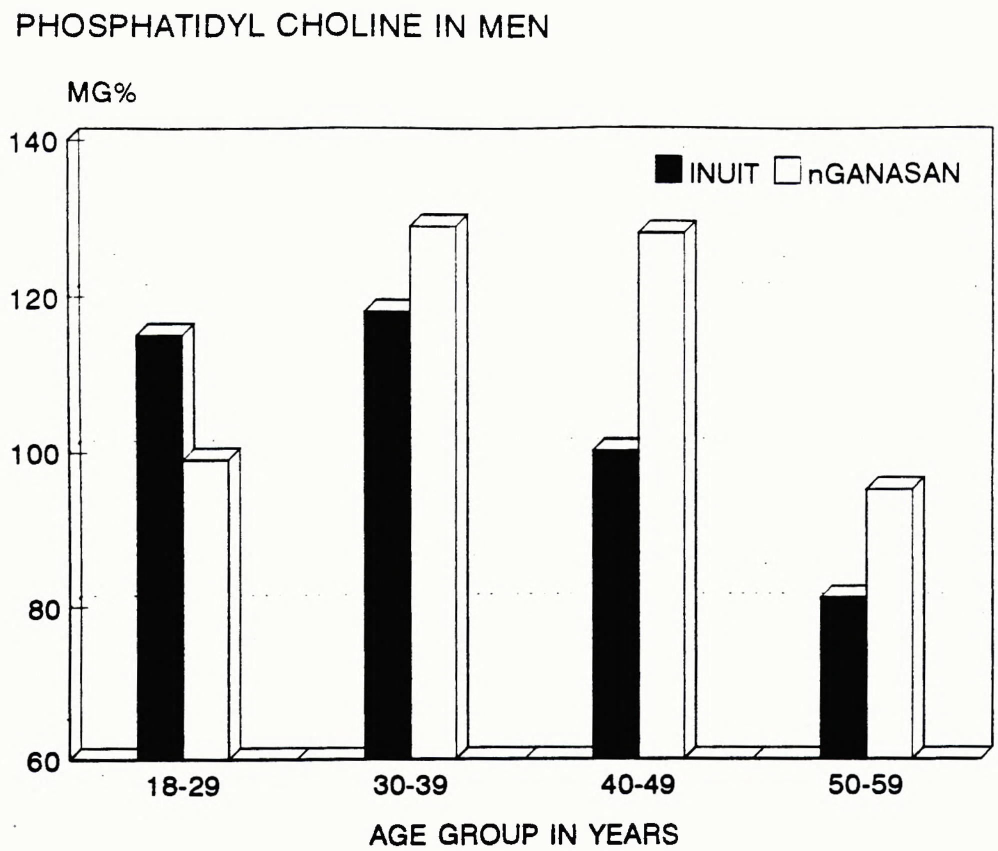


Figure 37. Free cholesterol in Inuit and nGanasan men and women.



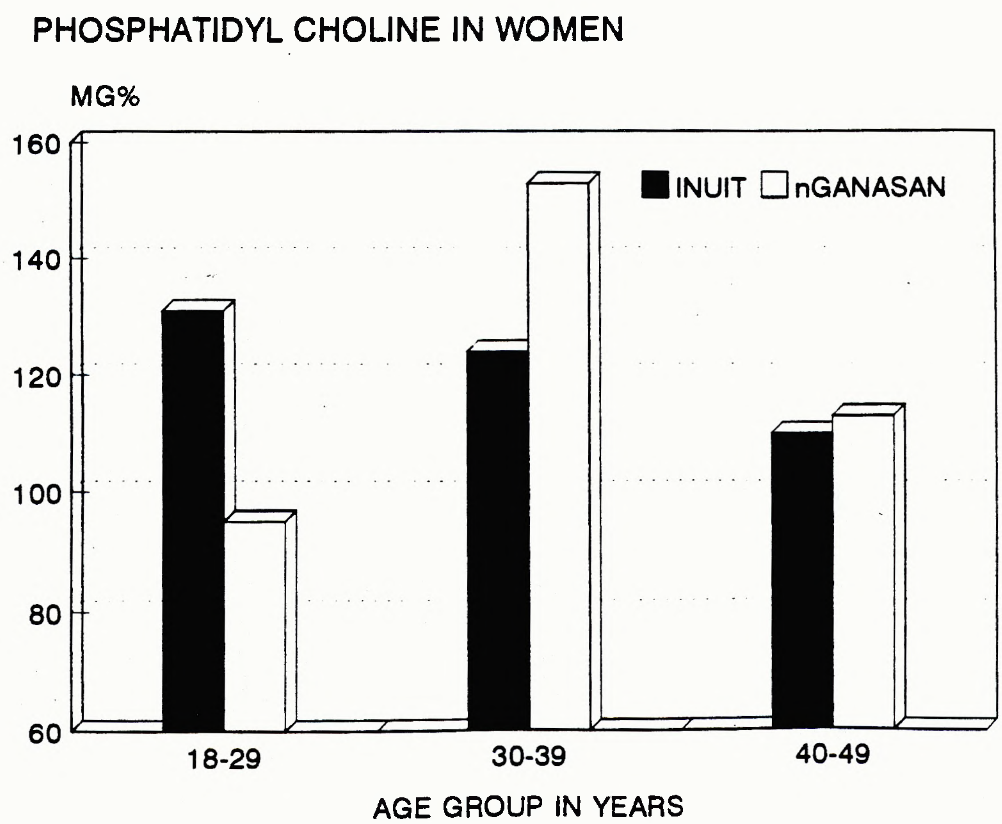
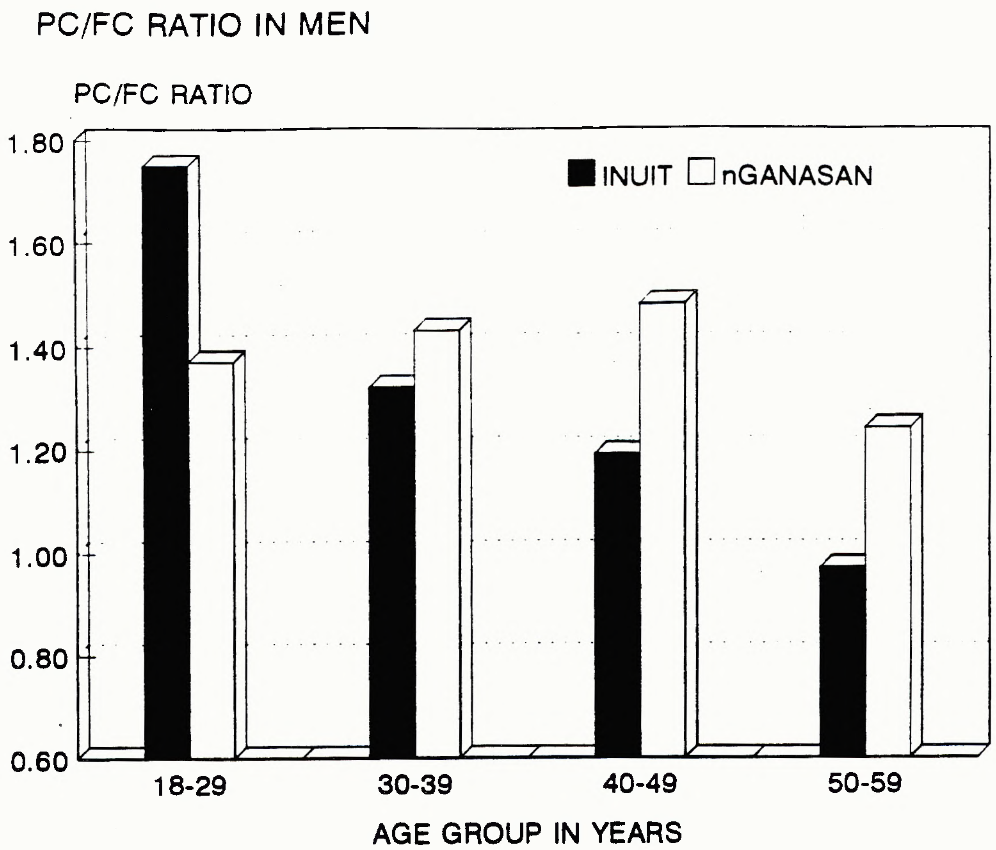


Figure 38. Phosphatidyl choline in Inuit and nGanasan men and women.



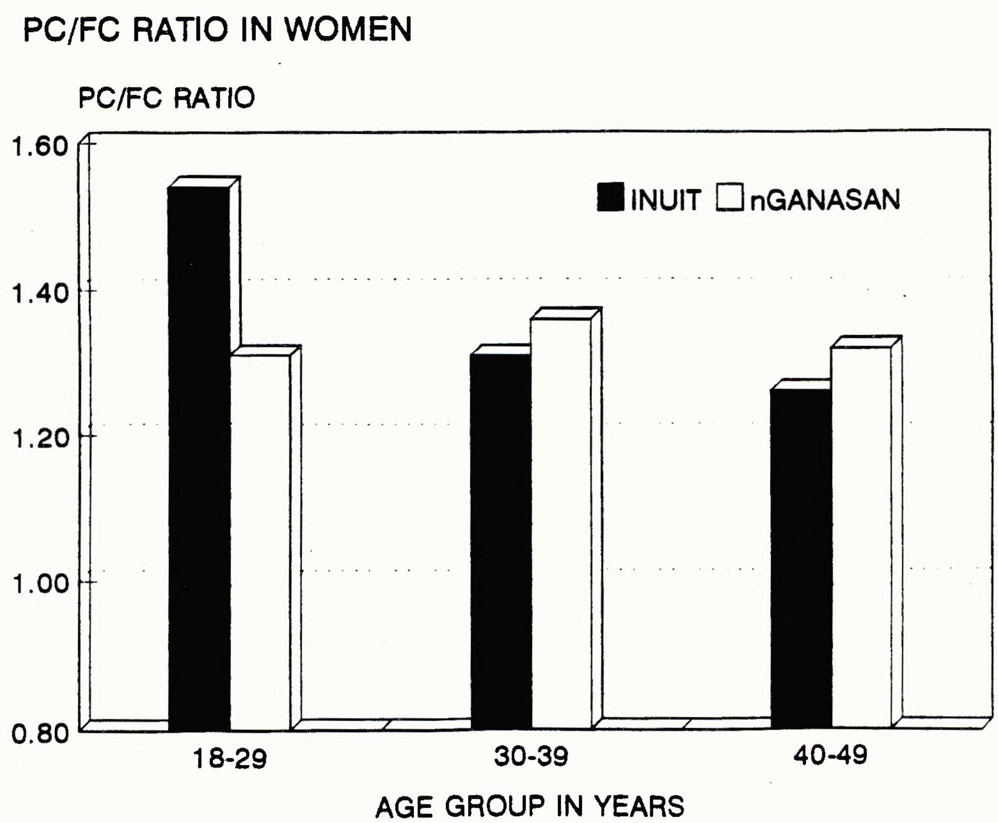
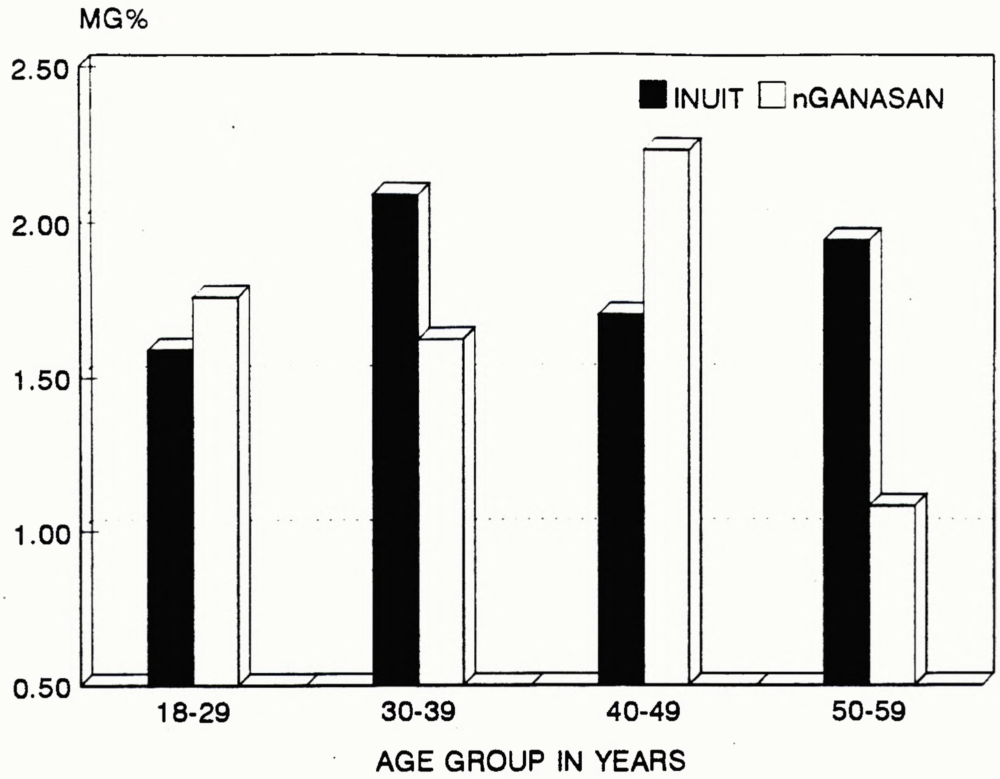


Figure 39. PC/FC ratio in Inuit and nGanasan men and women.

MONOGLYCERIDE IN MEN



MONOGLYCERIDE IN WOMEN

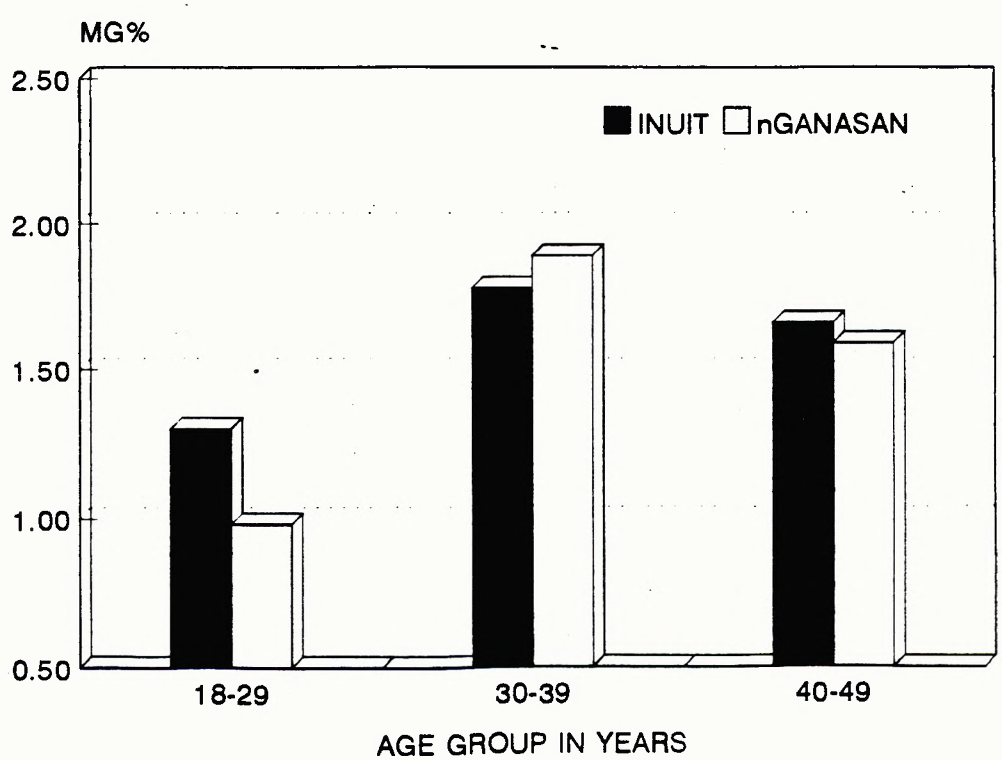
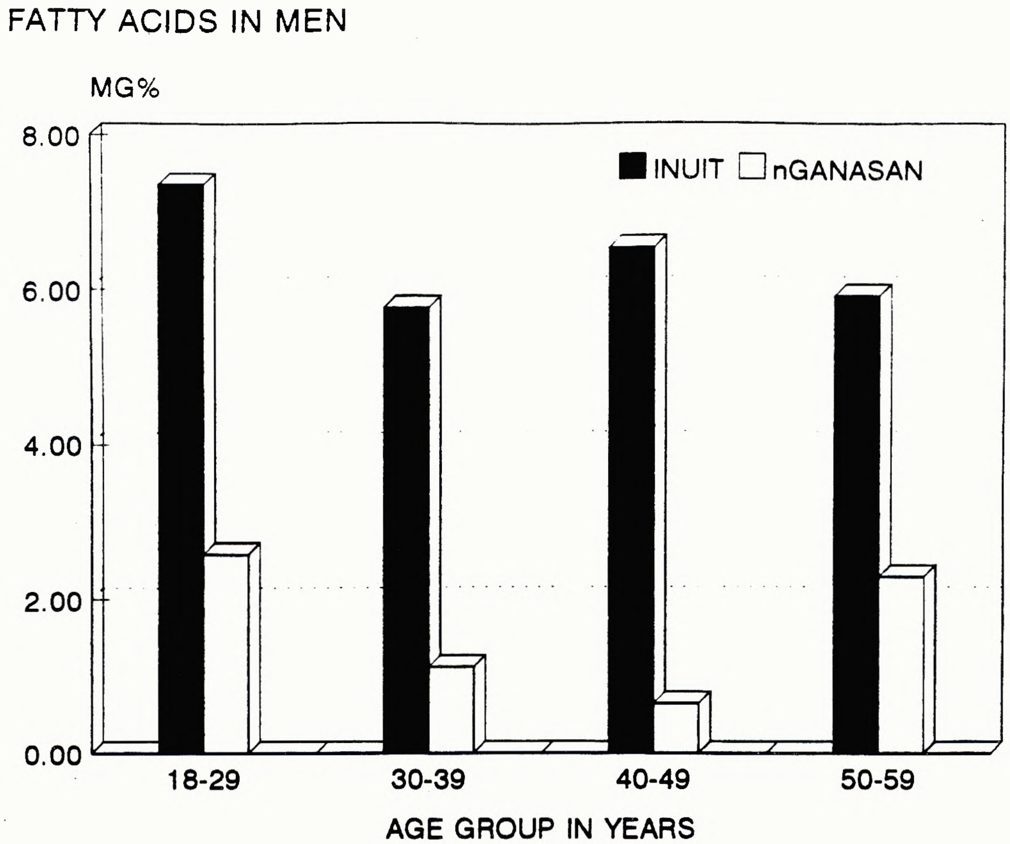


Figure 40. Plasma monoglyceride levels in Inuit and nGanasan men and women.



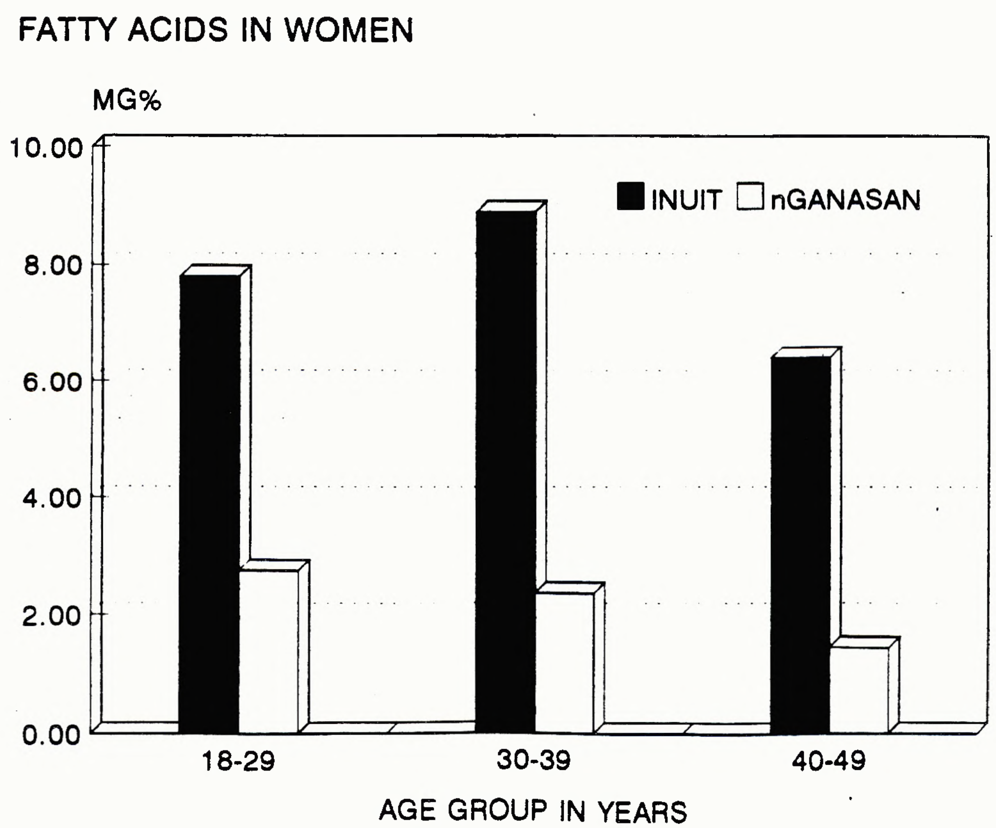
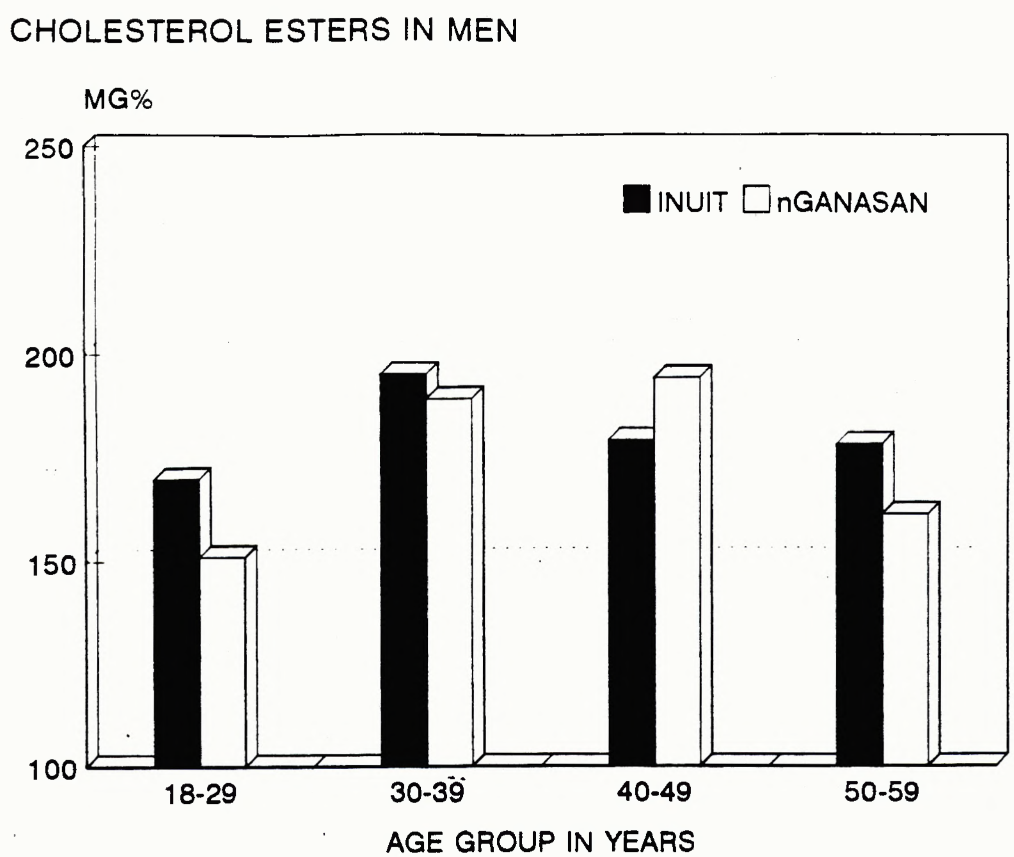


Figure 41. Plasma fatty acid levels in Inuit and nGanasan men and women.



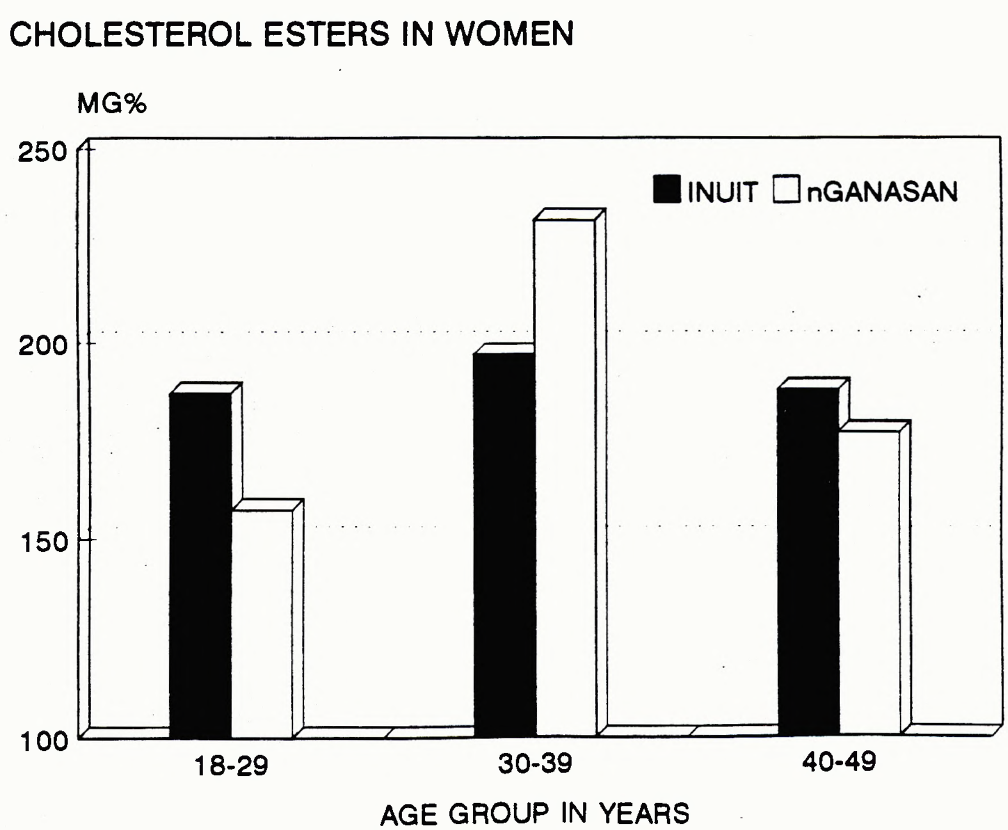
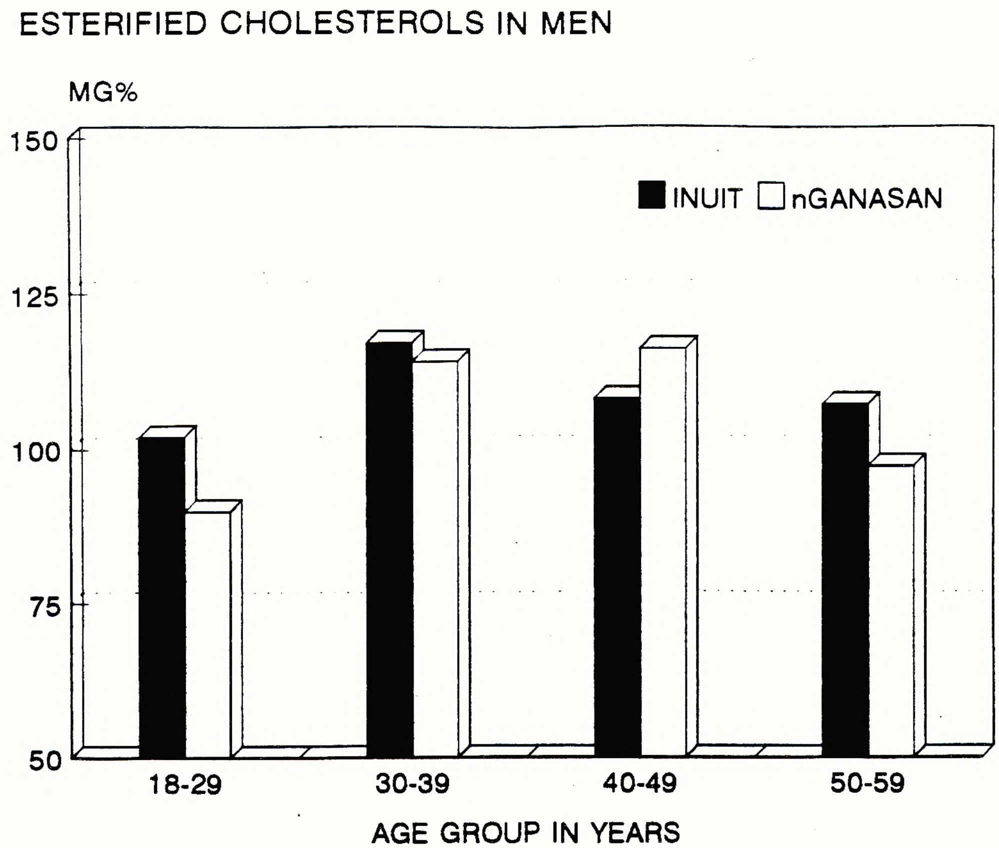


Figure 42. Plasma cholesterol ester levels in Inuit and nGanasan men and women.



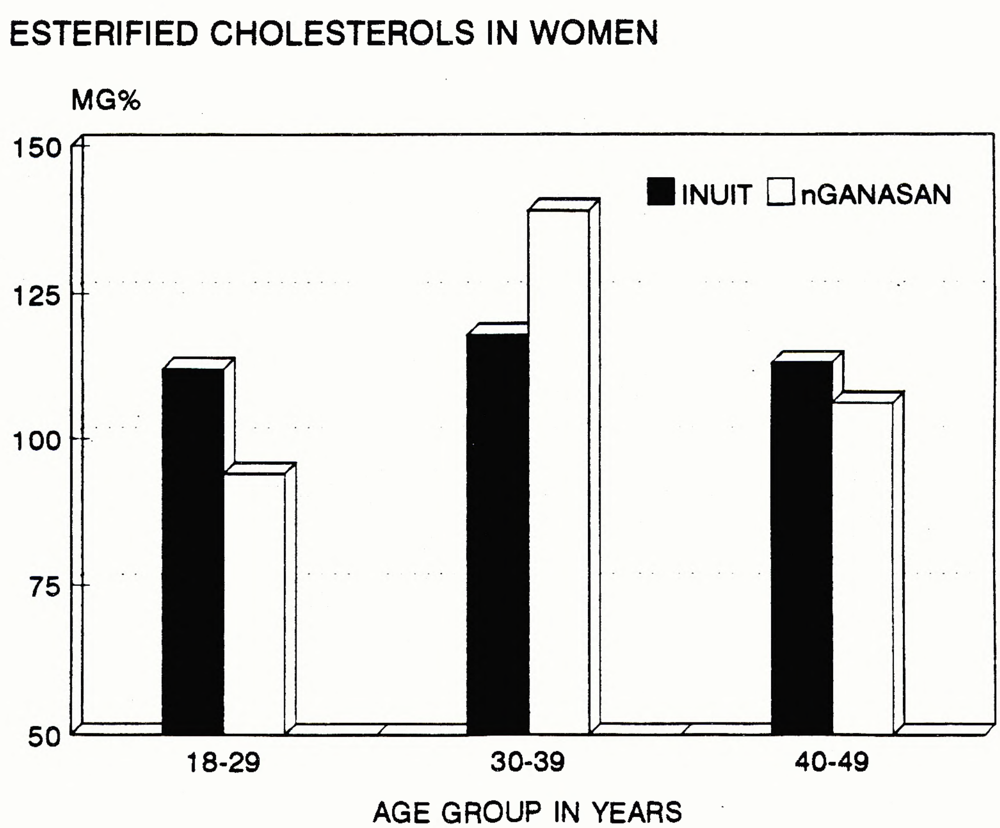
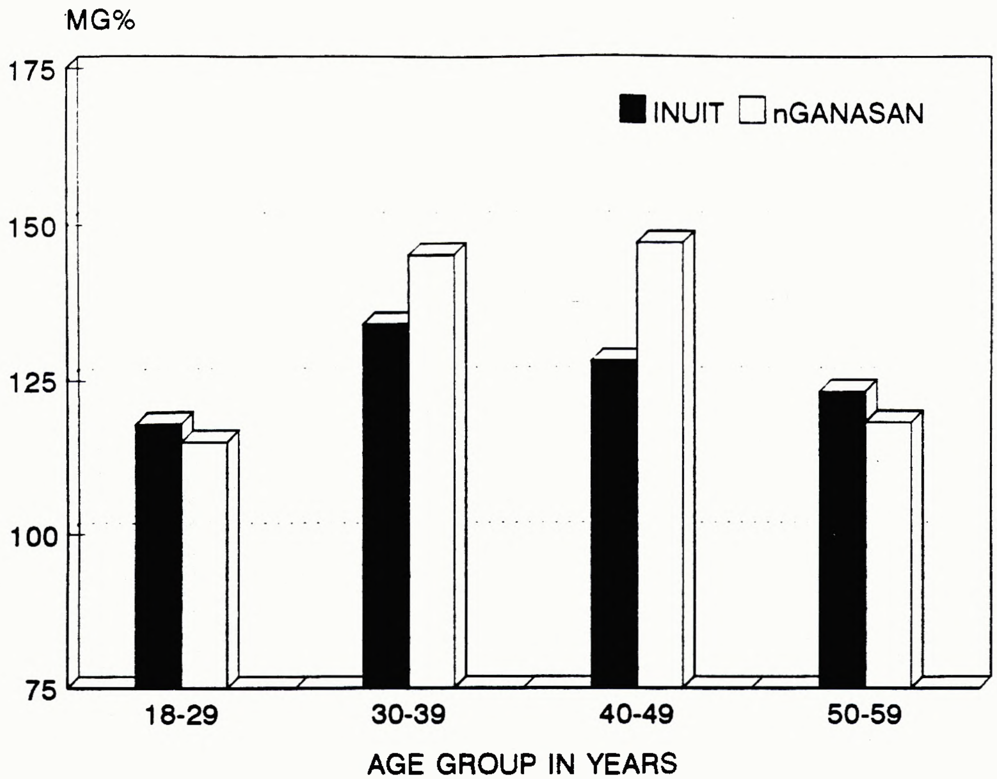


Figure 43. Plasma esterified cholesterol levels in Inuit and nGanasan men and women.

DIGLYCERIDE + CERAMIDE IN MEN



DIGLYCERIDE + CERAMIDE IN WOMEN

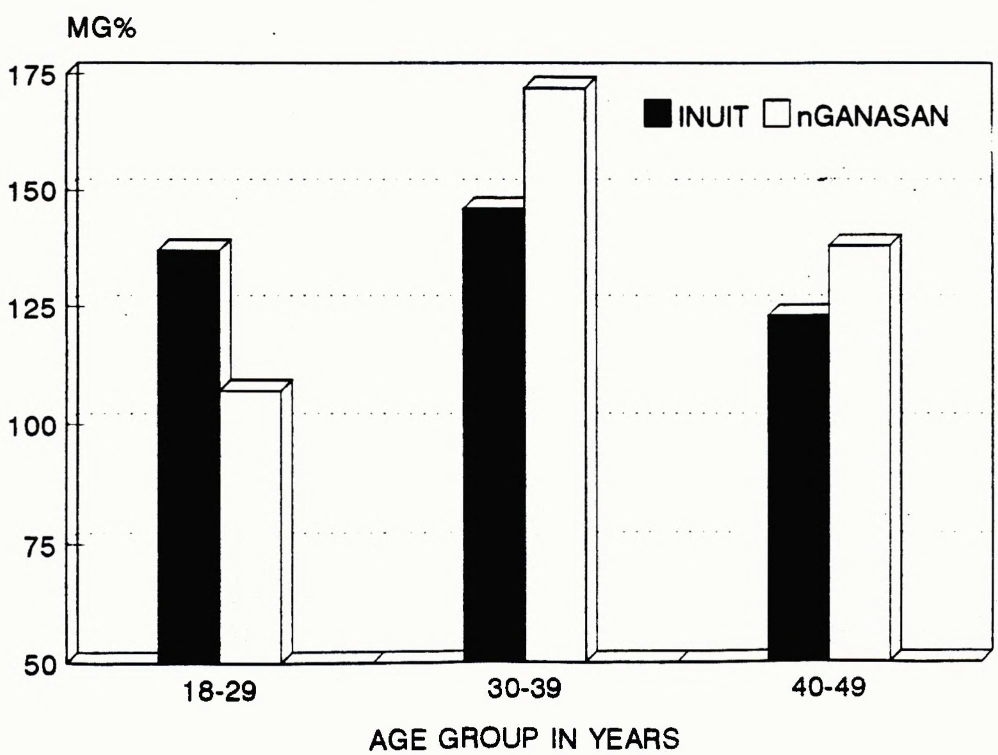
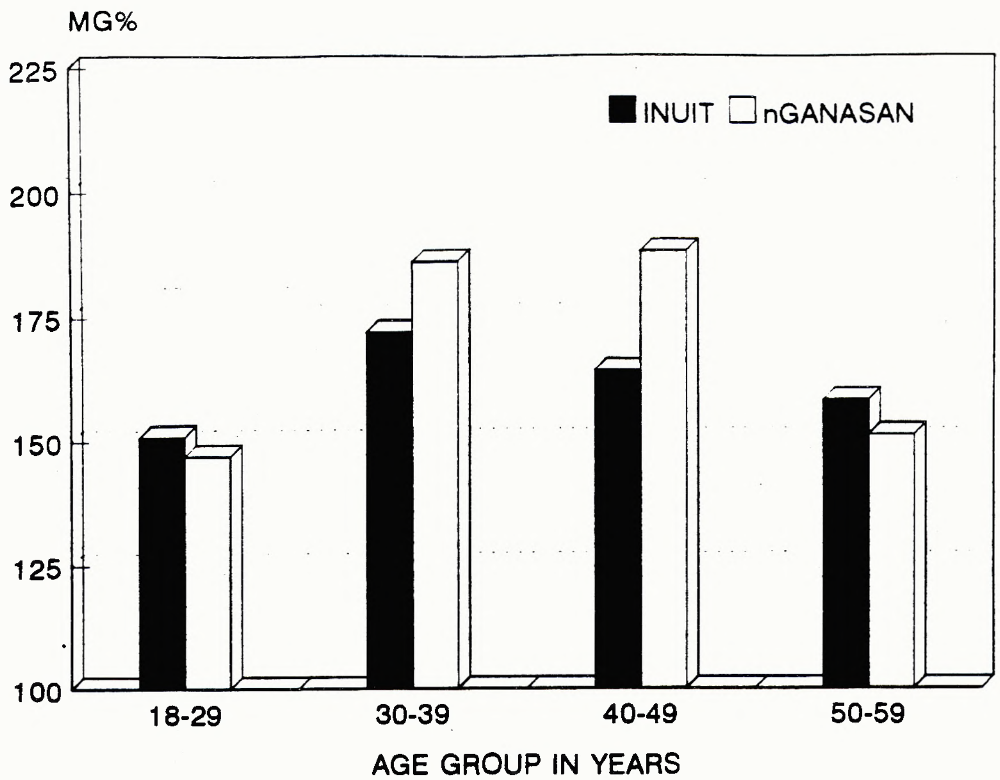


Figure 44. Plasma diglyceride + ceramide levels in Inuit and nGanasan men and women.

TOTAL PHOSPHOLIPID IN MEN



TOTAL PHOSPHOLIPID IN WOMEN

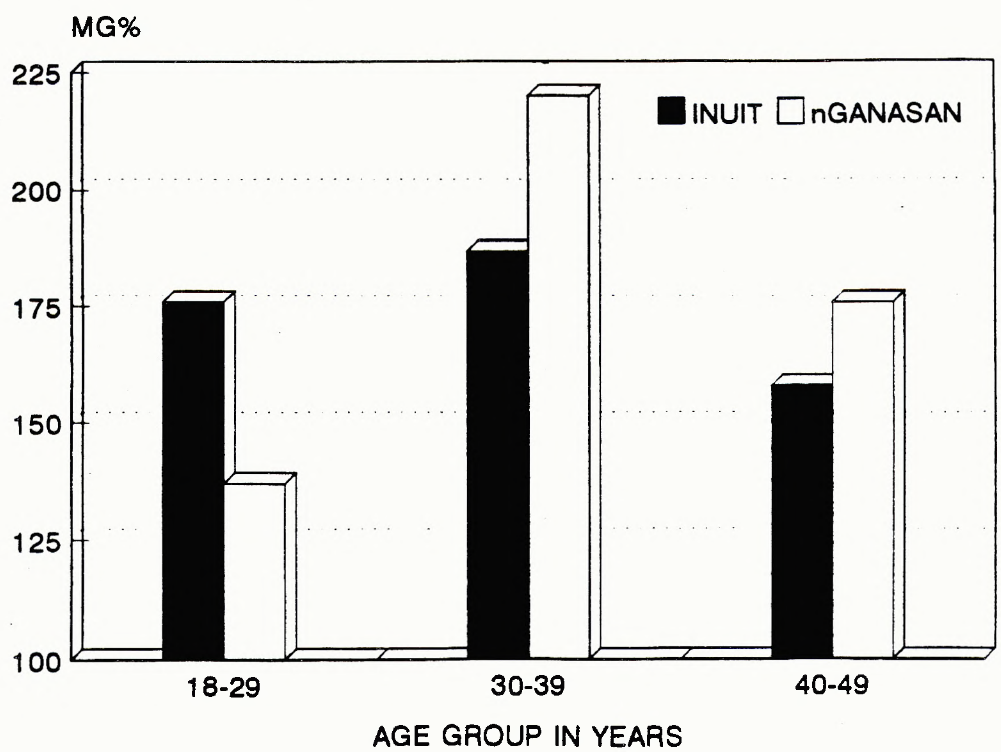
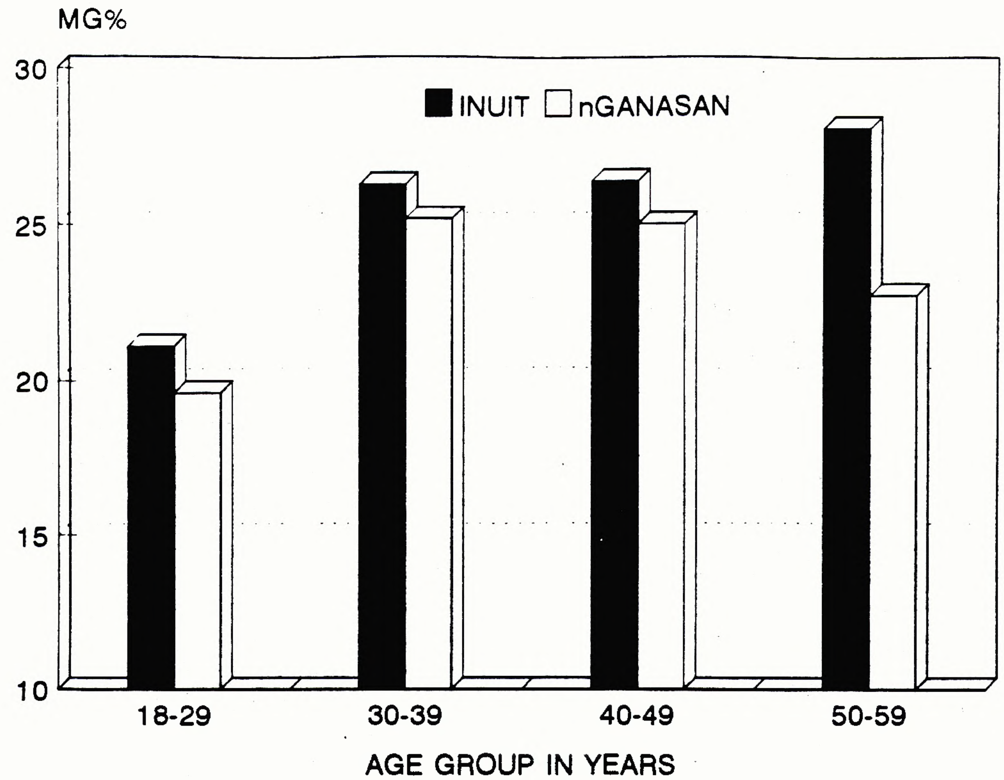


Figure 45. Plasma phospholipid levels in Inuit and nGanasan men and women.

SPHINGOMYELIN IN MEN



SPHINGOMYELIN IN WOMEN

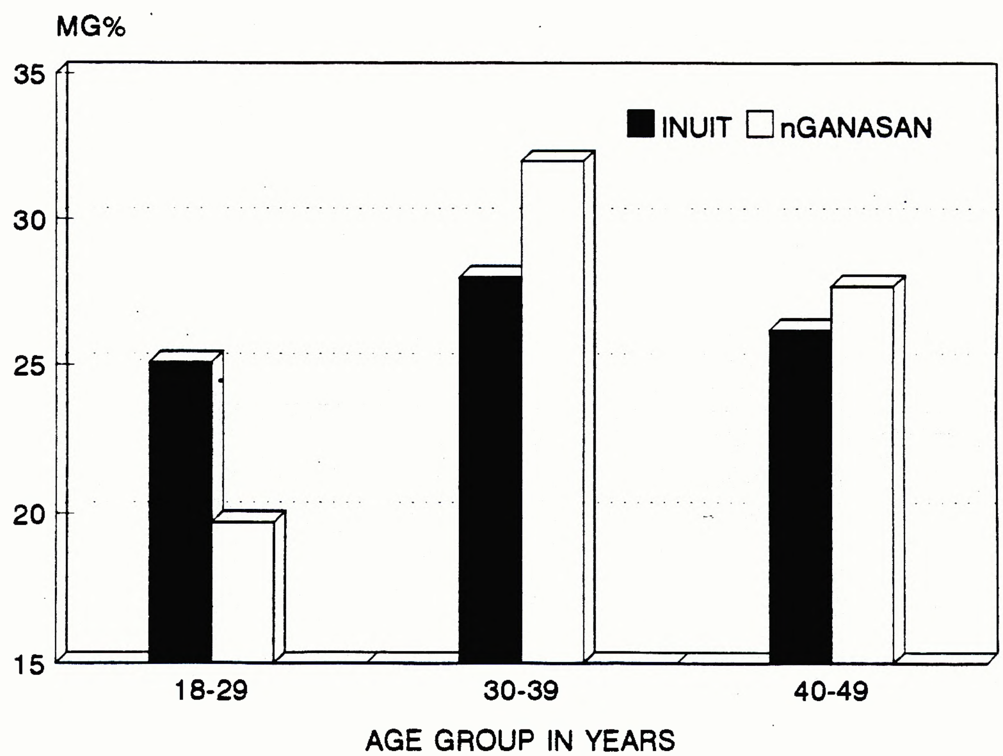


Figure 46. Plasma sphingomyelin levels in Inuit and nGanasan men and women.

3.3.3 Fatty Acid Profiles

Plasma samples were analysed for 17 fatty acids (FA). A comprehensive discussion of all of the 17 FA and their interactions is beyond the scope of this report. However, some of the commonly reported sums and ratios of the unsaturated fatty acids are described briefly below, with the summary data shown in Tables 33 to 38 and illustrated in Figures 47 to 67. Age-grouped data for all 17 of the FA in Inuit and nGanasan men and women are shown in Tables 43 to 50 in Appendix 1. Any effect of age is necessarily confounded with cohort. However, we believe that most of the differences between age groups reflect inter-generational or cohort differences.

3.3.4 Unsaturated Fatty Acids in Inuit Men and Women.

1. Omega-3 Fatty Acids (Table 33, Fig. 47)

The sum (ΣW3) of the omega-3 FA (18:3W3, 20:5W3, 22:5W3, and 22:6W3) showed a marked and progressive increase from the young to the older cohorts in both men and women. The largest increases were seen from age 18-29, through 30-49, to 50-59 years, with relatively little change thereafter. Comparing age 18-29 to 50-59 years, men and women showed an overall increase in the mean ΣW3 of 174 and 190% respectively. A one-way ANOVA of the data for men and women showed a highly significant increase ($p=0.000$) in the ΣW3 with age cohort for both sexes. A 2-way ANOVA confirmed a highly significant age effect ($p=0.000$), but did not show any sex differences or age*sex interaction.

2. Omega-6 Fatty Acids (Table 33, Fig. 48)

The sum (ΣW6) of the omega-6 FA (18:2W6, 20:3W6, and 20:4W6) also showed a strong age cohort trend but the reverse to that seen for the ΣW3, above. There was a marked decline in the ΣW6 from the young to the older cohorts in both men and women. As with the ΣW3, the largest changes occurred from 18-29, through 30-49, to 50-59 years. From age 18-29 to 50-59 years, the average values for men and women showed respective decreases in the ΣW6 of 36 and 33%. A one-way ANOVA of the data for men and women showed a highly significant decrease ($p=0.000$) in the ratio with age cohort in both sexes. The 2-way ANOVA confirmed a highly significant age effect ($p=0.000$), but no sex differences or age*sex interaction.

3. Omega-9 (Table 34 and 35, Fig. 49)

Both men and women showed a decrease in the 18:1W9 FA (W9) concentrations from young to older cohorts. From age 18-29 to 60-69 years, mean values decreased by 14 and 7% in men and women, respectively. A one-way ANOVA of the male and female data showed highly significant decreases of W9 with age cohort in both sexes, with $p=0.000$ and $p=0.008$ for men and women respectively. The 2-way ANOVA confirmed a highly significant age effect ($p=0.000$), with no sex differences, or age*sex interaction.

4. ΣOmega-7 + Omega-9 (Table 34 and 35, Fig. 50)

The sum of the 16:1W7, 18:1W7 and 18:1W9 FA showed little inter-cohort difference in either men or women. In the men aged 18-69, values remained in a narrow range of 29.9 to 32.0 weight% and then declined to 26.7 weight% at age 70-79 years. The women had similar readings, with values ranging from 28.5 to 32.6 weight% for women aged 18-69 years. The ANOVA did not show any statistically significant sex or age differences, or sex*age interaction.

5. Ratio Omega-6/Omega-3 (Table 33, Fig. 51)

Both men and women exhibited a progressive decrease in the ΣW6/ΣW3 ratio from the young to the older cohorts. For both sexes, the largest difference was seen between those aged 18-29 and those aged 30-39 years, with men and women showing respective decreases in the mean values of 44 and 51%. The overall differences between those aged 18-29 and those 60-69 years was 79 and 81% for men and women respectively. The ANOVA did not show any sex differences in the ΣW6/ΣW3 ratios but it did confirm a highly significant age effect ($p=0.000$). There was no age*sex interaction.

6. Other Omega Fatty Acid Ratios (Table 34 and 35, Fig. 52 and 53)

In both men and women, the (ΣW7+W9)/ΣW3 and the W9/ΣW3 ratios also showed a progressive decline from young to older cohorts. In both cases, the ANOVA showed a highly significant age effect ($p=0.000$), but no significant differences between men and women, and no age*sex interaction.

3.3.5 Unsaturated Fatty Acid Profiles in Inuit and nGanasan

1. Omega-3 FA

a) **Men** (Table 33 and 36, Fig. 54). Figure 54 suggests a trend to a gradual increase in the ΣW3 FA in the older cohorts of nGanasan men similar to that seen in the Inuit. However, a one-way ANOVA of the data for the nGanasan showed that the increase with age was not statistically significant. The ΣW3 were significantly higher (+47%, p=0.003) in the nGansan than in the Inuit men at age 18-29 years, similar for the two groups at age 30-39 years, and somewhat higher in the Inuit at 40-59 years, 49%(NS). A 2-way ANOVA showed that there were no statistically significant differences in total omega-3 levels between the 2 groups of men, but there was a highly significant age effect (p=0.000), and a significant age*group interaction (p=0.013).

b) **Women** (Table 33 and 36, Fig. 61). Similar to the nGanasan men, (and in contrast to the Inuit women), the nGanasan women did not show any significant increase in the ΣW3 levels from young to older cohorts. As in the men, above, the young nGanasan women (18-29 years) had significantly higher levels of ΣW3 than their Inuit peers (+67%, p=0.009), but, levels in the older nGanasan women were lower than in the Inuit, by 31% at ages 30-39 and 40-49 years. A 2-way ANOVA did not reveal any significant overall differences in the ΣW3 FA between the Inuit and nGanasan women, but there was a significant age effect (p=0.036) and a significant age*group interaction (p=0.025).

2. Omega-6 FA

a) **Men** (Table 33 and 36, Fig 55). The ΣW6 FA was higher in the nGanasan men at all ages and did not decrease in the older cohorts as it did in the Inuit men. At ages 18-29, 30-39, 40-49 and 50-59 years, the ΣW6 values were higher in the nGanasan by 15(p=0.027), 28(p=0.003), 45(p=0.002) and 87%(p<0.001), respectively. A one-way ANOVA of the nGanasan data did not show a significant change in the Σw6 levels with age. A 2-way ANOVA of the results for Inuit and nGanasan confirmed a highly significant overall difference (p=0.000) in the ΣW6 levels between the two groups of men, with a highly significant age effect (p=0.004) and age*group interaction (p=0.009).

b) **Women** (Table 33 and 36, Fig. 62). As in the men above, the ΣW6 FA was higher in the nGanasan women than in the Inuit at all ages; however, unlike the nGanasan men, the nGanasan women showed a trend towards a decrease of ΣW6 in the older cohorts. A one-way ANOVA of the data for nGanasan women confirmed that this trend was significant (p=0.044). At ages 18-29, 30-39 and 40-49 years, the ΣW6 values were higher in the nGanasan women by 24(p=0.029), 18(NS) and 29% (p=0.022), respectively. A 2-way ANOVA of the data for Inuit and nGanasan women confirmed a highly significant overall difference (p=0.002) in the ΣW6 levels between the two groups of women, with a significant age effect (p=0.001), but no age*group interaction.

3. Omega-9

a) **Men** (Table 34 and 37, Fig. 55). The 18:1W9 concentrations were higher in the Inuit men at all ages. At 18-29, 30-39, 40-49 and 50-59 years, the W9 levels were higher in the Inuit by 70($p<0.001$), 56($p=0.026$), 37(NS) and 136% ($p=0.003$), respectively. In the Inuit there was a progressive decrease of the W9 concentrations from young to older cohorts, showing a 14% total decrease of mean values from 18-29 to 60-69 years. A one-way ANOVA of the Inuit data confirmed a highly significant decrease ($p=0.000$) of W9 levels in the older cohorts. In the nGanasan men, the W9 levels remained essentially unchanged from 18-29 to 40-49 years, followed by a 46% (NS) decrease at age 50-59 years. A 2-way ANOVA of the Inuit and nGanasan data confirmed a highly significant overall difference ($p=0.000$) in the W9 levels between the two groups of men, with a highly significant age effect ($p=0.007$), but no age*group interaction.

b) **Women** (Table 35 and 38, Fig. 63). As in the men, the W9 levels were higher in the Inuit women at all ages. At 18-29, 30-39 and 40-49 years, the W9 values were higher in the Inuit by 89($p=0.002$), 5(NS) and 19% (NS), respectively. The Inuit women (like the men) showed a progressive decrease in the W9 levels in older cohorts, with a 7% total decrease of mean values from 18-29 to 60-69 years. A one-way ANOVA of the Inuit data confirmed a significant difference ($p=0.008$) in the W9 levels from young to older Inuit women. The nGanasan women did not show any significant changes in W9 with age. A 2-way ANOVA of the Inuit and nGanasan data confirmed a highly significant overall difference ($p=0.000$) in the W9 concentrations between the two groups of women, with a marginally significant age effect ($p=0.098$), and a highly significant age*group interaction ($p=0.006$).

4. Omega-7 + Omega-9

a) **Men** (Table 34 and 37, Fig. 57). The sum of the 16:1W7, 18:1W7 and 18:1W9 FA (ΣW7+W9) was markedly higher in the Inuit men at all ages. At 18-29, 30-39, 40-49 and 50-59 years, the values were higher in the Inuit by 58($p<0.001$), 53($p=0.012$), 47(NS) and 150% ($p=0.010$), respectively. There appeared to be little change of mean values with age in either group. In the Inuit aged 18-69 years, the (ΣW7+W9) concentrations remained in a narrow range of 29.9 to 32.0 weight%; in the nGanasan aged 18-39 years the values ranged from 14.5 to 14.9 weight% and then showed a statistically insignificant decrease to 8.0 weight% at age 50-59 years. A 2-way ANOVA confirmed that there was a highly significant overall difference ($p=0.000$) in the (ΣW7+W9) levels between the Inuit and nGanasan men, with no age effect or age*group interaction.

b) **Women** (Table 35 and 38, Fig. 64). As in the men, the (ΣW7+W9) was markedly higher in the Inuit women at all ages. At 18-29, 30-39, and 40-49 years, the values were higher in the Inuit by 73($p=0.003$), 10(NS) and 22% ($p=0.048$), respectively. In the

Inuit women the (ΣW7+W9) levels remained relatively unchanged with age, but the values appeared more variable in the nGanasan women. A one-way ANOVA of the data for both groups of women confirmed that there were no significant changes in (ΣW7+W9) with age in either the Inuit or the nGanasan women. A 2-way ANOVA of the data comparing the two groups of women confirmed that there was a highly significant difference ($p=0.000$) in the (ΣW7+W9) concentrations between the Inuit and nGanasan, with a significant age effect ($p=0.041$) and age*group interaction ($p=0.036$).

5. Ratio Omega-6/Omega-3

a) **Men** (Table 33 and 36, Fig. 58). At 18-29 years, the ratio of ΣW6/ΣW3 was significantly higher in the Inuit men (+53%, $p=0.003$), but in the older men the values were higher in the nGanasan. At 30-39, 40-49 and 50-59 years the ratio was higher in the nGanasan by 4(NS), 44(NS), and 162% ($p=0.058$). A one-way ANOVA of the ΣW6/ΣW3 with age for each group showed a highly significant decrease of the ratio in the older cohorts of Inuit ($p=0.000$), but no significant changes in the nGanasan. A 2-way ANOVA comparing the ratio in the two groups did not reveal any significant overall differences between the Inuit and nGanasan, but it did show a highly significant age effect ($p=0.000$) and a significant age*group interaction ($p=0.034$).

b) **Women** (Table 33 and 36, Fig. 65). The results for the women were similar to those seen in the men, above. At age 18-29 years, the ratio was significantly higher in the Inuit (+55%, $p=0.022$), but in the older women, the values were higher in the nGanasan. At 30-39 and 40-49 years, the ΣW6/ΣW3 was higher in the nGanasan by 36($p=0.026$) and 40% ($p=0.034$), respectively. A one-way ANOVA of the ratio with age for each group showed a highly significant decrease of ΣW6/ΣW3 in the older cohorts of Inuit women ($p=0.000$), but no significant changes in the nGanasan. A 2-way ANOVA of the ratio in Inuit and nGanasan did not reveal any significant overall differences between the two groups of women, but it did show a significant age effect ($p=0.012$) with no significant age*group interaction

6. Ratio (ΣW7+W9)/ΣW3

a) **Men.** (Table 34 and 37, Fig. 59). The (ΣW7+W9)/ΣW3 ratio was higher in the Inuit at all ages by 174($p<0.001$), 69($p=0.023$), 23(NS) and 106% (NS) at 18-29, 30-39, 40-49 and 50-59 years, respectively. A one-way ANOVA of the data with age for each group of men showed a highly significant decrease of (ΣW7+W9)/ΣW3 in the older Inuit ($p=0.000$), but no significant changes in the nGanasan. A 2-way ANOVA of the data for the Inuit and nGanasan showed that there was a highly significant overall difference in the ratio between the two groups of men, with a significant age effect ($p=0.010$), but no significant age*group interaction.

b) **Women** (Table 35 and 38, Fig. 66). In the Inuit women, the ratio was higher only at age 18-29 years (+250%, $p<0.001$), with the nGanasan women showing somewhat higher values at age 30-39 (+13%, NS) and 40-49 years (+9%, NS). A one-way ANOVA of the data with age for each group of women showed a highly significant decrease in the (ΣW7+W9)/ΣW3 in the older cohort of Inuit women ($p=0.000$), but no significant changes with age in the nGanasan. A 2-way ANOVA of the data for Inuit and nGanasan showed that there was a significant overall difference ($p=0.011$) in the ratio between the two groups of women, with no age effect, but a significant age*group interaction ($p=0.041$).

7. Ratio W9/ΣW3

a) **Men** (Table 34 and 37, Fig. 60). This ratio was higher in the Inuit men at all ages. At 18-29, 30-39, 40-49 and 50-59 years, the W9/ΣW3 ratio was higher in the Inuit by 199($p<0.001$), 75($p=0.031$), 23(NS), and 71% (NS), respectively. A one-way ANOVA of the data with age for each group of men showed a highly significant decrease of the W9/ΣW3 in the older Inuit ($p=0.000$), but no significant age-related changes in the nGanasan men. A 2-way ANOVA of the data for the two groups of men confirmed that there was a highly significant overall difference in W9/ΣW3 between the Inuit and nGanasan ($p=0.001$), with a highly significant age effect ($p=0.004$), and a marginally significant age*group interaction ($P=0.081$)

b) **Women** (Table 35 and 38, Fig. 67). The W9/ΣW3 ratio was higher in the Inuit women at age 18-29 years only (+289%, $p<0.001$); with the nGanasan having higher values at 30-39 (+15%, NS) and 40-49 (+9%, NS) years. A one-way ANOVA of the data with age for each group showed a highly significant decrease of W9/ΣW3 in the older Inuit women ($p=0.000$), but no significant age-related changes in the nGanasan. A 2-way ANOVA of the data for the Inuit and nGanasan confirmed that there was a significant overall difference ($p=0.010$) in the ratio between the two groups of women, with no age effect, but a significant age*group interaction ($p=0.037$).

3.3.6 Summary: Unsaturated Fatty Acids in Inuit

In the Inuit, the sum of the omega-3 fatty acid (ΣW3) showed highly significant increases with age ($p<0.0001$) to relatively high levels in the older men and women. This, combined with a steep negative age-gradient for the ΣW6 FA ($p<0.0001$), resulted in a highly significant decrease with age in the ΣW6/ΣW3 ratio in both men and women.

Other fatty acids, sums, and ratios showing highly significant ($p<0.0001$) decreases with age in both men and women were:- W9, (ΣW7+W9), (ΣW7+W9)/ΣW3, and W9/ΣW3.

There were no gender differences in any of the unsaturated fatty acids, their sums, or ratios in the Inuit population.

3.3.7 Summary: Unsaturated Fatty Acids in Inuit versus nGanasan

Gender-spesific ΣW3 FA values were similar in both populations; however, unlike the Inuit, neither the nGanasan men nor the nGanasan women showed significant age gradients for the ΣW3 FA. The ΣW6 FA values were significantly higher in the nGanasan for both men and women (M, $p<0.0001$; F, $p=0.002$). The nGanasan men did not show an age gradient for the ΣW6 FA, but there was a significant decrease with age in the nGanasan women ($p=0.044$), similar to that seen in the Inuit men and women.

There were no significant differences in gender-specific ΣW6/ΣW3 ratios between the two populations. Unlike the Inuit, the nGanasan did not show an age effect for this ratio.

The Inuit men showed significantly higher values for W9, ΣW7+W9, (ΣW7+W9)/ΣW3, and W9/ΣW3 at all ages. The Inuit women showed significantly higher values for W9, and ΣW7+W9 at all ages (18-29, 30-39, and 40-49 yr) and significantly higher overall (age 18-49 yr) values for (ΣW7+W9)/ΣW3 and W9/ΣW3.

With the exception of the ΣW6 FA in the women, the nGanasan (in contrast to the Inuit) did not show significant age gradients in any of the FA, sums, or ratios discussed above.

3.3.8 Correlations

Correlations of age, body mass, and the lipid profile with the unsaturated fatty acid concentrations are summarized in Table 39 and 40. In both male and female Inuit ΣW3 FA concentrations showed a strong positive correlation with age; whereas, ΣW6 FA, ΣW6/ΣW3, (ΣW7+W9)/ΣW3 and W9/ΣW3 ratios were all inversely correlated with age. Body mass was positively correlated with W3, and negatively correlated with ΣW6, ΣW6/ΣW3, (ΣW7+W9)/ΣW3 and W9/ΣW3 in the men, but not in the women. Total cholesterol was negatively related to (ΣW7+W9) in the men only. Triglyceride levels were negatively related to ΣW3, but positively related to (ΣW7+W9), ΣW6/ΣW3, (ΣW7+W9)/ΣW3 and W9/ΣW3 in men but not in women. The PC/FC ratio was negatively related to ΣW6, ΣW6/ΣW3, (ΣW7+W9)/ΣW3 and W9/ΣW3 in both men and women.

In the nGanasan subjects (Table 40), significant correlations were much more sparse, in part because of the much smaller sample size. In the men, there were no significant correlations with age or body mass. As in the Inuit, triglyceride levels showed a negative relationship to ΣW3 concentrations, and positive relationship to (ΣW7+W9),

$(\Sigma W7+W9)/\Sigma W3$ and $W9/\Sigma W3$, but in the nGanasan, triglycerides were also negatively related to $\Sigma W6$ concentrations. In the small sample of nGanasan women, triglycerides showed a similar pattern, with significant correlations between triglycerides and $(\Sigma W7+W9)/\Sigma W3$ and $W9/\Sigma W3$.

Table 33. Omega fatty acid profiles in Canadian Inuit men and women aged 18-79 years. Values shown are the mean, SD, and N, weight %.

AGE GROUP	MALE			FEMALE		
	Σw6	Σw3	Σw6/Σw3	Σw6	Σw3	Σw6/Σw3
18-29	31.4 5.6 29	6.00 3.22 29	6.65 3.18 29	32.1 4.9 22	5.47 2.89 22	7.60 3.83 22
30-39	28.2 4.9 18	9.55 4.54 18	3.70 2.02 18	28.3 4.8 15	9.56 4.44 15	3.73 2.08 15
40-49	22.6 5.2 16	15.53 6.38 16	2.42 3.04 16	24.0 5.8 7	13.92 4.79 7	2.03 1.13 7
50-59	20.2 5.0 16	16.42 4.70 16	1.31 0.47 16	21.5 3.0 12	15.86 4.87 12	1.60 0.99 12
60-69	20.7 2.8 4	15.54 2.35 4	1.38 0.38 4	20.0 3.9 3	13.96 2.30 3	1.44 0.14 3
70-79	22.3 1.8 3	16.73 0.55 3	1.34 0.15 3			

Table 34. Omega fatty acid profiles in Canadian Inuit men showing the mean, SD, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %)				
	ΣW3	ΣW7+W9	W9	(ΣW7+W9)/ΣW3	W9/ΣW3
18-29	6.00 3.22 29	32.0 4.5 29	25.2 3.9 29	6.72 3.57 29	5.39 2.98 29
30-39	9.55 4.54 18	29.9 3.3 18	22.5 3.5 18	3.71 1.46 18	2.87 1.28 18
40-49	15.53 6.38 16	30.0 3.6 16	20.3 4.0 16	2.94 3.17 16	2.17 2.73 16
50-59	16.42 4.70 16	31.4 10.6 16	19.0 4.4 15	2.31 1.96 16	1.23 0.60 15
60-69	15.54 2.35 4	30.9 1.7 4	21.7 1.4 4	2.01 0.21 4	1.43 0.27 4
70-79	16.73 0.55 3	26.7 1.1 3	18.4 1.2 3	1.60 0.07 3	1.10 0.10 3

Table 35. Omega fatty acid profiles in Canadian Inuit women showing the mean, SD, and N.

AGE GROUP (yr)	CONCENTRATION (weight %)				
	ΣW3	W7+W9	W9	(W7+W9)/ΣW3	W9/ΣW3
18-29	5.47 2.89 22	31.4 3.8 22	24.7 3.2 22	7.39 3.81 22	5.87 3.12 22
30-39	9.56 4.44 15	29.4 2.2 15	22.3 2.3 15	3.69 1.56 15	2.83 1.33 15
40-49	13.92 4.79 7	28.5 2.6 7	20.9 2.5 7	2.25 0.74 7	1.69 0.66 7
50-59	15.86 4.87 12	29.5 3.6 12	20.4 4.0 12	2.22 1.50 12	1.59 1.25 12
60-69	13.96 2.30 3	32.6 6.5 3	22.9 4.5 3	2.43 0.92 3	1.71 0.64 3

Table 36. Omega-3 and omega-6 fatty acid profiles in Siberian nGanasan men and women aged 18-59 years. Values shown are the mean, SD, and N, weight %.

AGE GROUP	MALE			FEMALE		
	Σw6	Σw3	Σw6/Σw3	Σw6	Σw3	Σw6/Σw3
18-29	35.9 6.5 16	8.80 2.18 16	4.36 1.60 16	39.7 7.1 7	9.16 3.50 7	4.89 1.94 7
30-39	36.1 6.3 7	9.49 1.74 7	3.86 0.73 7	33.4 3.9 2	6.58 0.98 2	5.09 0.17 2
40-49	32.7 2.6 4	10.08 3.34 4	3.48 0.98 4	30.9 1.2 2	9.63 0.73 2	3.22 0.12 2
50-59	37.9 4.6 3	11.35 1.89 3	3.43 0.90 3			

Table 37. Omega fatty acid profiles in Russian nGanasan men showing the mean, SD, and N.

AGE GROUP (yr)	CONCENTRATION (weight %)				
	ΣW3	W7+W9	W9	(W7+W9)/ΣW3	W9/ΣW3
18-29	8.80 2.18 16	20.2 7.9 16	14.8 6.5 16	2.45 1.19 16	1.80 0.95 16
30-39	9.46 1.74 7	19.5 7.9 7	14.5 7.2 7	2.19 1.11 7	1.64 0.95 7
40-49	10.08 3.34 4	20.5 8.8 4	14.9 7.9 4	2.39 1.46 4	1.77 1.19 4
50-59	11.35 1.89 3	12.6 8.5 3	8.0 8.0 3	1.12 0.78 3	0.72 0.73 3

Table 38. Omega fatty acid profiles in Russian nGanasan women showing the mean, SD, and N.

AGE GROUP (yr)	CONCENTRATION (weight %)				
	ΣW3	W7+W9	W9	(W7+W9)/ΣW3	W9/ΣW3
18-29	9.16 3.50 7	18.2 7.6 7	13.1 6.0 7	2.11 1.04 7	1.51 0.81 7
30-39	6.58 0.98 2	26.8 4.3 2	20.9 3.5 2	4.17 1.27 2	3.25 1.02 2
40-49	9.63 0.73 2	23.4 3.1 2	17.5 2.8 2	2.45 0.51 2	1.84 0.43 2

Table 39. Correlation of age , body mass (BM), total cholesterol (TC), free cholesterol (FC), Triglycerol (TG), and the PC/FC ratio with unsaturated fatty acids. Data for Igloolik Inuit.

	ΣW3	ΣW6	(ΣW7+W9)	ΣW6/ΣW3	(ΣW7+W9)/ΣW3	W9/ΣW3
MALE SUBJECTS						
AGE	0.69 ($p<0.001$)	-0.64 ($p<0.001$)	NS	-0.65 ($p<0.001$)	-0.56 ($p<0.001$)	-0.59 ($p<0.001$)
BM	0.28 ($p<0.008$)	-0.22 ($p<0.04$)	NS	NS	NS	NS
TC	NS	NS	-0.30 ($p<0.005$)	NS	NS	NS
FC	NS	NS	-0.25 ($p<0.022$)	NS	NS	NS
TG	-0.34 ($p<0.001$)	NS	0.26 ($p<0.017$)	0.28 ($p<0.009$)	0.41 ($p<0.001$)	0.43 ($p<0.001$)
PC/FC	-0.36 ($p<0.001$)	0.32 ($p<0.003$)	NS	0.31 ($p<0.004$)	0.28 ($p<0.009$)	0.29 ($p<0.008$)
FEMALE SUBJECTS						
AGE	0.73 ($p<0.001$)	-0.71 ($p<0.001$)	NS	-0.69 ($p<0.001$)	-0.63 ($p<0.001$)	-0.63 ($p<0.001$)
BM	NS	NS	NS	NS	NS	NS
TC	NS	NS	NS	NS	NS	NS
FC	NS	NS	NS	NS	-0.26 ($p<0.045$)	-0.26 ($p<0.044$)
TG	NS	NS	NS	NS	NS	NS
PC/FC	-0.60 ($p<0.001$)	0.55 ($p<0.001$)	NS	0.65 ($p<0.001$)	0.65 ($p<0.001$)	0.66 ($p<0.001$)

Table 40. Correlation of age , body mass (BM), total cholesterol (TC), free cholesterol (FC), Triglycerol (TG), and the PC/FC ratio with unsaturated fatty acids. Data for Volochanka nGanasan male subjects.

	ΣW3	ΣW6	(ΣW7+W9)	ΣW6/ΣW3	(ΣW7+W9)/ΣW3	W9/ΣW3
AGE	NS	NS	NS	NS	NS	NS
BM	0.45 ($p<0.027$)	NS	NS	NS	NS	NS
TC	NS	NS	NS	NS	NS	NS
FC	NS	NS	NS	NS	NS	NS
TG	NS	-.35 ($p<0.05$)	NS	NS	0.46 ($p<0.009$)	0.46 ($p<0.009$)
PC/FC	NS	NS	NS	NS	NS	NS

Figure 47. Total W3 fatty acids in Inuit men and women aged 18-79 years.

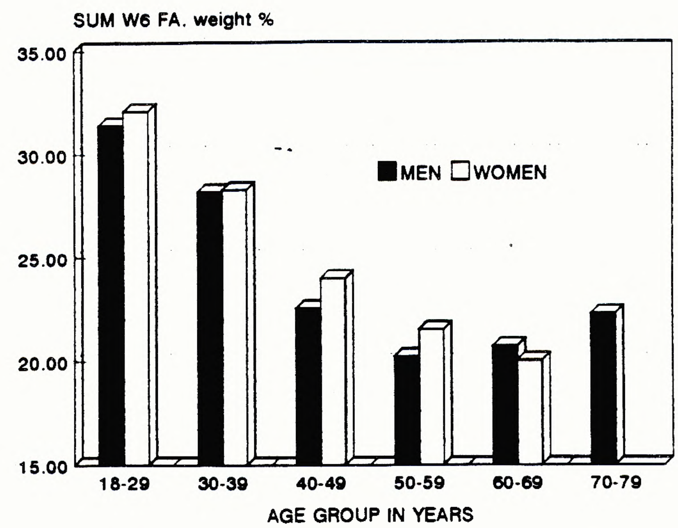


Figure 48. Total W6 fatty acids in Inuit men and women aged 18-79 years.

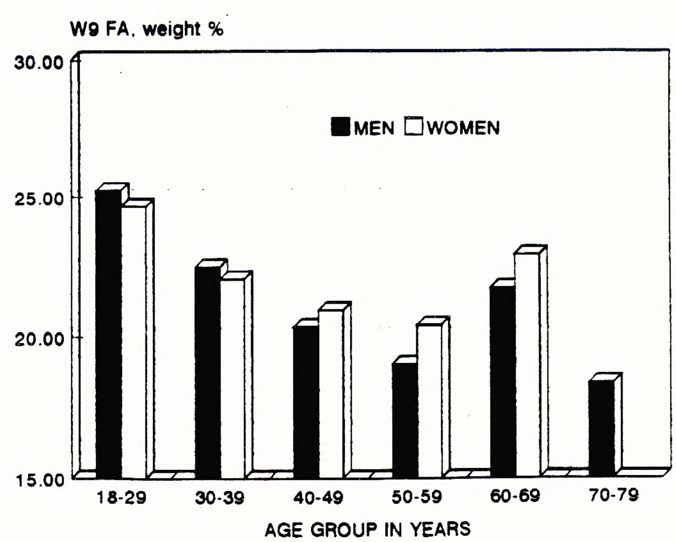


Figure 49. W9 fatty acids in Inuit men and women aged 18-79 years.

OMEGA FATTY ACIDS IN INUIT

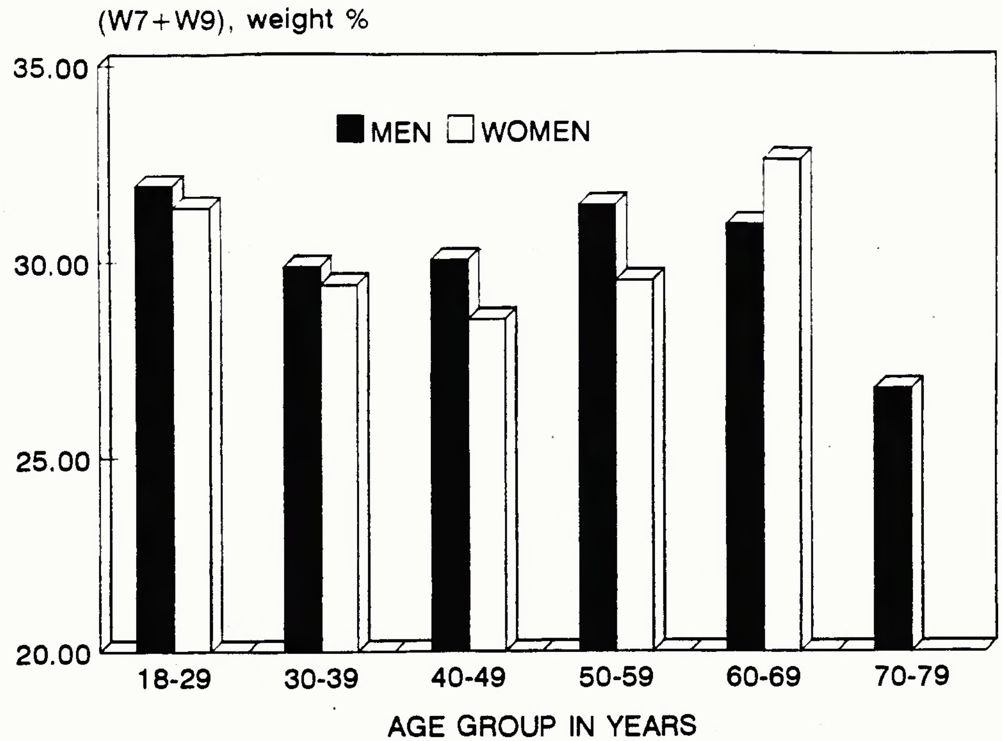


Figure 50. Sum of W7 and W9 fatty acids in Inuit men and women aged 18-79 years.

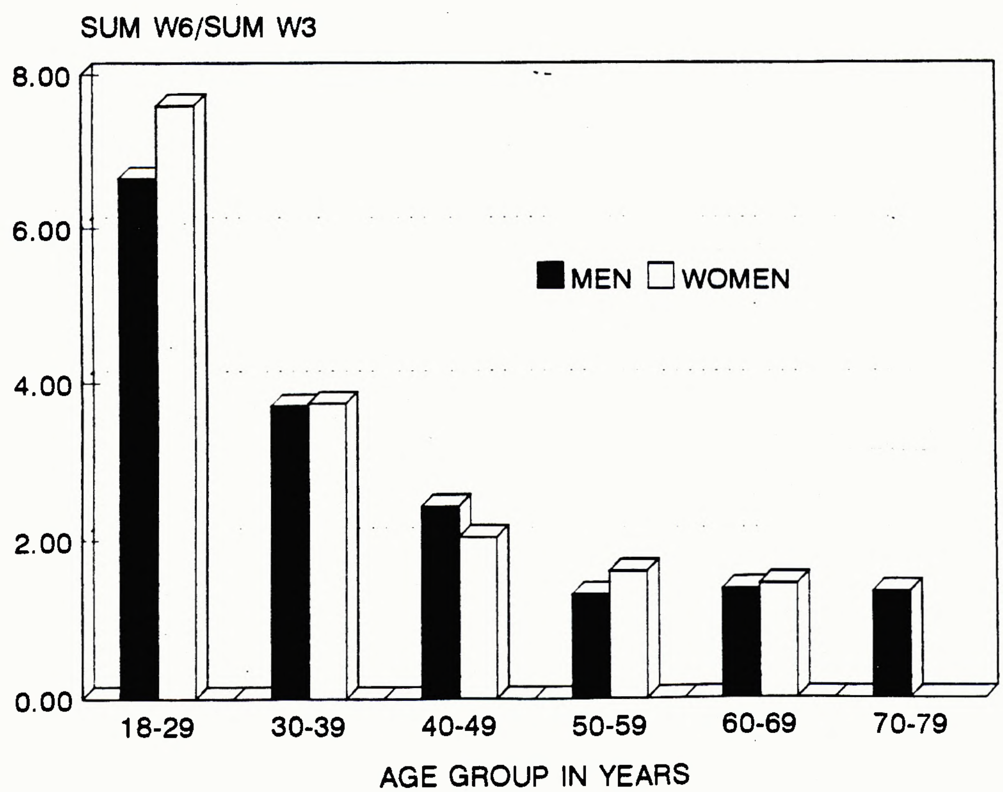


Figure 51. Ratio (sum W6/sum W3) FA in Inuit men and women aged 18-79 years.

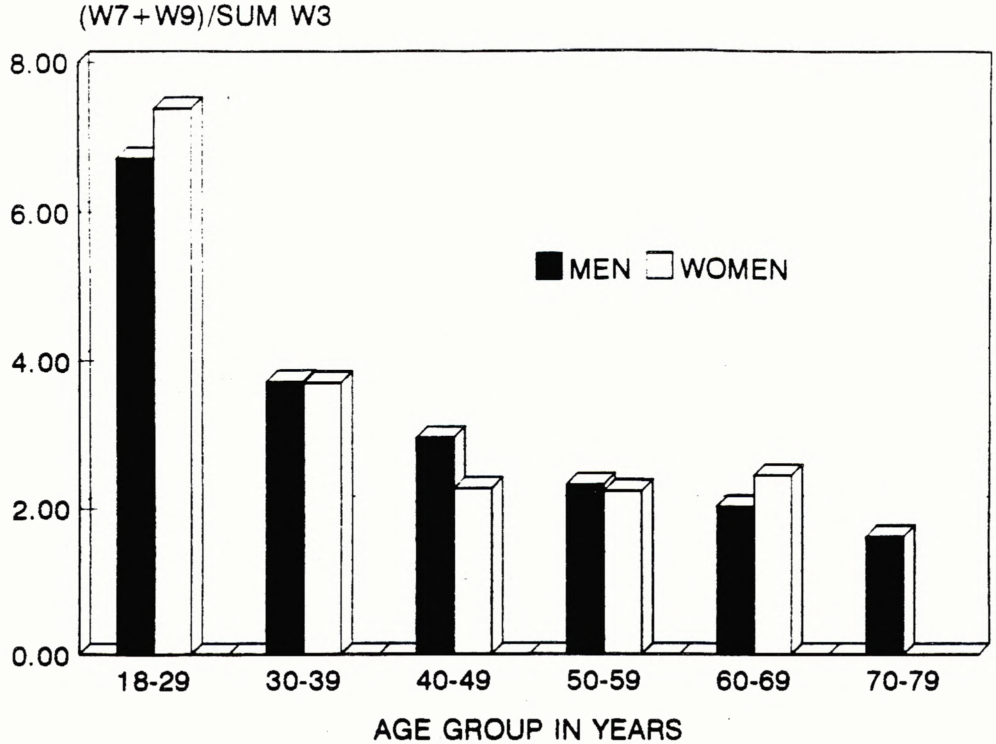


Figure 52. Ratio (W7+W9) to sum of W3 fatty acids in Inuit men and women aged 18-79 years.

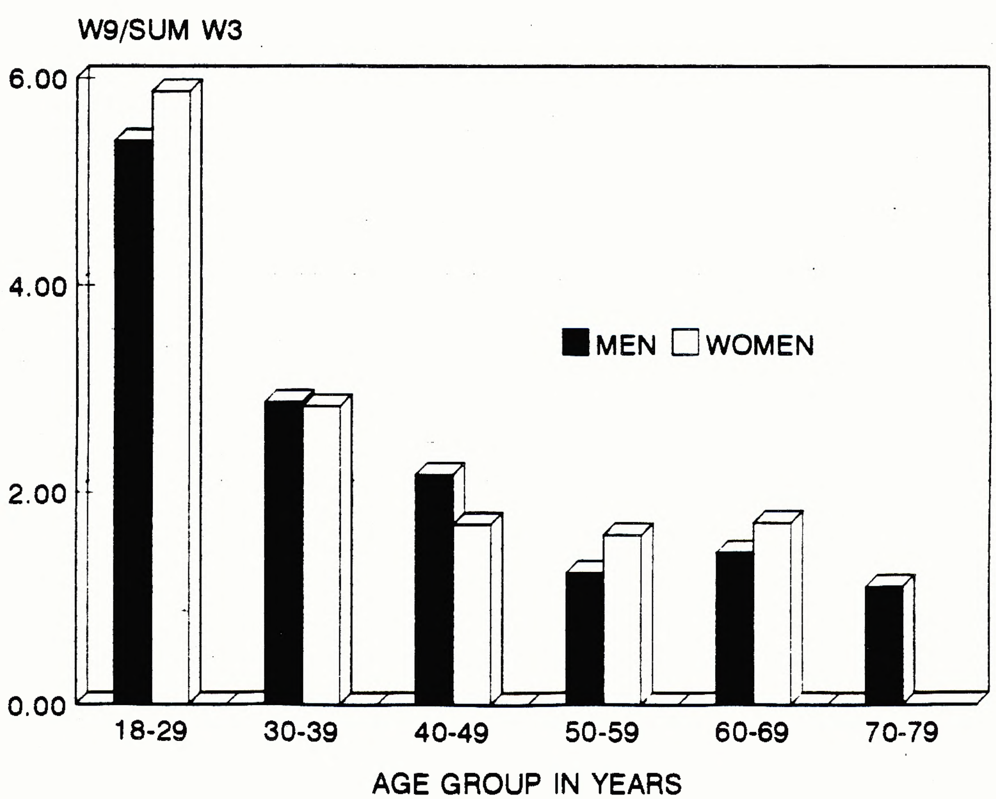


Figure 53. Ratio of W9 to sum W3 fatty acids in Inuit men and women aged 18-79 years.

OMEGA FATTY ACIDS IN MEN

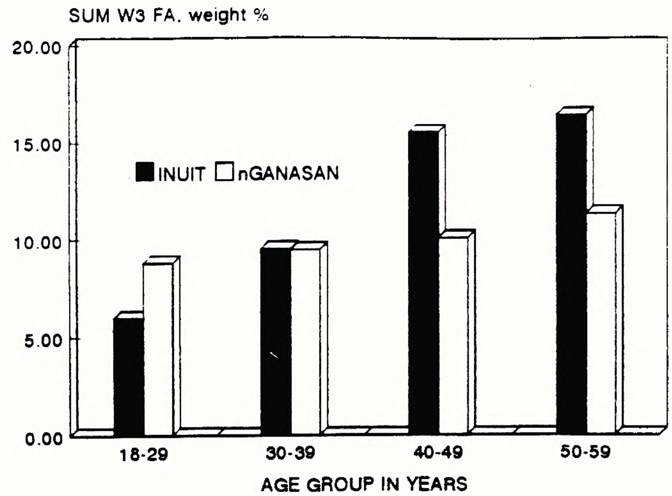


Figure 54. Total W3 fatty acids in Inuit and nGanasan men aged 18-59 years.

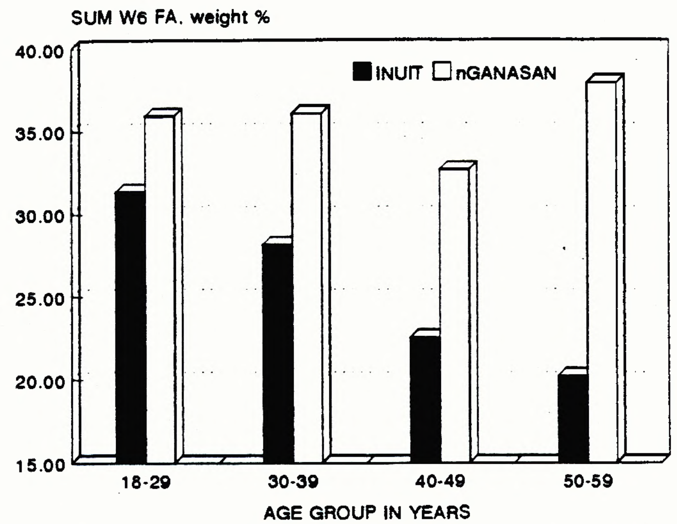


Figure 55. Total W6 fatty acids in Inuit and nGanasan men aged 18-59 years.

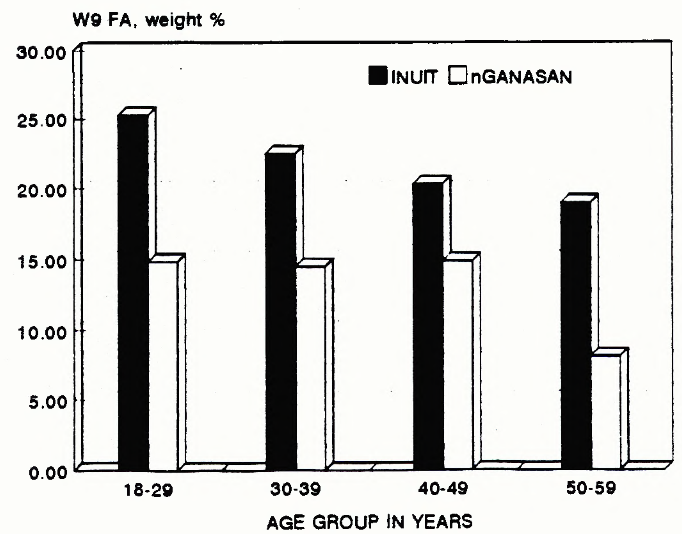


Figure 56. Omega-9 fatty acids in Inuit and nGanasan men aged 18-59 years.

OMEGA FATTY ACIDS IN MEN

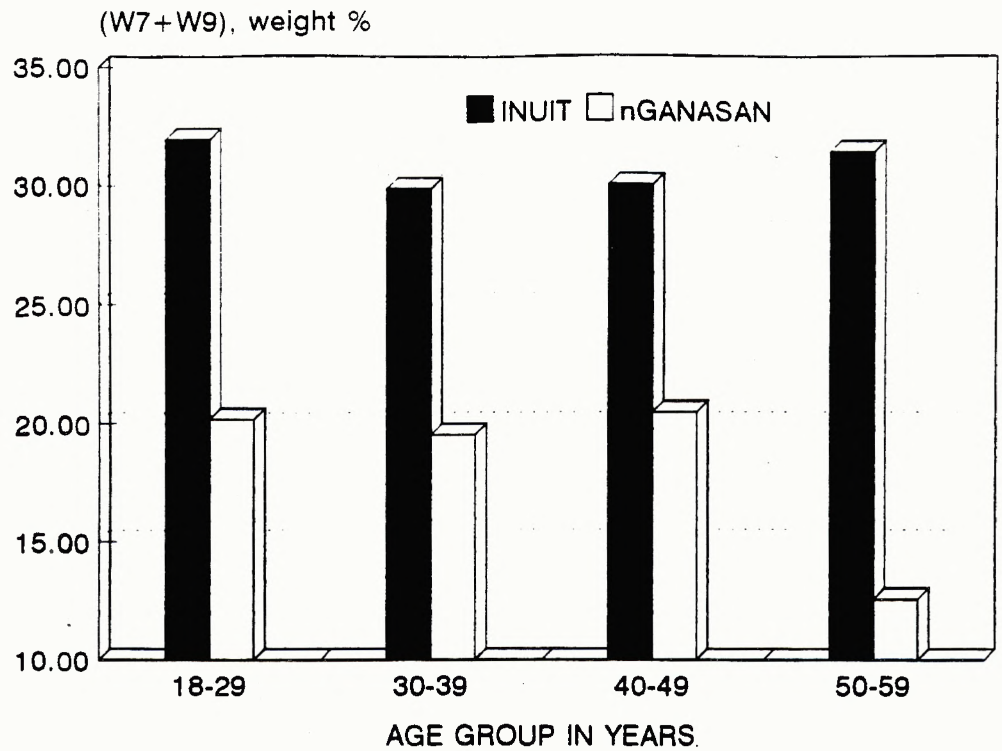


Figure 57. Sum W7 and W9 fatty acids in Inuit and nGanasan men aged 18-59 years.

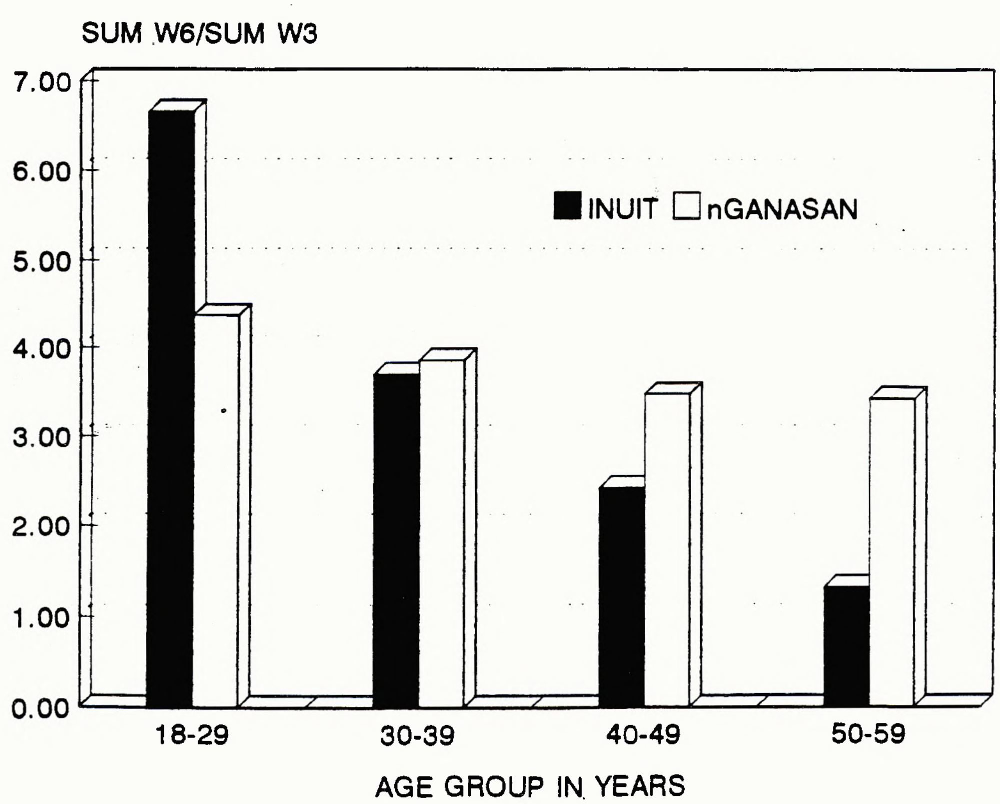


Figure 58. Ratio (sum W6/sum W3) FA in Inuit and nGanasan men aged 18-59 years.

OMEGA FATTY ACIDS IN MEN

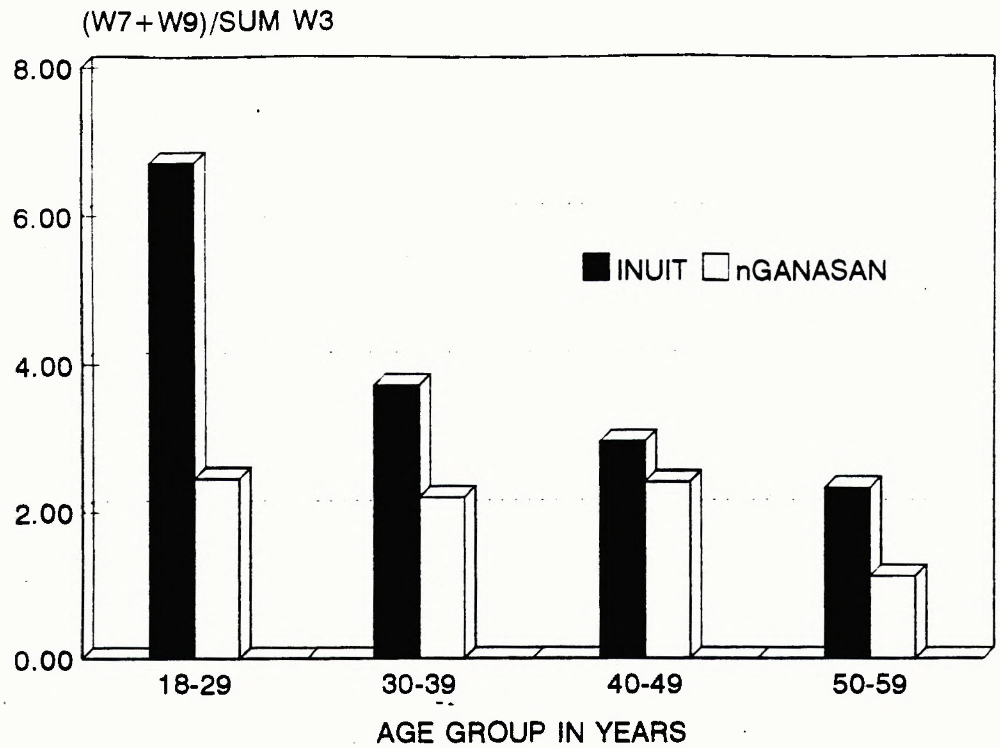


Figure 59. Ratio of (W7+W9) to sum of W3 fatty acids in Inuit and nGanasan men aged 18-59 years.

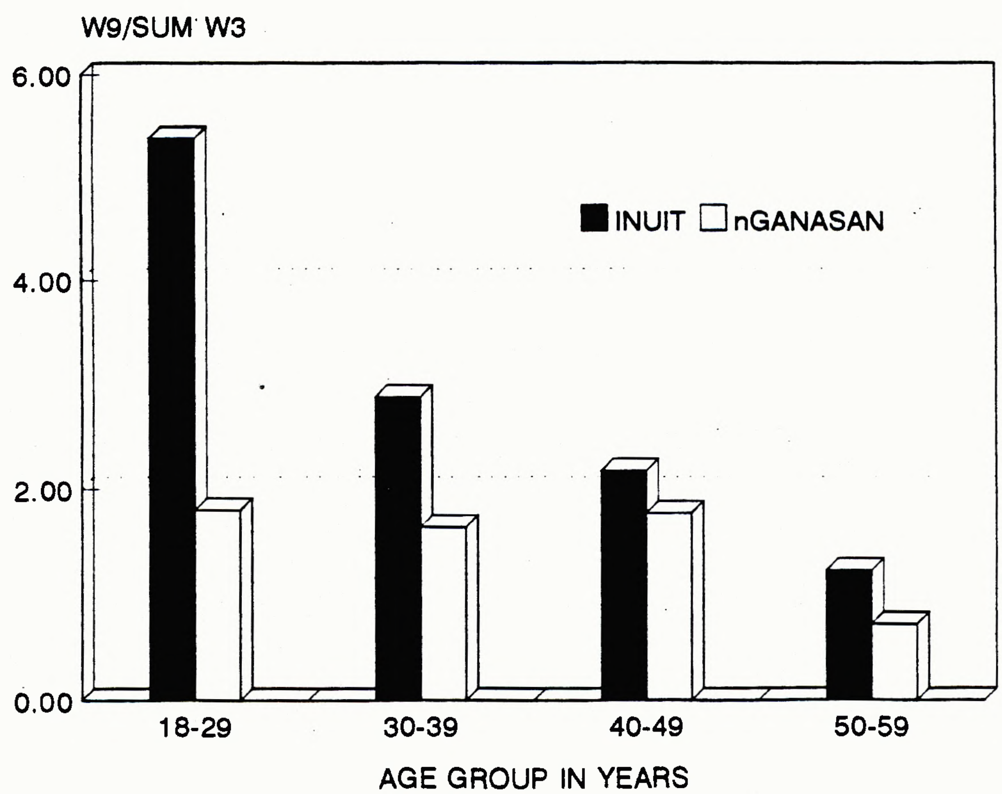


Figure 60. Ratio of W9 to sum W3 fatty acids in Inuit and nGanasan men aged 18-59 years.

OMEGA FATTY ACIDS IN WOMEN

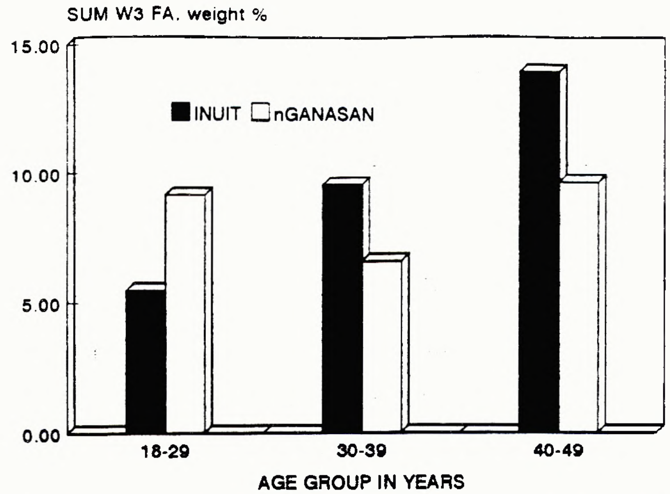


Figure 61. Total W3 fatty acids in Inuit and nGanasan women aged 18-49 years.

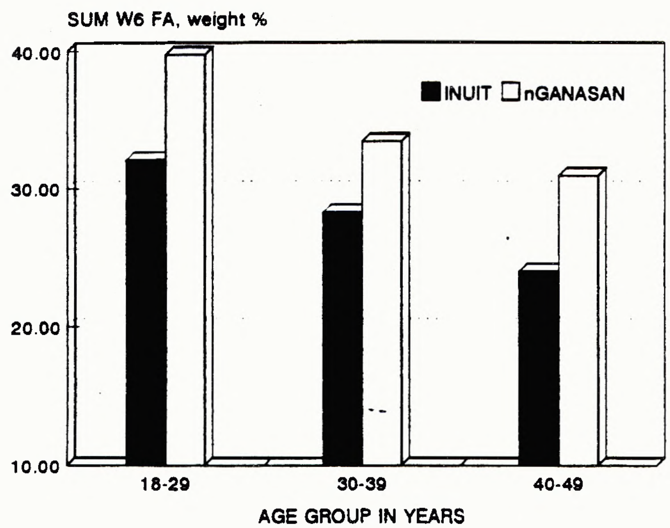


Figure 62. Total W6 fatty acids in Inuit and nGanasan women aged 18-49 years.

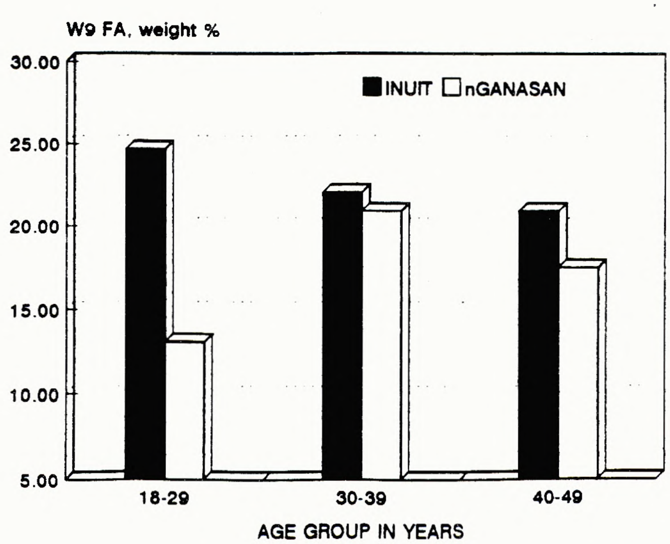


Figure 63. Omega-9 fatty acids in Inuit and nGanasan women aged 18-49 years.

OMEGA FATTY ACIDS IN WOMEN

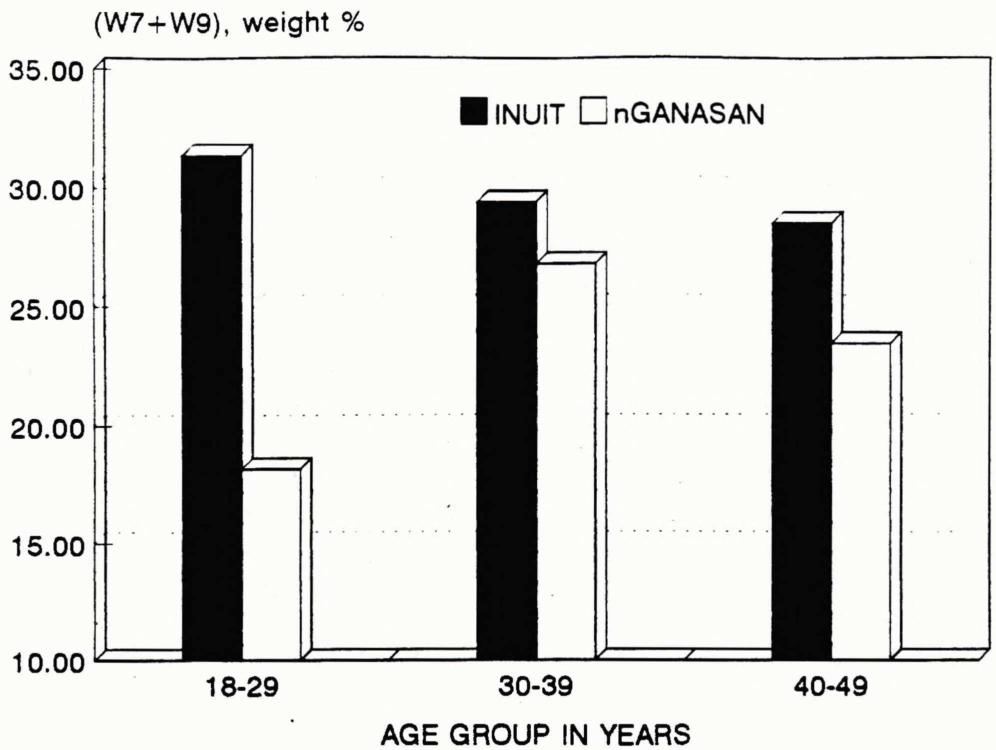


Figure 64. Sum W7 and W9 fatty acids in Inuit and nGanasan women aged 18-49 years.

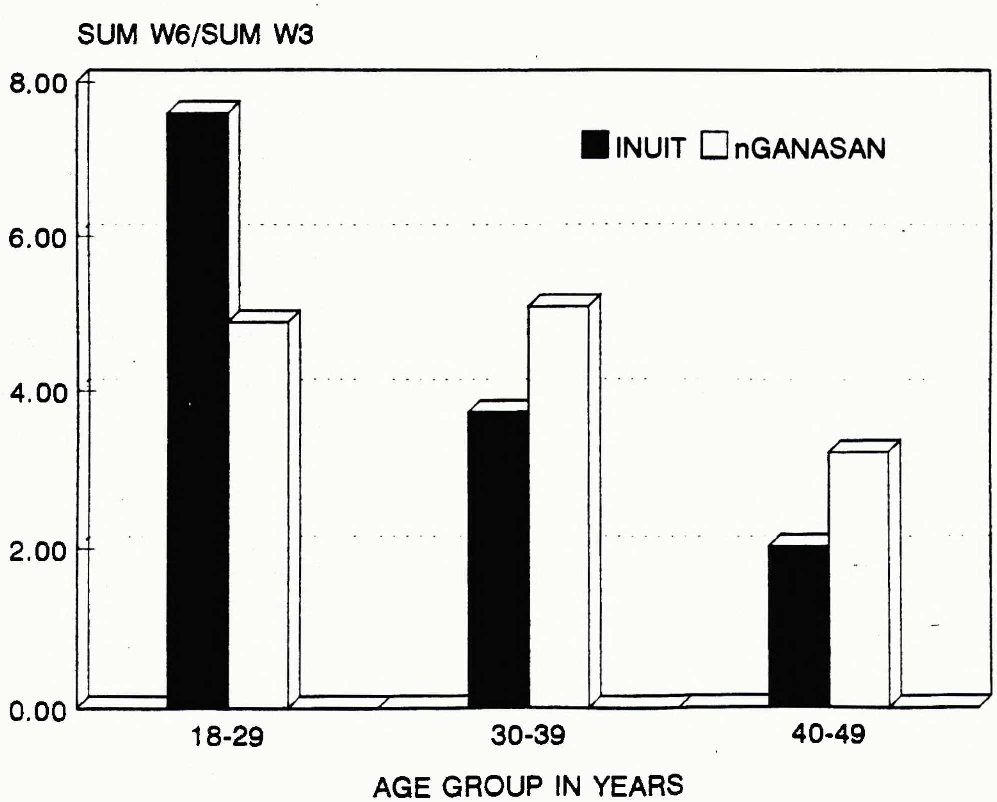


Figure 65. Ratio (sum W6/sum W3) fatty acids in Inuit and nGanasan women aged 18-49 years.

OMEGA FATTY ACIDS IN WOMEN

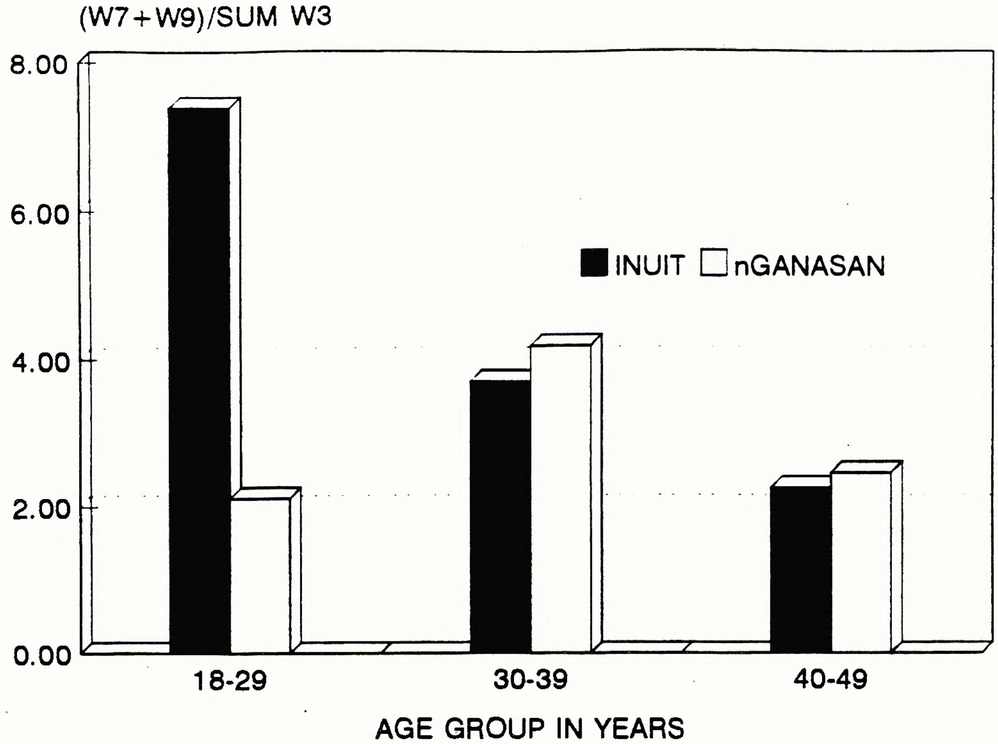


Figure 66. Ratio of (W7+W9) to sum of W3 fatty acids in Inuit and nGanasan women aged 18-49 years.

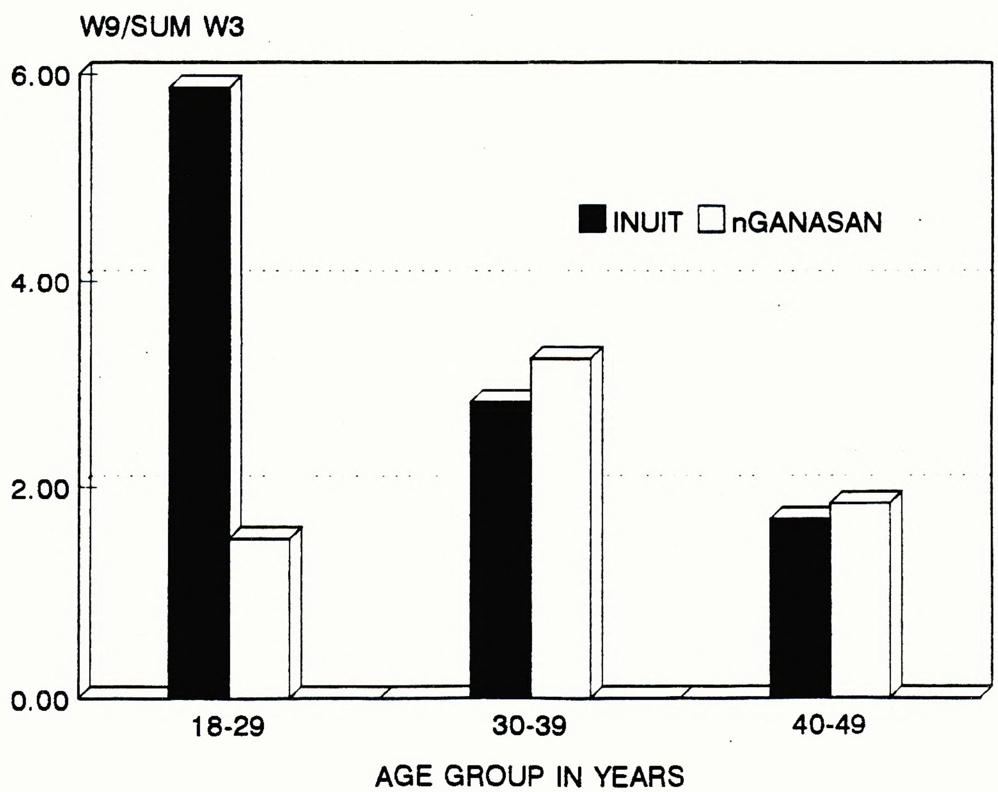


Figure 67. Ratio of W9 to sum W3 fatty acids in Inuit and nGanasan women aged 18-49 years.

3.4 Other Cardiovascular Risk Factors

Other cardiovascular risk factors that we considered included blood pressure, body build and cigarette consumption. The data are summarized in Tables 41 to 44 and shown graphically in Figures 68 to 76.

3.4.1 Results for Inuit

1. Systolic Blood Pressure (Table 41, Fig. 68)

Systolic blood pressures (SBP) were low normal values in all except the oldest category of men. Figure 68 shows that from age 18-29 to 50-59 years the systolic blood pressure was slightly higher in the men than in the women, by 6.7 ($p=0.002$), 6.4 ($p=0.036$), 1.7 , and 1.7% at ages 18-29, 30-39, 40-49 and 50-59 years respectively. Both the men and the women showed progressive increases in systolic pressure beginning at age 50-59 years, with the men showing a steep and marginally significant ($p=0.083$) 18.9% increase in the small sample aged 70-79 years. The ANOVA did not reveal any significant overall difference in systolic blood pressure between the men and women, but did show a significant age effect ($p=0.011$). There was no sex*age interaction.

In our sample of 145 Inuit men and women aged 18-79 years, there was only one hypertensive subject (SBP $\geq$ 160 mmHg), a 63 year old woman with a blood pressure reading of 160/90.

2. Diastolic Blood Pressure (Table 42, Fig. 69)

Diastolic blood pressures (DBP) were low normal values. The average diastolic pressure differed significantly between the sexes in one age group only, with the 30-39 year old men showing readings 11.5% ($p=0.015$) higher than the women. In both men and women, the diastolic pressure showed little change with age, with average readings at or below 73 and 72 mmHg in men and women respectively. The ANOVA did not show any significant overall differences in diastolic blood pressures between men and women, nor was there an age effect or sex*age interaction.

In our sample of 145 men and women aged 18-79 years, there was only one hypertensive subject (DBP > 90 mmHG), a 43 year old woman with a blood pressure reading of 135/95.

3. Chest/Waist Ratio (Table 43, Fig. 70)

Figure shows that all ages (18-69 years), the average chest/waist ratio (CWR) was (as expected) higher in the men than in the women and that there was a progressive decrease in the CWR with age in both sexes. The CWR was higher in the men by 3.5($p=0.008$), 5.4($p=0.014$), 5.5, 1.9, and 2.0% at ages 18-29, 30-39, 40-49, 50-59 and 60-69 years respectively. The total decrease in the CWR from age 18-29 to 60-69 years was 15.1 and 13.9% for men and women respectively. The ANOVA confirmed that there was a highly significant difference ($p=0.004$) in the CWR between the Inuit men and women, that there was a very strong age effect ($p=0.000$), and that there was no sex*age interaction.

4. Cigarette Smoking (Table 44)

Almost all of the adult Inuit were smokers but the reported consumption was less than in "white" smokers. Analysis of the data for individual age groups did not show any significant differences in average cigarette consumption between male and female smokers. The ANOVA confirmed that there was no significant overall difference between the two groups, no age effect, or any sex*age interaction. Nevertheless, comparison with cohorts from 1970 and 1980 suggested a slight trend for the number of smokers in a given cohort to decrease with age.

3.4.2 Comparative Data for Inuit and nGanasan

1. Systolic Blood Pressure

a) **Men** (Table 41, Fig. 71). Figure 71 shows that the average systolic pressure was substantially higher in the nGanasan men at all ages. Readings were higher in the nGanasan by 14.2 ($p<0.001$), 17.1 ($p=0.045$), 30.2 ($p<0.001$) and 4.9% at ages 18-29, 30-39, 49-49, and 50-59 years respectively. The ANOVA confirmed that there was a highly significant difference ($p=0.000$) in the systolic blood pressure between the two groups of men, with no age effect, and a marginally significant ($p=0.054$) age*group interaction.

Three (or 9.4%) of our sample of 32 nGanasan men were hypertensives (>160 mmHg). There were no hypertensives in our sample of 83 Inuit men.

b) **Women** (Table 41, Fig. 72). Similar to the men, systolic pressures were higher in the nGanasan women at all ages. The readings in the nGanasan were higher by 14 ($p<0.001$), 28.5 ($p=0.006$), 49.0 ($p<0.001$), and 42.2% ($p<0.001$) at ages 18-29, 30-39, 40-49, and 50-59 years respectively. In the Inuit women, the systolic blood pressures remained relatively constant (≈ 104 mmHg) from age 18-29 to 40-49 years and then rising by 8.7% to 113 mmHg at age 50-59 years. In contrast, values for the nGanasan women, the systolic pressure became progressively greater from age 18-29 (119 mmHg) to 50-59 years (160 mmHg, 34% greater). The ANOVA confirmed a highly significant group difference ($p=0.000$), age effect ($p=0.000$), and age*group interaction ($p=0.001$).

Seven (or 23.3%) of our sample of 30 nGanasan women were hypertensive (>160 mmHg) as compared to only one hypertensive woman (or 1.7%) in our sample of 59 Inuit women.

2. Diastolic Blood Pressure

a) **Men** (Table 42, Fig. 73). At all ages, the diastolic pressures were higher in the nGanasan than in the Inuit men. At ages 18-29, 30-39, 40-49, and 50-59 years, the average readings of the nGanasan exceeded those of the Inuit by 11.3 ($p=0.011$), 21.3 ($p=0.003$), 24.5 ($p=0.003$) and 8.5% respectively. The ANOVA confirmed that there was a highly significant difference ($p=0.000$) in the diastolic blood pressures between the Inuit and nGanasan men, and that there was no age effect or age*group interaction.

Five (16.7%) of the 32 nGanasan men were hypertensive (>90 mmHg). There were no hypertensives in our sample of 83 Inuit men.

b) **Women** (Table 42, Fig. 74). As in the men, above, the nGanasan women had higher diastolic blood pressures than the Inuit women at all ages. At 18-29, 30-39, 40-49 and 50-59 years the average pressures in the nGanasan women were higher by 12.7 ($p=0.016$), 31.1 ($p<0.001$), 37.3 ($p=0.002$) and 46.4% ($p=0.005$) respectively. In the Inuit women, average diastolic pressures remained relatively constant over the age range studied with a low of 65.3 mmHg at 30-39 years and a high of 71.7 mmHg at 50-59 years. In contrast, the diastolic pressures of the nGanasan women increased progressively from a low of 77.3 mmHg at 18-29 years to a high of 105.0 mmHg at 50-59 years. The ANOVA confirmed a highly significant overall group difference ($p=0.000$), age effect ($p=0.001$), and age*group interaction ($p=0.017$).

Nine (30%) of the 30 nGanasan women were hypertensive (=>90 mmHg) as compared to one hypertensive (1.7%) in our sample of 59 Inuit women.

3. Chest/Waist Ratio (CWR)

a) **Men** (Table 43, Fig. 75). Both the Inuit and nGanasan men had a progressive decrease in the CWR with age, showing respective decreases of 10.1 and 11.6% fro age 18-29 to 50-59 years. The ANOVA confirmed a highly significant age effect ($p=0.000$), but did not show any overall difference in the CWR between the Inuit and nGanasan, nor was there an age*group interaction.

b) **Women** (Table 43, Fig. 76). As in the men, the CWR decreased progressively with age in both the Inuit and nGanasan women. The total decrease from age 18-29 to 50-59 years was 8.7 and 12.3% for Inuit and nGanasan respectively. The ANOVA showed a highly significant age effect (p=0.001), but did not reveal an overall difference in the CWR between the two groups of women, nor was there an age*group interaction.

4. Smoking (Table 44)

a) **Men**. The proportion of regular cigarette smokers in our sample of 18-59 year old nGanasan men was 78%, very similar to the 80% rate for Inuit men aged 17-59 years. The ANOVA did not show any overall difference in the average cigarette consumption of smokers between the Inuit and nGanasan, nor was there any age effect or age*group interaction.

b) **Women**. The proportion of regular cigarette smokers in our sample of 18-59 year old nGanasan women was 56%, substantially lower than the 80% rate for 17-59 year old Inuit women. The Inuit women smoked more than the nGanasan at all ages except 40-49 years. At ages 18-29, 30-39 and 50-59 years, cigarette consumption was higher in the Inuit by 112 (p=0.002), 297 (p<0.001) and 14% respectively. The ANOVA confirmed that the cigarette consumption of female smokers was significantly higher in the Inuit (p=0.006); there was no age effect or age*group interaction.

3.4.3 Combinations of Major Cardiovascular Risk Factors

Table 45 shows the distribution of subjects by number of major risk factors for cardiovascular disease (regular cigarette smoking, high blood pressure, and high blood cholesterol) for Inuit and nGanasan men and women. Table 46 presents the same data in more detail, showing combinations of the major risk factors.

In general, both groups had similar proportions of subjects with at least one risk factor. Overall, 80% of the Inuit men and 74% of the Inuit women had at least one risk factor. The corresponding rate for at least one factor in the nGanasan was 91 and 70% for men and women respectively. However, the proportion of subjects with one risk factor only was substantially higher in the Inuit, with rates of 74 and 77% for Inuit men and women respectively. The corresponding rates in the nGanasan were 55 and 40% for men and women respectively. Furthermore, the proportion of subjects with 2 major risk factors was substantially higher in the nGanasan, with rates of 36 and 30% for men and women respectively as compared to the respective rates of 6 and 7% in Inuit men and women.

The most remarkable difference between the two groups (Table 46) was in the proportion at risk due to high blood pressure (HBP) and the combination of smoking (SMK) plus high blood pressure (SMK+HBP). In our sample of Inuit, 4% of the men and 6% of the women were at risk due to HBP; the corresponding figures for the nGanasan sample were 36 and 45%. The proportion at risk due to SMK+HBP was 1 and 2% in the Inuit men and women, and 29 and 18% in the nGanasan men and women respectively. Another interesting difference was that none of the nGanasan were at risk due to high blood cholesterol (HBC); whereas, in our sample of Inuit, 6% of the men and 5% of the women were at risk due to HBC.

We also took our larger sample of volunteers with data for aerobic power and looked at the distribution of subjects according to the AHA criteria for the risk of cardiovascular disease based on relative aerobic power (Table 47). In our sample of Inuit, 19% of the men and women were at risk on the basis of their relative aerobic power; the corresponding figures for the nGanasan were 17 and 41% for men and women respectively.

Table 41. Systolic blood pressure (mmHg) in Canadian Inuit and Siberian nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	111.6 7.3 29	127.4 14.9 19	104.6 8.0 22	119.2 11.9 13
30-39	110.3 9.9 18	129.2 17.4 6	103.7 6.7 15	133.3 24.0 9
40-49	107.5 12.7 16	140.0 14.1 5	105.7 14.0 7	157.5 18.9 6
50-59	114.4 12.2 16	120.0 14.1 2	112.5 13.4 12	160.0 0.0 2
60-69	116.3 13.8 4		120.0 36.1 3	
70-79	138.3 12.6 3			

Table 42. Diastolic blood pressure (mmHg) in Canadian Inuit and Siberian nGanasan men and women. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	71.6 7.2 29	79.7 11.6 19	68.6 7.3 22	77.3 10.5 13
30-39	72.8 10.1 18	88.3 9.8 6	65.3 6.4 15	85.6 12.4 9
40-49	69.1 9.0 16	86.0 11.4 5	68.6 13.5 7	94.2 8.0 6
50-59	71.3 10.4 16	77.5 10.6 2	71.7 11.4 12	105.0 21.2 2
60-69	72.5 5.0 4		70.0 17.3 3	
70-79	73.3 5.8 3			

Table 43. Chest/waist ratio in Canadian Inuit and Siberian nGanasan. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	1.19 0.05 28	1.21 0.05 19	1.15 0.05 21	1.14 0.05 15
30-39	1.18 0.07 18	1.17 0.05 6	1.12 0.06 15	1.06 0.07 9
40-49	1.15 0.06 16	1.16 0.06 5	1.09 0.12 7	1.03 0.07 7
50-59	1.07 0.06 16	1.07 0.04 2	1.05 0.21 12	1.00 0.00 1
60-69	1.01 0.05 4		0.99 0.08 3	
70-79	1.07 0.04 3			

Table 44. Cigarette consumption (#/day in smokers).Data for Canadian Inuit and Siberian nGanasan. Values shown are the mean, SD, and N.

AGE GROUP (yr)	MALES		FEMALES	
	INUIT	nGANASAN	INUIT	nGANASAN
18-29	13.0 7.9 28	10.0 7.0 15	10.4 4.7 22	4.9 3.4 9
30-39	14.9 6.3 16	15.8 12.1 5	11.9 1.4 16	3.0 0.0 2
40-49	14.1 7.0 10	11.0 3.4 4	7.8 5.0 5	9.0 4.7 5
50-59	10.9 5.9 11	10.0 0.0 1	11.4 4.2 8	10.0 0.0 1
60-69	8.0 0.0 1		13.5 16.3 2	

Table 45. Distribution of subjects by number of major risk factors* for cardiovascular disease by ethnic group and sex.

Group and Sex	Number of Subjects	Number of risk factors; % of subjects			
		None	One	Two	Three
Inuit Men	89	20	74	6	0
Inuit Women	62	16	77	7	0
nGanasan Men	22	9	55	36	0
nGanasan Women	10	30	40	30	0

* Major risk factors are: regular smoking (one or more cigarettes every day); high blood cholesterol (total plasma cholesterol >220 mg%); high blood pressue (diastolic pressure => 90 mmHg or systolic pressure =>160 mmHg).

Table 46. Distribution of subjects by combination of major risk factors* for ethnic group and sex showing %(N/total N).

Group and Sex	Risk factors, % of subjects (N/Total N)							
	SMK	HBP	HBC	SMK+HBP	SMK+HBC	HBP+HBC	SMK+HBP +HBC	NONE
Inuit Men	73 (66/90)	4 (4/90)	6 (6/89)	1 (1/90)	4 (4/90)	0 (0/89)	0 (0/89)	20 (18/89)
Inuit Women	79 (53/67)	6 (4/67)	5 (3/62)	2 (1/67)	5 (3/62)	0 (0/62)	0 (0/62)	16 (10/62)
nGanasan Men	78 (40/51)	36 (15/42)	0 (0/31)	29 (12/42)	0 (0/31)	0 (0/31)	0 (0/31)	9 (2/22)
nGanasan Women	50 (18/36)	45 (15/33)	0 (0/11)	18 (6/33)	0 (0/11)	0 (0/11)	0 (0/11)	30 (3/10)

* SMK: regular smoking, one or more cigarettes every day.

HBP: high blood pressure (diastolic => 90 mmHg or systolic => 160 mmHg)

HBC: high blood cholesterol (total plasma cholesterol >220 mg%)

Table 47. Distribution of subjects according to the AHA criteria for the risk of cardiovascular disease based on relative aerobic power.

Group and Sex	Total Number Tested	Number at Risk	Per Cent at Risk
Inuit men	160	31	19
Inuit women	115	22	19
nGanasan men	42	7	17
nGanasan women	34	14	41

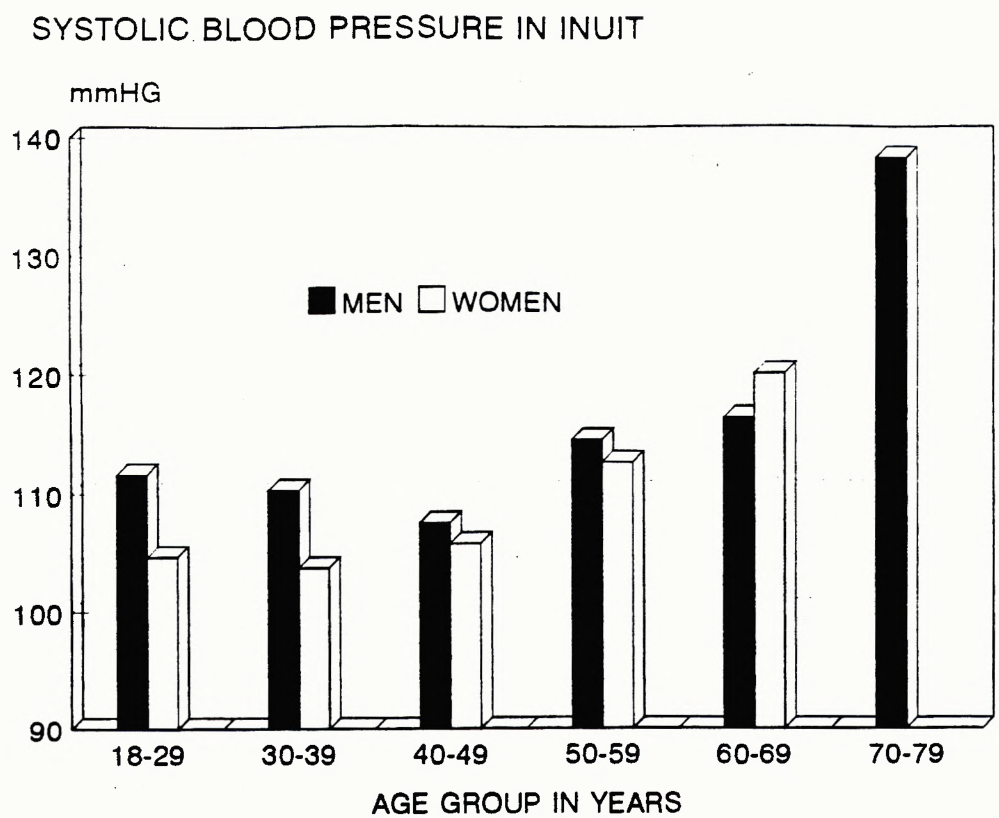


Figure 68. Systolic blood pressure in Inuit men and women aged 18-79 years.

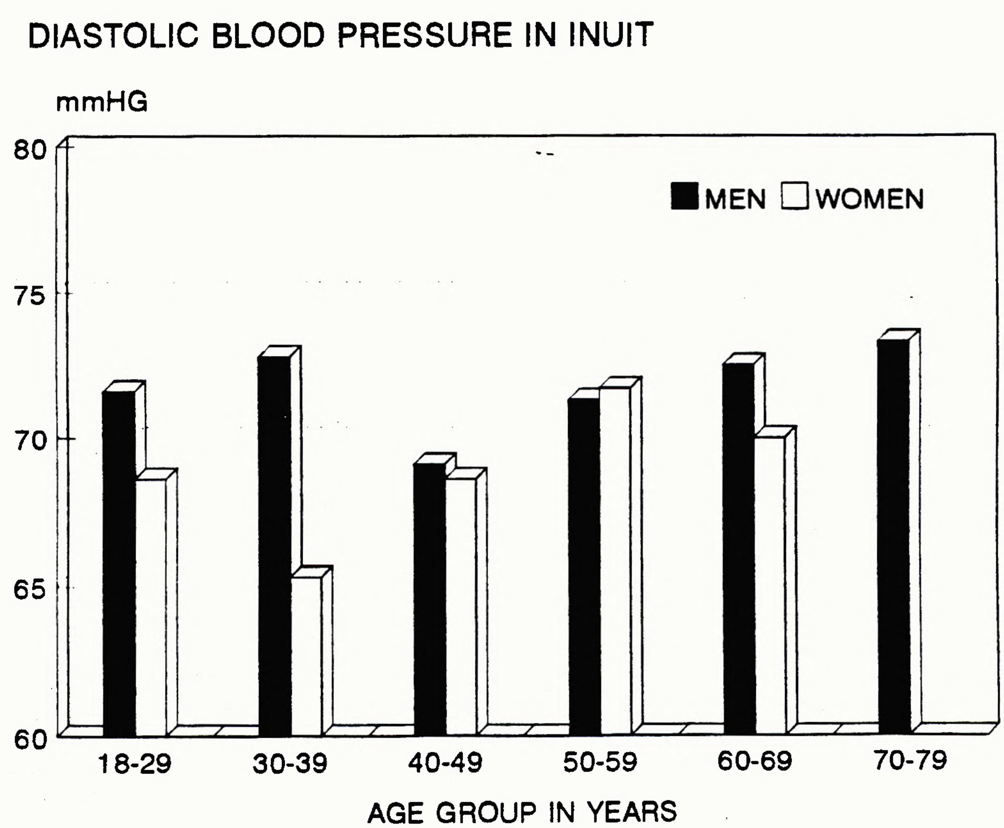


Figure 69. Diastolic blood pressure in Inuit men and women aged 18-79 years.

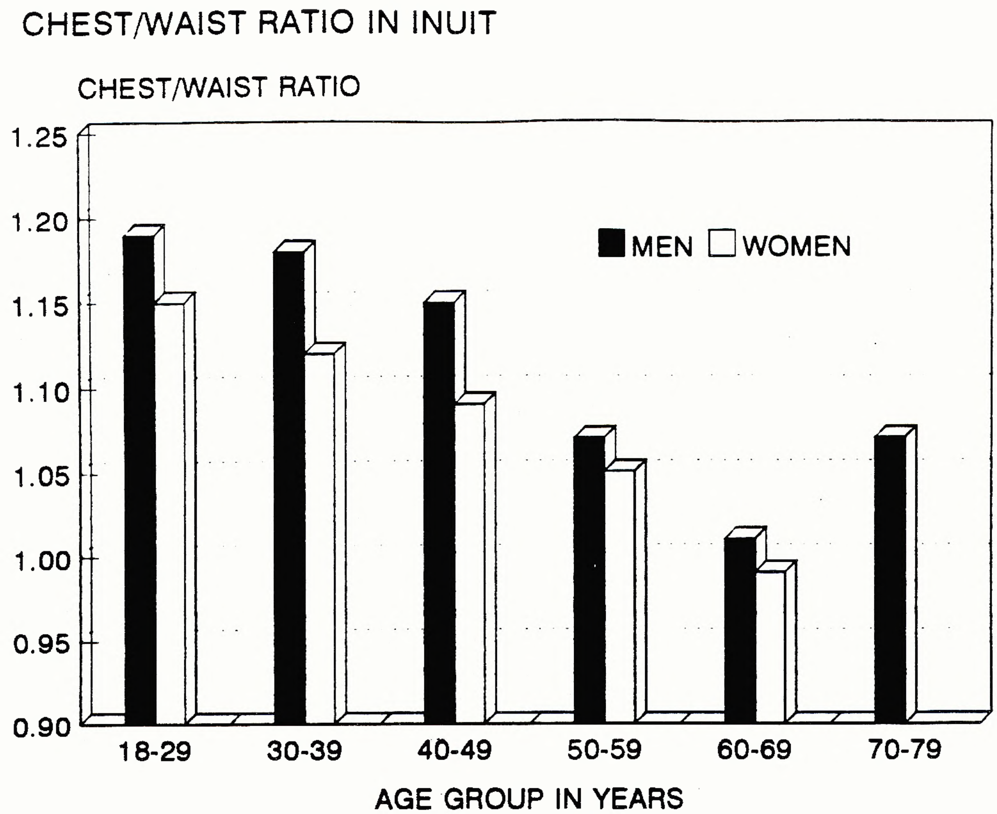


Figure 70. Chest/waist ratio in Inuit men and women aged 18-79 years.

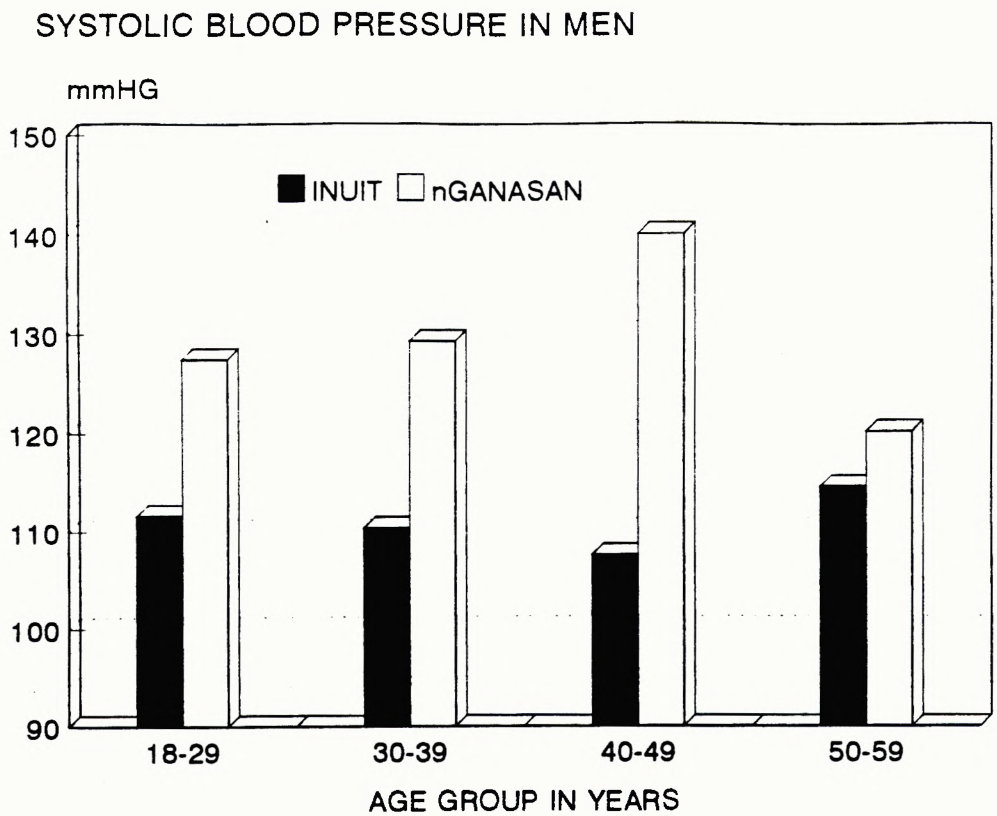


Figure 71. Systolic blood pressure in Inuit and nGanasan men aged 18-59 years.

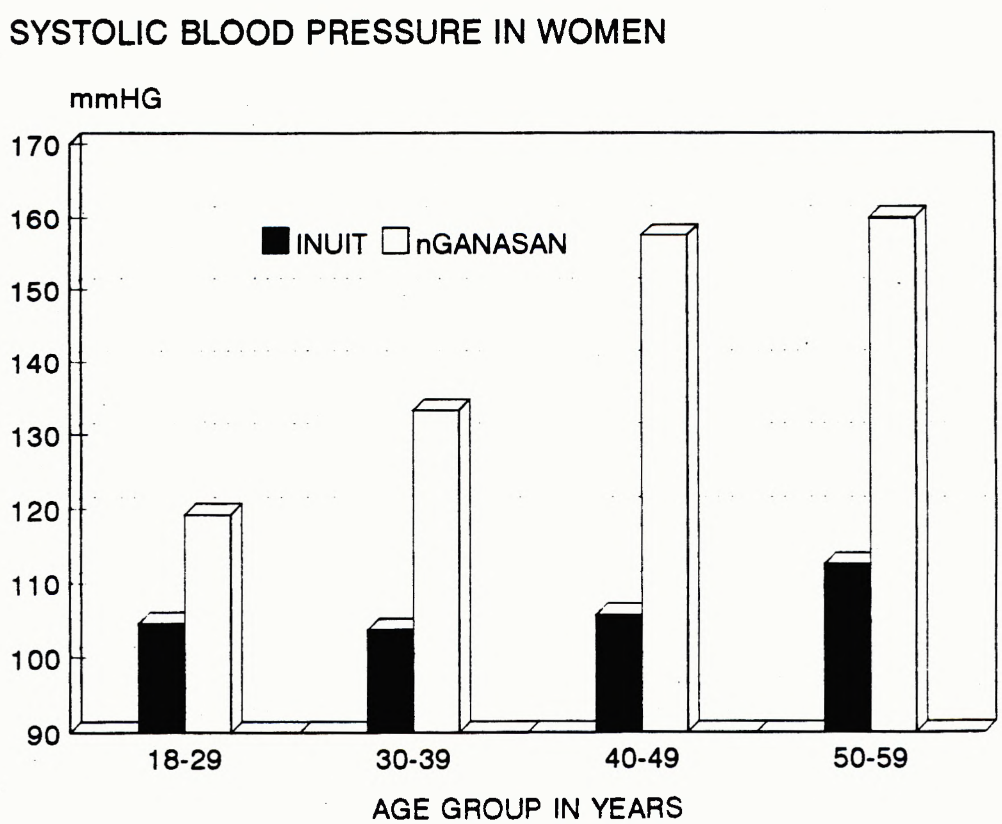


Figure 72. Systolic blood pressure in Inuit and nGanasan women aged 18-59 years.

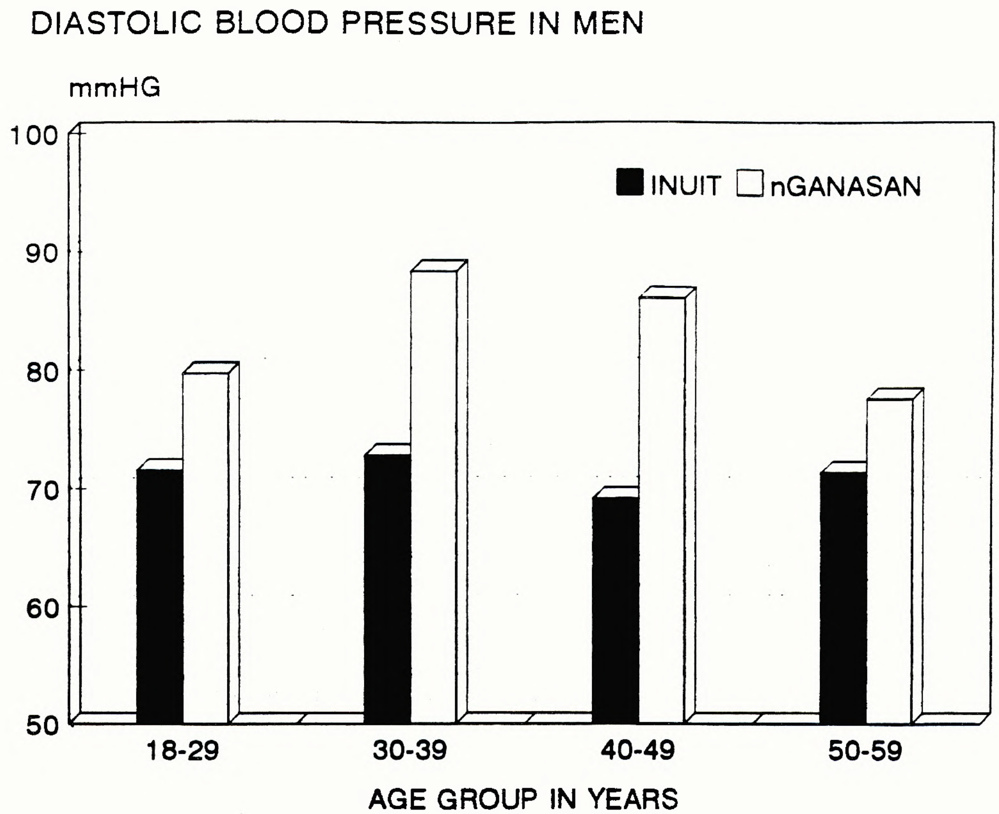


Figure 73. Diastolic blood pressure in Inuit and nGanasan men aged 18-59 years.

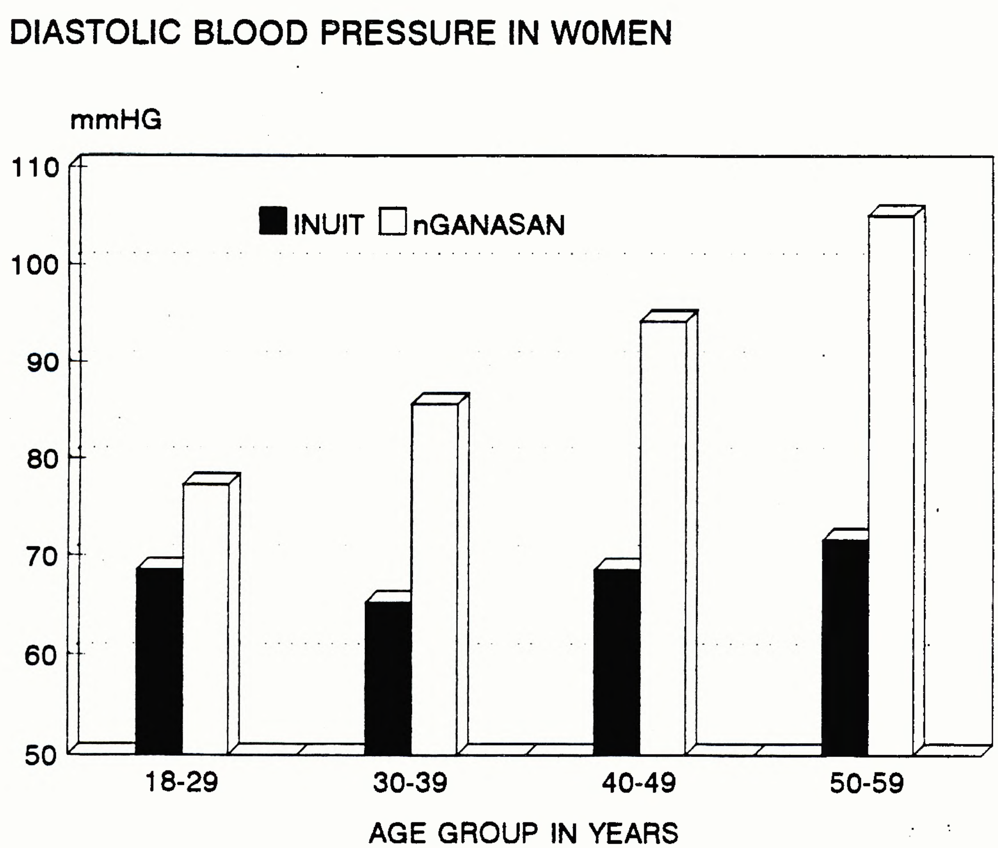


Figure 74. Diastolic blood pressure in Inuit and nGanasan women aged 18-59 years.

CHEST/WAIST RATIO IN MEN

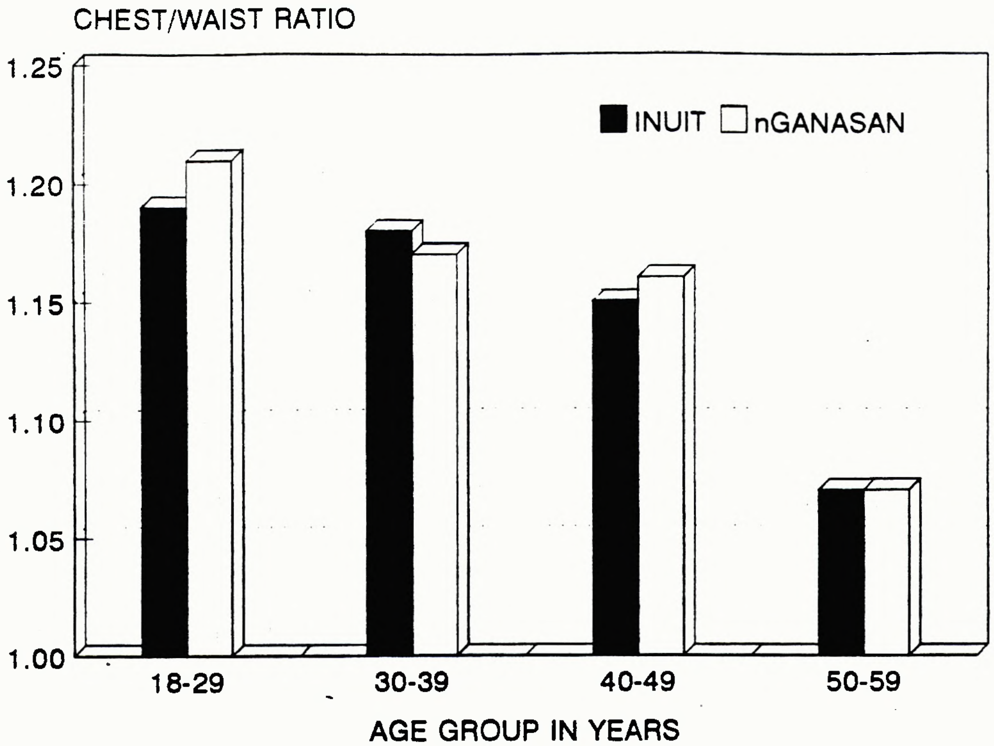


Figure 75. Chest/waist ratio in Inuit and nGanasan men aged 18-59 years.

CHEST/WAIST RATIO IN WOMEN

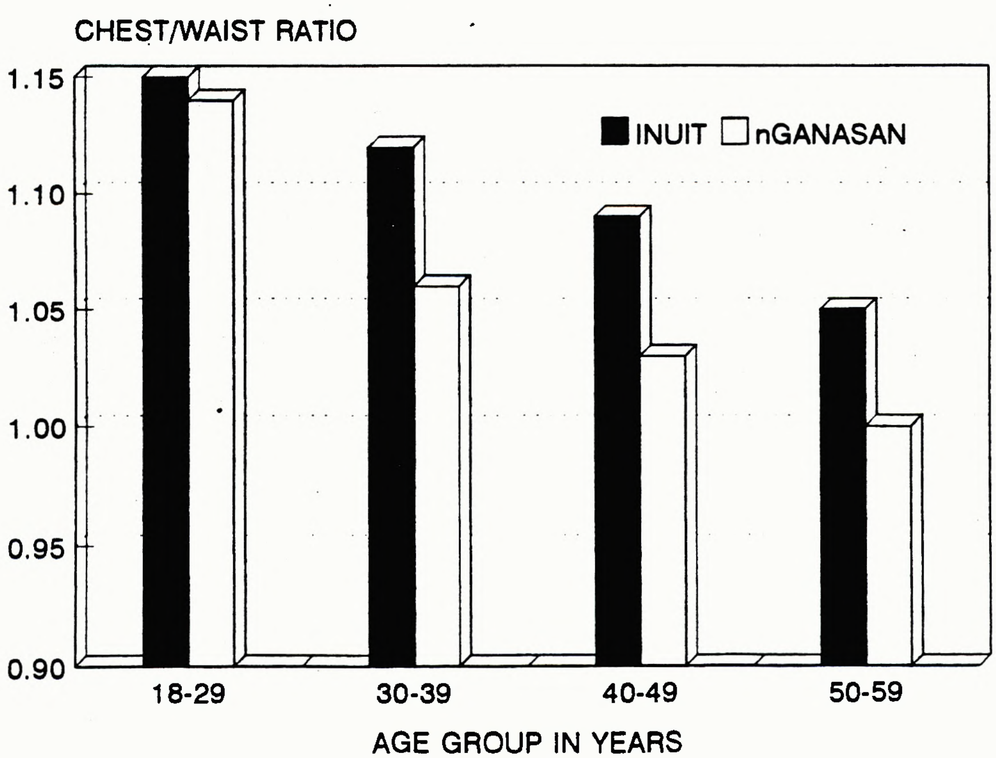


Figure 76. Chest/waist ratio in Inuit and nGanasan women aged 18-59 years.

3.5 Health Data for nGanasan

As explained in the introduction, we were not able to collect reliable additional data beyond what we, ourselves, had measured in our field laboratory. Our research group did not have an interpreter/translator to help us with a detailed analysis of the medical records held at the local "hospital". However, we did inspect a summary log of the cases seen by the nurses in 1991. We were told that all the cases seen in 1991 had not as yet (January 1993) been categorized and logged, indicating that their record keeping was less than optimal. Nevertheless, the data did give us an indication of some of the medical/social problems encountered in Volochanka. The table below highlights some of that data.

Alcoholism	71	Ischemic heart disease	8
Oligophrenia	55	Gastric/duodenal ulcer	5
Gastritis	29	Glaucoma	5
Hypertension	20	Nephritis	5
Chronic otitis media	18	Bronchial asthma	2
Bronchitis	17	Cancer	2
Chronic pneumonia	15	Eczema	2
Tonsilitis	11	Sore throat	2
Chronic gall bladder	9		

The most striking features of this data are the number of documented alcoholics (71 per ~ 1000 inhabitants) and the high rate of mental deficiency (55/1000). We were also surprised to see that there were only 20 recorded cases of hypertension and no mention of tuberculosis. In our sample of 75 adults we had seen 30 hypertensive individuals (DBP=>90, SBP=>160 mmHg); and, our interviews identified 19 of 146 individuals with a history of tuberculosis.

3.5.1 Alcohol and Violence

Alcohol abuse was the most visible symptom of the underlying social and economic problems in Volochanka. Drinking was a near-universal pastime indulged in at every opportunity by men, women, and even children. Alcohol was readily available and drunkeness appeared to be laregly tolerated. The preferred drink was Спирт ("Spirt", 95% alcohol). Home distilled alcohol or "Samagan" was also popular, common, and a readily available substitute provided by several local "entrepreneurs". The poorest drinkers made their own concoctions by fermenting any available sugar or starch based substances (primarily bread) to produce a brew known locally as "braga".

Drunks could be seen in the streets at any time, day or night. Workers were often intoxicated and drinking on the job was not uncommon. On one occasion, we had scheduled to test the 12 women employees of the local fur shop. Only two of them showed up for testing and told us that the rest were off work, drunk. Several times we had to turn away obviously intoxicated subjects who showed up at the laboratory for testing.

Violence was common, judging by the number of subjects who showed up for testing bearing old knife scars and fresh bruises. An informal interview with the "local" police officer (normally stationed in Dudinka, 350 km distant) on one of his rare patrols to the village, revealed that alcohol abuse was the cause of most, if not all, of his problems - theft, drunken fights, domestic violence, suicide, and murder. Unfortunately he was unable to provide us with any statistics, since all the records were held in Dudinka. However, during our relatively short stay in Volochanka, there were three tragic incidents that testified to the high level of alcohol-related violence in the village:

a) A couple left their flat to continue drinking at a friend's place, leaving their two young children at home. For security and "safety", they padlocked the door from the outside. While they were gone a fire broke out and the children perished.

b) One of the nurses was found dead with a knife in her heart. The death was ruled as a suicide by the "local" police officer.

c) A man in a drunken rage beat his wife unconscious with a nail-studded piece of lumber. Her injuries (multiple fractures and lacerations) were beyond the resources and skills of the local hospital staff and she was evacuated by helicopter to Dudinka, using up one of the few "medivac" flights allocated to Volochanka.

3.6 Discussion and Conclusions

3.6.1 General

In Igloolik, we had excellent living and working conditions, volunteer response was very good, and data collection was relatively routine. Conditions in Volochanka were much more difficult. In Volochanka we were unable to collect all of the data that we wanted, nor did we gain access to the number of volunteers that we had recruited in Igloolik. Our final sampling accounted for more than half of the adult population of Igloolik and about 32% of the Volochanka nGanasan. Nevertheless, despite the difficulties in Volochanka, we met or exceeded most of our original objectives.

The overall aim of our study was to compare the Native populations of two communities at differing stages of acculturation: Igloolik, NWT, Canada and Volochanka, Taimir, Russia in terms of growth and development, body composition, physical fitness, strength, and lung function. We also wanted to assess the relative cardiovascular risk factors in these two populations based on blood lipid profiles, blood pressure, smoking, and physical fitness. We hypothesised that:

1. Growth and development would be delayed, with smaller adult size in the less acculturated settlement of Volochanka;

2. Measures of health-related fitness would be higher in Volochanka; and

3. The proportion of subjects with major cardiovascular risk factors would be higher in Igloolik than in Volochanka.

Both the Iglulingmuit and the Volochanka nGanasan have experienced substantial cultural changes during the present century, but the nature, duration, and pace of change have been quite different for the two groups. The Inuit have seen very rapid changes in their material culture, but - at least in the Igloolik region - they have largely managed to preserve their cultural identity and language. The acculturation process began much earlier for the nGanasan than for the Iglulingmuit, with a particular impact during the Stalinist period of collectivization. The long period of Marxist-Leninist education has had a heavy influence on their culture and language, but has brought much less change in their material culture than the Inuit have experienced from the mid 1960s.

Our comparative studies focused on and revealed some of the physiological, biochemical, and anthropometric consequences of the two relatively different acculturation processes. However, our immediate inspection of Volochanka made it clear that the physical aspect of acculturation (activity patterns, nutrition) was not the only external factor affecting our comparisons: - obvious and large differences in the socio-economic status of the two communities were going to be an important dimension affecting our findings. Although we were quick to recognize the potential impact of socio-economic factors on the relative health and well-being of the two groups, unfortunately we lacked the resources to gather hard data to verify many of our impresssions.

During the past 30 years, the Iglulingmuit have gained full control of municipal government, with full participation in the regional and federal political process, and they now have a strong voice in nearly all decisions affecting their daily lives. Most importantly, the various levels of government operate in their own language. This introduces the concept of self-esteem which is an important element in the overall equation affecting health. In contrast, the nGanasan have essentially been "colonized" since the Stalinist era, with rejection of traditional cultural values, discouragement of local language, and ridgid indoctrination in Marxist-Leninist principles of state socialism. The concepts of self-esteem and their importance to health and well-being were not within our initial mandate, and we lack formal data to back-up our impressions. However, we mention the differences in self-esteem and socio-economic status of the two groups, recognizing that they are important potential factors affecting the relative health of the two populations of Aboriginal peoples.

For the nGanasan, the acculturation process had begun much earlier, in the late 1920s and early 1930s when they were forcibly collectivized and moved into villages and state farms.

Contrary to some recent reports, we found that the nGanasan exposure to processed market foods, formal schooling, and other characteristics of the currently dominant Russian culture was not only more prolonged but also more extensive than the Inuit exposure to the dominant North American culture. In the socio-cultural sense the nGanasan were **more**, rather than less, "acculturated" than the Inuit. On the other hand, in terms of physical aspects such as mechanization, access to labour-saving appliances, and the provision of municipal and other services, the nGanasan of 1990 have yet to approach levels that the Inuit were already experiencing in the late 1960s.

3.6.2 Fitness, Strength and Anthropometry

Height

Contrary to our expectations, there were no significant differences in the growth and development of Inuit and nGanasan children, nor were here any notable differences in the heights of adults.

In our earlier studies of the Inuit(13) we had found evidence suggesting a secular trend to increased height at any given age associated with acculturation to such aspects of "North American" lifestyle as limited physical activity and the consumption of processed foods. We had assumed that the nGanasan would still be in the early stages of acculturation to the dominant Russian culture with continued reliance on country food, and that in consequence growth, development and adult height would be comparable to what we had seen in the Iglulingmuit in 1970. Our hypothesis proved to be only partially correct. The Inuit at all ages are still shorter than the people of Southern Cananda, and they do not differ materially from the nGanasan. We do not have detailed information on protein intake, but doubt that the shorter stature is due to nutritional deficiencies. Rather, it seems a continuing expression of a limited gene pool in the two communities.

Body Mass and Composition

The Inuit men were heavier than the nGanasan at all ages, but the higher body mass in the Inuit was due primarily to larger accumulations of fat during middle age. Inuit men had significantly higher levels of subcutaneous and total body fat but the lean body mass was essentially similar in both groups of men at all ages. Setting as the limit for cardiovascular health 31% fat, equivalent to a 20% increase over ideal body mass, 4.4% of the Inuit and none of the nGanasan exceeded this level.

There were no significant differences between the two groups of women in subcutaneous fat, total body fat, or lean body mass. However, the young Inuit women were significantly lighter than their nGanasan counterparts, suggesting that they had accepted the current message of the North American media that "slim is beautiful". In Volochanka there is access to only 2 channels of state television, but these are free of advertisements where slim models are used to sell merchandise.

Both the Inuit and the nGanasan women had significantly higher levels of subcutaneous and total body fat than the men of their group. Again setting the clinical ceiling at 20% over ideal weight for height, equivalent to 35 % body fat, 33.1% of the Inuit and 37.5% of the nGanasan exceeded this level.

The Inuit children were heavier than the nGanasan (significantly so in the boys) and the Inuit boys and girls were significantly fatter than the nGanasan children at all ages.

Strength

In the men, grip strength was higher in the Inuit but leg extension force was superior in the nGanasan. Both groups of women had similar grip strength but the Inuit women had significantly higher leg strength.

Grip strength was similar for both groups of boys but the nGanasan boys (like the nGanasan men) had significantly higher leg strength. In the girls, grip strength was significantly higher for the nGanasan. The older Inuit girls had a higher leg strength but the differences were not statistically significant.

The higher grip strength in the Inuit men can probably be attributed to the ownership and use of powerful snowmobiles, something which is still relatively rare among the nGanasan. The superior leg strength in the nGanasan men is most likely due to the fact that much of their hunting and travelling is still done on foot or on skiis, whereas, in Igloolik, travel by snowmobile, all-terrain cycle, car, and truck is now near-universal. It is very common to see the Iglulingmuit using mechanized transport to cover even very short distances in and around the village. The forested parts of the Taimir also have more soft snow in winter, whereas in the Igloolik area a more limited snowfall is quickly packed to a firm surface by winds. In Volochanka there was no snow clearance or removal, whereas in Igloolik the streets are kept clear by snowplows and a snowblower.

The greater leg strength in the Inuit women and older girls is most likely due to the Inuit tradition of carrying babies and very young children on their backs in the large hoods of the woman's parka or "amauti" as they go about their daily routines and chores. There is no similar tradition among the modern-day nGanasan women.

Fitness

Neither population currently has an outstanding aerobic power. In the men, absolute aerobic power was significantly higher in the Inuit, but relative values were essentially similar in both groups, reflecting the higher total body fat burden seen in the Inuit men. The higher absolute aerobic power found in the Inuit men was contrary to expectations, given their relatively mechanized lifestyle. It may be that many of the villagers still do sufficient walking over snow-covered and rough surfaces to maintain their aerobic condition. The alternative hypothesis of a difference in intrinsic body build seems ruled out, since there were no significant differences in aerobic power between the two groups of women.

Aerobic Power

As a group, the Inuit boys and girls had significantly higher absolute and relative aerobic power than did the nGanasan children. Factors that could explain the lower aerobic power in the nGanasan children might include:

1. Lack of appropriately protective winter clothing. Most of the nGanasan children that we saw were poorly clothed. Good winter boots, mitts, and parkas were a rarity. Thus, it was not surprising that we rarely saw children playing outside during our stay in Volochanka. This was in stark contrast to Igloolik, where the children are well-dressed and play outside even in the coldest weather, even when (especially when!) school is closed due to blizzard conditions.

2. Lack of indoor recreational/sports facilities. In Volochanka, the only indoor sports facility is a small gymnasium at the school, but we rarely saw it being used as such either during or outside school hours (our "laboratory" was situated a few doors down the corridor from the gym so that we had a good impression of utilization during a period of about 3 months). Unlike Igloolik (which boasts a large gym with a regulation sized basketball court, an indoor arena and curling rink, swimming pool, and recreation hall) there were no organized sports or recreational programs in Volochanka.

Listening to the nGanasan talk about their pastimes and activities, we gained the impression that they were much more active physically in the spring, summer, and fall than during the bitter months of the Taimir winter. We heard tales of great distances (hundreds of kilometers) covered on foot by hunters, trappers, and ivory seekers (fossilized mammoth tusks and teeth continue to be a valuable source of cash in this region). Women and children also spent long hours roaming over large areas gathering berries and mushrooms (not commonly found in the Igloolik area) and looking for ivory in the summer and fall. Thus, there may be a substantial seasonal summer/winter fluctuation in fitness in the nGanasan, an effect that we once postulated but did not find in the Iglulingmuit.[14]

Dynamic Lung Volumes

With the exception of a higher FVC in the Inuit girls, there were no significant differences in dynamic lung volumes between the two groups of men, women, and children. However, regression equations showed a lower ageing coefficient for both FEV and FVC in the nGanasan men and women. These results were surprising given that:

1. The coal-fired heating and cooking facilities in Volochanka were a source of both indoor and outdoor air pollution that was not seen in Igloolik. Calm weather and/or temperature inversions resulted in episodes of particularly heavy air pollution in Volochanka for some 10% of the period of our visit;

2. Living conditions were much more crowded in the nGanasan homes and thus the burden of indoor air pollution from both coal and tobacco smoke was much greater for the nGanasan; and

3. The proportion of cigarette smokers and the estimated daily cigarette consumption was similar in both groups of men, although less in the nGanasan women. It may be that the modern Canadian tendency to construct buildings that allow almost zero ventilation in winter months led to higher indoor pollution levels in Igloolik, despite the availability of central heating. The rapid introduction of modern hospital faclities may have created inter-cohort differences not seen with the slower paced acculturation and simple medical facilities of Volochanka.

3.6.3 Lipid and Fatty Acid Profiles

General

Volunteer response for the blood studies exceeded our expectations and the sample analyses provided by Dr. A. Kuksis' laboratory at the Banting and Best Institute, University of Toronto, was far more detailed than we had anticipated (detailed profiles were obtained on 12 lipids and 17 fatty acids **for both plasma and serum samples**). Our Russian colleagues (Dr. Lev Panin and Dr. Pavel Vloshinsky) at the Institute of Biochemistry in Novosibirsk performed additional analyses on aliquots of the same samples for plasma VLDL, LDL, HDL2, HDL3; serum enzyme activity (AST, ALT, GGT); the rate of glycolysis in hemolysed erythrocytes; serum hormones (cortisol, insulin, T3, and T4); and, VLDL, LDL, and HDL serum cholesterol. Unfortunately, we have to date only had sufficient resources to do a preliminary statistical analysis on a portion of the data generated by the plasma samples. The results of that statistical analysis are presented in this report.

However, in addition to the data from the samples analysed by the Russians, we also have data on serum profiles (as distinguished from plasma profiles) for both lipids and fatty acids that require further statistical analyses. Of particular interest are the data from the 194 **paired** plasma and serum samples. Our preliminary inspection of this data suggests that there are substantial differences in lipid and fatty acid concentrations between plasma and serum concentrations in samples collected from the same subjects. If, as we suspect, these differences prove to be statistically significant, there could be important practical implications for future blood sampling, analyses, and use and application of the results.

Plasma Lipids in Inuit

In the Inuit, there were significant gender differences in 5 of the 12 plasma lipids, with the women showing higher concentrations of free cholesterol, phosphatidyl choline, diglyceride + ceramide, total phospholipids, and sphingomyelin.

Phosphatidyl choline and the PC/FC ratio showed significant decreases with age in both men and women. The men showed significant increases in sphingomyelin concentrations with age; there was a similar trend in the Inuit women, but the effect was not statistically significant.

Plasma Lipids in Inuit versus nGanasan

The Inuit and nGanasan populations showed significant differences in only 2 of the 12 plasma lipids. There were large and highly significant differences in the total fatty acid concentrations, with substantially higher concentrations ($\approx$220%) in the Inuit for both men and women. The only other notable difference between the two groups was seen in the men, with the Inuit showing significantly higher sphingomyelin concentrations. Although all samples were obtained in the fasting state, these values presumably reflect mainly dietary differences between the two populations.

3.6.4 Unsaturated Fatty Acids

The most striking finding in the Inuit data is the steep age gradient in plasma concentrations of total omega-3 (ΣW3) and omega-6 (ΣW6) fatty acids. Although values for the younger Inuit are not remarkable, values for the older members of the Igloolik community show very high plasma concentrations of ΣW3. These findings are best explained by a high intake of country foods (arctic char and marine mammals) among the older Inuit. Such a hypothesis is supported by the age-related gradient in plasma levels of the individual omega-3 fatty acids; the main gradients are for the 20:5W3 and 22:6W3 components, which are derived primarily from marine foods.[15] We have recognized that the community is currently undergoing a rapid transition from country to market foods, and that the younger Inuit are apparently the most acculturated members of this population.[16]

The traditional coastal Inuit have a low serum trigylceride level.[17] Adoptation of a fish or fish oil diet also reduces serum triglyceride levels[18, 19, 20, 21, 22, 23] and (if eicosapentanoic acid outweighs docosohexanoic acid) increases HDL2 cholesterol.[18, 20, 21, 23] Such a change has many favourable health effects: the tendency to thrombus formation is reduced, with a decreased risk of atherosclerotic disease, and there are also reductions of joint pain in rheumatoid arthritis, healing of ulcerative colitis, and a decreased vulnerability to a variety of tumours. It has been argued that humans evolved with adaptation to a ΣW6/ΣW3 ratio of around 1.0,[24] and plainly the traditional coastal Inuk remains close to this standard. The young Inuit and nGanasan are far from this ideal ratio, although in many instances still comparing favourably with city dwellers. Further, the older, traditional Inuit had approximately a 2:1 balance of 20:5W3/22:6W3 fatty acids, again a favourable ratio in terms of lipid profile.[20]

The correlation matrices suggest that as the diet of fish and marine mammals has been abandoned, and the ΣW3 FA levels have fallen, the Inuit have shown a rise of plasma triglycerides. There is also a rise in the PC/FC ratio, which at first inspection seems at varience with the published association between a low PC/FC ratio and heart disease in urban subjects.[15]

The nGanasan subjects underwent an enforced displacement from the tundra into settlements with an economy based upon the collective farming of reindeer during the early 1930s. As tundra residents, their consumption of unsaturated fatty acids had probably always been lower than that of coastal Inuit, and ready access to reindeer meat further reduced their intake of omega-3 fatty acids. Thus, even the oldest nGanasan now have lower ΣW3 FA levels than the traditional Inuit. Moreover, the ratio of 20:5W3/22:6W3 FA shows an unfavourable 1:2 ratio. Nevertheless, the ΣW6/ΣW3 ratio of 3-5 remains far below the value of 10-25 that characterizes the urban North American. It is unclear how far this reflects the heavier level of physical effort demanded of life on a tundra collective farm, and how far it may be attributed to a diet of the exceptionally lean reindeer meat rather than the fat-marbled, force-fed beef of the North American diet.

The older coastal Inuit have almost optimal plasma ratios of ΣW6/ΣW3 FA, with a high ratio of 20:5W3 to 22:6W3 FA, suggesting the continued choice of a diet rich in fish and marine mammals. However, these favourable trends are less evident in younger Inuit, probably as a consequence of acculturation of more recent generations to market food. Plasma triglyceride concentrations show the expected negative relationship to the ΣW3 FA levels, and recent changes in dietary patterns seem likely to increase the prevalence of coronary atherosclerosis and other forms of chronic disease as those who are consuming market foods reach a coronary prone age. nGanasan subjects living on the Taimir tundra do not show any age gradient of the ΣW3 FA. It is argued that this population has for many decades drawn its protein largely from reindeer supplemented by other country game. The ΣW6/ΣW3 ratio for the nGanasan is much higher than in the traditional coastal Inuit, but has not yet reached the peaks seen in North American urban society.

3.6.5 Cardiovascular Risk Factors

The relative prevalence of major cardiovascular risk factors in the two populations was contrary to our initial expectations, with the nGanasan showing a higher proportion of men and women at risk than the Inuit. The most remarkable risk factor distinguishing the two populations was the significantly higher average blood pressures in the nGanasan. An indirect, high-salt diet may be a contributing factor. Because refrigeration is not commonly available in Volochanka, villagers use large quantities of salt in preserving and smoking fish and meat. In fact, one of the few staples that **was** available in relative abundance at the village store was large burlap sacks of salt. There is a need for more formal comparisons of salt intake in Igloolik and Volochanka. The blood pressures of the nGanasan could also be increased by various stressors, including:

1. very crowded living conditions;

2. the constant concern over and the effort needed to procure the basic necessities of life such as food, clothing, and coal for heat, etc;

3. high levels of alcohol consumption and violence in the community; and

4. little or no control over the events governing their daily lives.

4. RECOMMENDATIONS

1. There is a need for a detailed, up-to-date dietary and nutrition survey for the Inuit population. The information would be very useful to public health professionals, educators, and scientists. Currently very little data is available linking diet to other nutritional indices in the Canadian Inuit.

2. Our preliminary findings on the differences in lipid and fatty acid concentrations between plasma and serum samples merit further investigation.

3. Nunavut school boards should be encouraged to include in their curriculum from the earliest grades the most recent scientific findings on Native peoples (such as the data reported here) to emphasize the deleterious effects of:

   a) reduced habitual physical acivity;

   b) poor diet (including the potential negative consequences of changing from traditional to market foods);

   c) smoking; and

   d) sedentary lifestyles.

   It is important that the educational material is current with what can be seen and read in the media and that it reflect reality as found in Native communities.

4. A more innovative and aggressive anti-smoking campaign is required in the circumpolar school systems. To date, our approach to smoking prevention among the Inuit has been largely ineffective. Over 80% of the adults still smoke and the number of children and student smokers is now much higher than it was 20 years ago. The methods and campaigns used to discourage smoking to date have failed. We need a better understanding of what makes smoking attractive to young Native people and then offer equally attractive alternatives.

5. Advantage should be taken of the strong data base currently available for Igloolik to study on an ongoing basis the prevalence of diabetes mellitus and its complications.

6. Detailed knowledge of family trees should be used to quantify the inherited component of the variables measured.

7. Given the rapid pace of acculturation in Igloolik, it will be important to collect further benchmark data on this community in the winter of 1999-2000.

APPENDIX: Fatty Acid Profiles in Canadian Inuit and Siberian nGanasan Men and Women Showing Age-grouped Data for Individual Fatty Acids (Tables 48-55)

Table 48. Fatty acid profiles in Canadian Inuit men. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %) 14:0	15:0	16:0	16:1W7	16:0DMA	18:0	18:1W7	18:1W9	18:0DMA	22:0
18-29	0.90	0.24	21.0	3.22	0.36	7.25	3.50	25.2	0.22	0.49
	0.30	0.04	2.0	1.27	0.15	0.87	0.82	3.9	0.08	0.11
	29	29	29	29	29	29	29	29	29	15
30-39	0.99	0.27	21.9	3.75	0.41	7.81	3.66	22.5	0.24	0.57
	0.28	0.05	1.8	1.36	0.19	1.07	1.01	3.5	0.11	0.18
	18	18	18	18	18	18	18	18	18	11
40-49	0.78	0.23	21.2	4.89	0.47	8.21	4.55	20.6	0.29	0.39
	0.14	0.03	1.8	1.74	0.19	1.01	1.28	4.1	0.14	0.07
	17	17	17	17	17	17	17	17	17	13
50-59	0.83	0.26	20.9	5.26	0.55	8.06	8.36	19.0	0.36	0.40
	0.14	0.04	3.2	1.53	0.31	1.74	14.75	4.4	0.16	0.12
	16	16	16	16	16	16	16	15	16	10
60-69	0.78	0.22	21.5	5.26	0.67	8.59	3.94	21.7	0.36	0.28
	0.16	0.02	0.9	1.67	0.47	1.28	1.24	1.4	0.19	0.04
	4	4	4	4	4	4	4	4	4	3
70-79	0.79	0.23	22.5	4.91	0.83	8.98	3.48	18.4	0.48	0.40
	0.21	0.03	0.8	1.20	0.32	0.39	0.54	1.2	0.12	0.07
	3	3	3	3	3	3	3	3	3	3

Table 49. Omega-3 and omega-6 fatty acid profiles in Canadian Inuit men. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %)						
	18:2W6	20:3W6	20:4W6	18:3W3	20:5W3	22:5W3	22:6W3
18-29	27.0	1.05	3.34	0.56	2.00	1.07	2.37
	5.4	0.29	0.76	0.39	2.05	0.42	1.01
	29	29	29	29	29	29	29
30-39	23.2	0.87	4.08	0.48	4.19	1.48	3.40
	5.1	0.26	1.21	0.15	3.52	0.53	0.98
	18	18	18	18	18	18	18
40-49	17.4	0.69	4.45	0.40	8.65	1.73	4.74
	6.0	0.15	1.40	0.23	4.87	0.65	1.34
	16	16	16	16	16	16	16
50-59	14.6	0.70	4.96	0.36	9.47	1.90	4.68
	4.4	0.18	1.32	0.13	3.54	0.53	1.67
	16	16	16	16	16	16	16
60-69	15.1	0.65	5.03	0.32	8.15	1.90	5.17
	2.1	0.13	1.04	0.10	1.66	0.39	0.80
	4	4	4	4	4	4	4
70-79	15.8	0.73	5.76	0.26	8.83	1.77	5.86
	0.7	0.03	1.17	0.07	0.78	0.22	0.59
	3	3	3	3	3	3	3

Table 50. Fatty acid profiles in Canadian Inuit women. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %) 14:0	15:0	16:0	16:1W7	16:0DMA	18:0	18:1W7	18:1W9	18:0DMA	22:0
	0.90	0.23	21.6	3.52	0.34	7.15	3.20	24.7	0.19	0.52
18-29	0.21	0.04	2.0	0.82	0.12	1.26	0.52	3.2	0.06	0.12
	22	22	22	22	22	22	22	22	22	13
	0.84	0.24	22.2	4.00	0.42	8.31	3.38	22.0	0.24	0.49
30-39	0.21	0.03	1.4	1.14	0.12	1.23	0.65	2.3	0.07	0.11
	15	15	15	15	15	15	15	15	15	12
	0.84	0.23	21.1	4.46	0.60	8.75	3.13	20.4	0.33	0.43
40-49	0.15	0.03	4.4	1.25	0.22	0.89	0.60	2.8	0.11	0.09
	7	7	8	7	7	8	7	8	7	6
	0.79	0.24	21.3	4.84	0.49	9.16	4.26	20.4	0.31	0.40
50-59	0.13	0.02	1.7	1.01	0.17	1.22	1.10	4.0	0.12	0.13
	12	12	12	12	12	12	12	12	12	9
	1.00	0.24	22.9	5.86	0.37	7.83	3.82	22.9	0.20	0.47
60-69	0.47	0.02	2.0	1.51	0.11	1.19	1.04	4.5	0.04	0.10
	3	3	3	3	3	3	3	3	3	3

Table 51. Omega-3 and omega-6 fatty acid profiles in Canadian Inuit women. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %)						
	18:2W6	20:3W6	20:4W6	18:3W3	20:5W3	22:5W3	22:6W3
18-29	27.5 4.8 22	1.27 0.35 22	3.30 0.62 22	0.45 0.12 22	1.81 1.81 22	0.92 0.40 22	2.29 0.88 22
30-39	23.3 4.9 15	0.88 0.20 15	4.13 1.09 15	0.42 0.08 15	4.14 2.95 15	1.38 0.58 15	3.62 1.09 15
40-49	18.2 6.8 7	0.71 0.10 7	5.12 1.24 7	0.47 0.14 7	6.64 2.80 7	1.70 0.71 7	5.11 1.55 7
50-59	15.6 3.8 12	0.74 0.11 12	5.20 1.31 12	0.41 0.14 12	9.11 3.86 12	1.84 0.60 12	4.50 1.00 12
60-69	14.9 3.1 3	0.77 0.09 3	4.36 0.93 3	0.32 0.03 3	6.57 1.54 3	1.76 0.37 3	5.31 0.82 3

Table 52. Fatty acid profiles in Siberian nGanasan men. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %)									
	14:0	15:0	16:0	16:1W7	16:0DMA	18:0	18:1W7	18:1W9	18:0DMA	22:0
18-29	1.24	0.35	23.5	2.64	0.51	8.58	2.73	14.8	0.36	0.61
	0.34	0.07	2.3	0.94	0.21	1.38	0.93	6.5	0.15	0.14
	16	16	16	16	16	16	16	16	16	16
30-39	1.06	0.32	23.5	2.82	0.64	8.38	2.22	14.5	0.43	0.60
	0.20	0.04	2.2	0.56	0.22	0.80	0.71	7.2	0.14	0.17
	7	7	7	7	7	7	7	7	7	7
40-49	1.24	0.27	24.9	2.98	0.91	8.32	2.61	14.9	0.61	0.54
	0.41	0.06	2.1	0.81	0.77	0.64	1.24	7.9	0.52	0.15
	4	4	4	4	4	4	4	4	4	4
50-59	0.87	0.30	25.2	3.16	0.95	9.53	1.36	8.0	0.63	0.70
	0.16	0.03	4.3	1.07	0.15	0.45	1.37	8.0	0.08	0.27
	3	3	3	3	3	3	3	3	3	3

Table 53. Omega-3 and omega-6 fatty acid profiles in Siberian nGanasan men. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %)						
	18:2W6	20:3W6	20:4W6	18:3W3	20:5W3	22:5W3	22:6W3
18-29	28.8	0.85	6.26	0.56	2.44	1.84	3.96
	6.7	0.12	1.95	0.12	1.15	0.65	0.85
	16	16	16	16	16	16	16
30-39	27.7	0.75	7.57	0.56	3.02	1.90	4.01
	5.9	0.13	1.63	0.12	1.03	0.32	0.92
	7	7	7	7	7	7	7
40-49	24.0	0.75	7.92	0.54	3.48	1.92	4.14
	3.4	0.26	4.66	0.24	1.66	0.62	1.14
	4	4	4	4	4	4	4
50-59	25.1	1.08	11.77	0.74	3.78	1.78	5.05
	4.3	0.19	0.88	0.06	0.42	0.92	0.80
	3	3	3	3	3	3	3

Table 54. Fatty acid profiles in Siberian nGanasan women. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %) 14:0	15:0	16:0	16:1W7	16:0DMA	18:0	18:1W7	18:1W9	18:0DMA	22:0
18-29	1.02	0.32	22.5	2.30	0.52	7.65	2.81	13.1	0.33	0.68
	0.35	0.13	2.5	1.01	0.08	0.51	1.05	6.0	0.03	0.21
	7	7	7	7	7	7	7	7	7	7
30-39	0.94	0.27	22.2	3.25	0.69	8.05	2.64	20.9	0.50	0.63
	0.23	0.01	2.0	0.59	0.33	0.91	0.17	3.5	0.27	0.07
	2	2	2	2	2	2	2	2	2	2
40-49	0.74	0.21	24.6	3.20	0.92	8.38	2.70	17.5	0.64	0.56
	0.10	0.06	2.1	0.02	0.13	0.95	0.29	2.8	0.00	0.15
	2	2	2	2	2	2	2	2	2	2

Table 55. Omega-3 and omega-6 fatty acid profiles in Siberian nGanasan women. Values shown are the mean, standard deviation, and sample size.

AGE GROUP (yr)	CONCENTRATION (weight %)						
	18:2W6	20:3W6	20:4W6	18:3W3	20:5W3	22:5W3	22:6W3
18-29	31.3	1.07	7.36	0.52	2.68	1.51	4.44
	9.2	0.22	2.87	0.14	2.17	0.69	1.32
	7	7	7	7	7	7	7
30-39	25.5	1.41	6.47	0.39	1.16	1.91	3.12
	2.6	0.12	1.21	0.09	0.30	0.42	0.36
	2	2	2	2	2	2	2
40-49	20.6	0.79	9.52	0.48	2.99	1.85	4.31
	1.3	0.18	0.09	0.17	0.52	0.20	0.58
	2	2	2	2	2	2	2

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