Hypertension among the Inuit from Nunavik: should we expect an increase because of obesity?

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Received 16 September 2009; Accepted 5 July 2010

ABSTRACT

Objectives. Because of their recent adoption of a Westernized lifestyle, an increased risk of developing hypertension (HTN) is suspected among Inuit populations. This study aimed to assess the exact prevalence of HTN in Nunavik Inuit and to examine its association with other major risk factors of cardiovascular disease.

Study design. A cross-sectional population-based study.

Methods. We analysed biological and anthropometric data and the medical history of 832 Inuit.

Results. The overall prevalence of HTN (≥140/90 mmHg or the use of medication) was 19% with no gender difference. Obesity (body mass index [BMI] ≥30 kg/m²) was the highest prevalent cardiovascular risk factor (23%), and was significantly associated with HTN (OR for BMI<25 kg/m² vs. BMI 30–34 kg/m²: 7.9 [3.5–17.9]; OR for BMI<25 kg/m² vs. BMI ≥35 kg/m²: 14.4 [5.6–36.7]). An increase in odds of prehypertension (preHTN) (130–139/80–89 mmHg) was also observed as the BMI increased (p for trend, p<0.0001).

Conclusion. The prevalence of HTN in the Inuit populations has reached values similar to those of their Westernized counterparts. Furthermore, not only HTN but also preHTN states are significantly associated with obesity even after adjusting for confounding variables. These results clearly indicate that HTN is becoming a growing health challenge in Nunavik because of pandemic obesity.

(Int J Circumpolar Health 2010; 69(4):361–372)

Keywords: Hypertension, prehypertension, obesity, Inuit, abdominal obesity, fat
INTRODUCTION

Hypertension (HTN) is known to be a major modifiable risk factor of cardiovascular diseases (CVD), including coronary heart disease (CHD) and stroke (1,2). Obesity has been recognized as a key factor in the causal chain leading to HTN in humans (3–5). This strong association has been observed in many epidemiological studies in different ethnic groups of all ages and both genders (3–5).

Several CVD, such as CHD, have been reported to be rare among Inuit populations, whereas cerebrovascular diseases were more common (6–9). The Inuit traditional way of life and particularly their omega-3 fatty acid-enriched diet are thought to have a strong influence on these events. Nevertheless, the recent transition towards a Westernized lifestyle which includes changes in dietary habits and physical activity has been postulated to explain a possible increment in CVD risks (4,10,11), including HTN.

Results from the 1992 health survey among Nunavik Inuit revealed that systolic blood pressure (SBP) was remarkably low (112 mmHg) compared to southern populations (5,12), despite a 19% prevalence of obesity (body mass index [BMI] ≥30 kg/m²) (13). A preliminary observation of the 2004 Nunavik health survey disclosed that high blood pressure (≥140/90 mmHg) in this population has nearly doubled in 12 years (14). In parallel, we noticed a 9% increase of obesity during the same period (14).

Thus, the aim of our study is to assess the prevalence of HTN in Nunavik Inuit, a population in which endemic obesity is rapidly reaching levels comparable to southern populations (15). This study also examines the association of hypertension in this population with other major risk factors of cardiovascular diseases.

MATERIAL AND METHODS

Population, study design and participation
This study, representing the baseline of the “Circumpolar Inuit Health in Transition” cohort, was conducted during the Nunavik Health Survey entitled Quanuippitaa? How are we? This health survey was conducted from August to October 2004 among the Inuit adult population (aged 15 and over) residing in the 14 Nunavik communities, except for residents of collective dwellings and households in which there were no Inuit aged 18 years or older. Interviews and examinations were conducted on the Canadian Coast Guard icebreaker the CCGS Amundsen, which visited the 14 Nunavik communities.

The survey plan was a stratified random sampling of private Inuit households. The community of residence was the only stratification variable used. Among the 677 households visited, 521 agreed to participate in the survey. The household response rate was thus 78%. A total of 1,056 individuals signed a consent form and completed at least 1 structured interview or clinical assessment. Among adults (18–74 years of age), 914 agreed to participate in a longitudinal follow-up component of the study. This component involved permission to follow participants over time as well as permission to review and abstract information in individual medical files.

In the present analysis, we excluded pregnant women (n=26), non-Inuit residents (n=20), people taking non-steroidal anti-inflammatory
drugs (16) and individuals for whom we had incomplete data on anthropometric and arterial pressure measurements (n=36) from the original sample. The final sample included 832 participants. During the survey, we asked the participants to fast at least 8 hours before venipuncture for the collection of data on unbiased basal biological parameters. Some participants did not conform to this request and were thus excluded from analysis on glucose, insulin and triglycerides parameters (n=135).

The survey was approved by the Ethics Committees of Université Laval and Santé Publique du Québec. Participants provided their written consent before completing the interviews and clinical tests.

**Instruments and laboratory analysis**

During the clinical session, the participants were interviewed about their health status by a registered nurse (questionnaires were available in English and Inuktitut). Their health status was corroborated by a review of their medical files during the summer of 2005 by 2 nurses. The participants then underwent venipuncture and physical measurements, including anthropometric assessments. All interviews, clinical tests and anthropometric evaluations were conducted according to standardized protocols as follows.

**Anthropometric measurements**

Participant height was quantified with a stadiometer with each person standing barefoot on a hard surface against a wall. Body weight and body composition were measured with a bioelectrical impedance analyser (Tanita TBF-300, GHT, IL, USA). The percentage of body fat (%BF) was used as a continuous as well as a dichotomous variable (high %BF: ≥30 cm in men and ≥40 cm in women). Waist circumference (WC) was measured in centimetres using a graduated inelastic tape at the narrowest circumference of the trunk, at the end of a normal expiration. If a subject’s waist was not sufficiently defined, WC was measured at roughly slightly below the last floating rib. Hip circumference (HC) was quantified by placing the measuring tape horizontal to the hips at the pubic symphysis and the most prominent part of the buttocks. These values were recorded to the nearest centimetre. The mean of 4 measurements was used for statistical analysis. We determined obesity in the population according to internationally recommended cut-off points, such as BMI ≥30 kg/m² (17). The designation of abdominal obesity was based on WC (≥102 cm in men and ≥88 cm in women), according to cut-off levels proposed by the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) (18). The waist-to-hip ratio (WHR) and waist-to-stature ratio (WSR) were calculated as the WC divided by the HC or height in centimetres, respectively. Both variables were used according to their continuous or dichotomous form. High WHR were ≥0.90 in men and ≥0.85 in women. High WSR was defined as greater or equal to 0.65 (19,20).

**Blood pressure values and the definition of hypertension**

Blood pressure (BP) was measured by the Canadian Coalition for High Blood Pressure technique (21) with mercury sphygmomanometers, 15-inch stethoscopes and cuffs sized to the subjects’ arms. Prior to the BP measurement, the study subjects had to rest for 5 minutes and had not to have eaten or smoked for at least 30 minutes. Each subject had 3 BP readings. Mean BP was calculated from the last 2 measurements. Mean BP was calculated from the last 2 measurements. An individual was defined as having HTN if
his/her BP was at least 140/90 mmHg (22) or if he/she had a previous diagnosis of HTN with or without medication. Moreover, individuals with systolic blood pressure (SBP) of 120–139 mmHg and/or diastolic blood pressure (DBP) of 80–89 mmHg were classified as prehypertensive (preHTN). People below these BP ranges were classified as normotensive (NTN) (23). The mean of pulse pressure was defined as the difference between SBP and DBP.

**Biological parameters**

After centrifugation, all tubes were labelled and stored at -80°C onboard the Amundsen. They were then sent to the Centre hospitalier de l’Université Laval (CHUL) where they were analysed for complete lipid profile, glucose and insulin concentrations.

Biochemical measurements were performed with the Auto-Analyzer II (Technicon Instruments Corporation, Tarrytown, New York) and reagents from Roche Diagnostics (Laval, QC, Canada). Fasting plasma glucose levels were assessed (reference value [RV]: 3.6–5.8 mmol/L), along with total cholesterol (Chol) and triglycerides. The high-density lipoprotein cholesterol (HDL-C) fraction was obtained after the precipitation of other lipoproteins. Low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald formula (24).

Fasting plasma insulin levels were measured with the Elecsys-2010 system from Diagnostics (Laval, QC, Canada). Reference values for insulin are 0–150 pmol/L. Insulin sensitivity was evaluated by homeostasis model assessment (HOMA-IR). HOMA-IR was defined by the product of fasting insulin and glucose concentration divided by 22.5 (25). Menopausal status was determined by self-reported information collected during the structured interview supplemented by medical file data such as hysterectomy, ovariectomy or hormone therapy.

**Statistical analyses**

All the data were analysed by the bootstrap technique, taking into account the complex sampling strategy used and to correct for related errors. Analyses were also weighted to achieve representativeness of the study population. Weights were adapted to the non-response rate of each measuring instrument.

For normally distributed variables, arithmetic means were calculated and were accompanied by their corresponding standard error (SE). Geometric means were considered for variables with a log-normal distribution. The analysis of variance allowed us to compare arithmetic or geometric means, and the chi-square test with corrections for a design effect was included to compare proportions. Ordinal logistic regressions were performed to evaluate the odds of hypertension or prehypertension with regards to major independent risk factors, namely, morphological measures (BMI, WC, WHR, WSR or %BF), adjusting for potential confounders. NTN was considered as the reference category. Odds ratio obtained were accompanied with 95% confidence intervals. Variables were deemed to be confounders when their inclusion in the model modified the regression coefficient of major independent risk factors by more than 10%. The potential confounders evaluated in all multivariate analyses were age, gender, blood lipid profile markers (HDL-C, total C, LDL-C, triglycerides), fasting glucose, fasting insulin and HOMA-IR.

To better describe the relationship between blood pressure and its main risk factor, we...
performed a multivariate regression analysis, excluding people with HTN or type 2 diabetes (T2D) (n=170). Type 2 diabetes diagnosis was obtained by analysing data from the medical files. Statistical analyses were conducted at a threshold of \( \alpha = 0.05 \). All analyses were undertaken with SAS v. 9.1 and SUDAAN v.9.3 software (SAS Institute, Cary, NC, USA).

RESULTS

Women represented 50.3% of the sample retained in our analysis. The overall prevalence of HTN was 19.0±1.3% (mean±SE). As reported in Figure 1, the prevalence increased with age and reached 76% among elders (≥65 years), with gender differences only detected in the 18–24 age group (men: 10.0% vs. women: 2.5%, p=0.02).

We found a prevalence of self-reported HTN of 17.0±1.2%. However, among these self-declared HTN participants, we only found a mention of HTN in the medical record in 50.0% of the cases. Consistently, the agreement measure between HTN reported in the medical file and auto-declared HTN was poor (kappa=0.51; p<0.0001). In addition, among participants with a mention of HTN in their medical file, 28.0% were unaware of their disease.

Moreover, the proportion of HTN under control, defined as the number of treated hypertensive individuals with BP <140/90 mmHg divided by the total number of hypertensives (26), was 17.0%. The proportion of treated hypertensives under control was 26.0%. These results suggest inadequate screening, diagnosis and management of HTN.

Table I presents the cardio-metabolic characteristics of the study population adjusted for age and gender according to HTN categories. We observed a difference in gender proportion in the preHTN group (men 40.9±2.3 vs. women 22.3±1.8, p≤0.0001). Similar gender difference was observed in the NTN group (men 38.1±2.3 vs. women 60.4±2.0, p≤0.0001), but not in the HTN group (men 21.1±1.7 vs. women 17.2±1.5, p=0.23). Obesity (BMI ≥30 kg/m²) was the highest prevalent risk factor (23.0%), and was significantly associated with hyperten-

![Figure 1. Prevalence of HTN with standard errors across age groups stratified by gender. Notes * = proportion significantly different, p=0.02. HTN: ≥140/90 mmHg or declared HTN on medical file and/or the use of medication.](image-url)
sive status (p<0.0001). No particular characteristics were observed in the lipid profile, except in triglycerides in which a trend was discernible. People with HTN had higher triglyceride levels (p<0.0001). Based on smoking status, a difference of proportion of smokers was seen among groups. Moreover, an increase of waist circumference was significantly observed with the increase of the daily tobacco consumption (p<0.00001).

Using criteria applied to anthropometric measures, we observed that, in comparison to normal subjects (BMI <25 kg/m$^2$), overweight (BMI 25–29 kg/m$^2$), obese (BMI 30–34 kg/m$^2$) and severely obese individuals (BMI ≥35 kg/m$^2$) had respectively a 5.5 [95% CI: 2.7–10.9], 7.9 [3.5–17.9] and 14.4 [5.6–36.7] odds ratio (OR) for being HTN (p for trend p<0.0001), and respectively a 1.8 [1.2–2.4], 2.5 [1.5–4.3] and 2.5 [1.2–5.4] odds ratio for being preHTN (p for trend p<0.0001). Similar significant results were obtained with other morphological measures: WC (OR for HTN: 4.7 [2.5–9.0]; OR for preHTN: 2.0 [1.3–3.0]) (p for trend p<0.0001); WHR (OR for HTN: 4.0 [2.0–7.5]; OR for preHTN: 1.49 [0.9–2.6]) (p for trend p<0.0001); waist-to-height ratio (OR for HTN: 2.9 [1.5–5.3]; OR for preHTN: 1.3 [0.9–2.2]) (p for trend p<0.0001); and body fat (OR for HTN: 1.7 [0.8–3.4]; OR for preHTN: 1.5 [0.9–2.6]) (p for trend p<0.0001). We performed the same analysis with continuous anthropometric data. Figures 2a and 2b present an OR and 95% confidence intervals (95% CI) for the

**Table I.** Age- and gender-adjusted cardiovascular risk factors among participants according to HTN categories: HTN, preHTN and NTN.

| VARIABLES               | HTN 19% (n=160) Mean±SE | PreHTN 32% (n=253) Mean±SE | NTN 49% (n=419) Mean±SE | p value c |
|-------------------------|--------------------------|-----------------------------|-------------------------|-----------|
| Age (year) a b          | 49.6±1.1                 | 35.0±0.7                    | 32.6±0.4                | <0.0001   |
| Gender (% male) a b      | 56.0±2.6                 | 65.5±2.2                    | 39.6±1.6                | <0.0001   |
| SBP (mmHg)              | 135±1                    | 124±1                       | 109±0                   | <0.0001   |
| DBP (mmHg)              | 84±1                     | 77±0                        | 68±0                    | <0.0001   |
| Pulse pressure           | 50.5±1.0                 | 47.1±1.0                    | 40.8±0.0                | <0.0001   |
| BMI (kg/m$^2$)           | 31.0±0.5                 | 27.6±0.3                    | 25.8±0.2                | <0.0001   |
| Obesity (≥30 kg/m$^2$) % | 37.3±4.1                 | 17.3±2.3                    | 16.2±2.0                | <0.0001   |
| Body fat (%)             | 31.1±0.6                 | 26.6±0.5                    | 24.3±0.4                | <0.0001   |
| Waist girth (cm)         | 100.4±1.1                | 91.6±0.7                    | 87.4±0.6                | <0.0001   |
| Waist-to-hip ratio       | 0.93±0.1                 | 0.89±0.0                    | 0.87±0.0                | <0.0001   |
| Waist-to-height ratio    | 62.6±0.7                 | 57.2±0.4                    | 54.9±0.4                | <0.0001   |
| HOMA-IR a d              | 13.9±2.1                 | 10.7±1.5                    | 9.4±1.3                 | <0.01     |
| Glucose (mmol/L) d       | 4.7±1.0                  | 4.5±1.0                     | 4.4±1.0                 | 0.08      |
| Insulin (pmol/L) d       | 63.4±1.1                 | 50.4±1.0                    | 47.9±1.0                | <0.0001   |
| Total C (mmol/L)         | 4.9±0.1                  | 5.1±0.0                     | 4.9±0.0                 | 0.09      |
| Total C/HDL ratio a      | 3.4±0.1                  | 3.3±0.1                     | 3.1±0.0                 | 0.06      |
| HDL-C (mmol/L)           | 1.6±0.0                  | 1.7±0.0                     | 1.7±0.0                 | 0.05      |
| LDL-C (mmol/L)           | 2.3±0.1                  | 2.9±0.1                     | 2.7±0.0                 | 0.21      |
| Triglycerides (mmol/L)   | 1.2±0.1                  | 1.1±0.1                     | 1.0±0.0                 | <0.0001   |
| Smoking (yes %)          | 67.2±4.5                 | 80.5±2.2                    | 80.1±2.2                | 0.0034    |
| Alcohol consumption:     |                          |                             |                         |           |
| ever drink alcohol (yes %) | 83.1±3.4               | 87.4±2.2                    | 86.9±1.0                | 0.0068    |

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HTN: ≥140/90 mmHg or use of medication; PreHTN: 130–139/80–89 mmHg.

a geometric means with standard errors
b age and gender are unadjusted
c p values presented are p trends
d corresponds only to subject in fasting condition
risk of HTN and preHTN, respectively associated with 1-unit increments in each anthropometric measure. Each OR was adjusted for corresponding confounding effects such as age, gender, HOMA-IR and consumption of tobacco (consumer vs. non-consumer).

In apparently healthy participants (without HTN or declared diabetes), the relationship between BP and HOMA-IR, an insulin resistance surrogate, as determined by age-adjusted Pearson correlation coefficients, was not significant (Table II). BP and all morphological parameters were significantly linked except in menopausal women, as shown in Table II. BMI and WC were closely linked to BP in both genders. WHR showed the lowest Pearson correlation values. In parallel, higher correlation coefficients were observed between morphological measures and HOMA-IR. Once again, BMI and WC presented high Pearson correlation values, mainly in menopausal women (BMI, r=0.64; p<0.0001 and waist r=0.62; p<0.001).

Table III provides data from the multivariate analysis of BP parameters as dependent variables and anthropomorphic measures as the main predictor in the Inuit population, excluding postmenopausal women. These analyses mainly corroborate previous results obtained from Pearson partial correlations. However, insulin resistance was not a confounding factor of the relationship tested as suggested in the literature. We performed similar analyses in postmenopausal women and none reached statistical significance (data not shown).

### Table II. Age-adjusted Pearson correlations stratified by gender.

|                  | Men n=276 | Women n=310 | Menopausal women n=40 |
|------------------|-----------|-------------|-----------------------|
|                  | HOMA-IR^a | SBP | DBP | HOMA-IR^a | SBP | DBP | HOMA-IR^a | SBP | DBP |
| BMI              |            | 0.37 | 0.24 | 0.31 | 0.35 | 0.28 | 0.30 | 0.64 | ns | ns |
| Waist            |            | 0.40 | 0.21 | 0.30 | 0.35 | 0.28 | 0.28 | 0.62 | ns | ns |
| Hip              |            | 0.33 | 0.21 | 0.23 | 0.34 | 0.26 | 0.25 | 0.61 | ns | ns |
| Waist-to-height ratio | 0.38 | 0.17 | 0.29 | 0.34 | 0.26 | 0.28 | 0.60 | ns | ns |
| Waist-to-hip ratio |     0.20 | 0.18 | 0.28 | 0.16 | 0.16 | 0.18 | 0.20 | 0.18 | 0.28 |
| SBP              |            | ns | 0.63 | ns | 0.72 | ns | 0.74 | ns |
| DBP              |            | ns | 0.63 | ns | 0.72 | ns | 0.74 | ns |

^aHOMA-IR presented was used on is log transformed form. All correlations were significant at p<0.0001 except for those indicated by b, c and d which were significant at p<0.001, p<0.01 and p<0.05, respectively.
ns = non-significant. From these analyses, we excluded hypertensive and diabetic patients (n=170) and 36 individuals not in fasting condition.

Figure 2. OR of (a) HTN adjusted for age, gender, HOMA-IR and tobacco consumption and (b) preHTN adjusted for age, gender, HOMA-IR and tobacco consumption.
Hypertension and obesity in Nunavik Inuit

DISCUSSION

As opposed to what has been reported previously, the prevalence of HTN among Nunavik Inuit has now reached national Canadian values (21%) (27), as well as a similar prevalence to those found in Quebec (23%) and Ontario (24.4%) (28). Furthermore, not only HTN but also preHTN states in this ethnic group are significantly associated with many adiposity-related indicators, even after adjusting for confounding variables.

Our results corroborate the work of Pollex and colleagues that did not observe any difference in HTN in a small group of Inuit (n=168) compared to Caucasians (n=53) from the same Arctic region (29). Twelve years after the 1992 Nunavik Inuit health survey, the prevalence of HTN has approximately doubled (14). As in other populations, high DBP was not seen in Inuit 50 years or older. Such data concur with the viewpoint of Williams et al., who recently suggested redirecting our clinical focus towards SBP in patients from this age group (30).

Most studies performed among Inuit populations state that blood pressure was lower than among Caucasians and ischemic heart disease was less common than cerebrovascular disease (12,31,32). A recent survey of hospitalized Greenland Inuit confirms that strokes, mainly infarct strokes, were more frequent than myocardial infarction (9). Consequently with the increase of HTN in this population, an increase in strokes may be expected.

In terms of HTN treatment in our study population, the proportion obtained here was similar to that found in the general Canadian population (17.2%) (26). However, HTN control among treated hypertensive individuals was considerably lower than the proportion found in the rest of Canada (26% vs. 45%) (26). The worst proportion was found as age increased. Consequently, we suggest raising public health awareness among older age categories, reinforcing the recently expressed idea of sending a reliable and simple message to the elderly to improve the management of the disease (30,33). Particular emphasis should be placed on women, as the HTN control proportion appeared to be lower than among men in all age groups. A similar poor control of HTN in women was highlighted recently in the U.S. (1).

Table III. Regression coefficients from the multiple linear regression analysis of BP parameters as dependent variables and anthropomorphic measures as the main predictor in Inuit men and women, excluding postmenopausal women.

|             | SBP |             | DBP |
|-------------|-----|-------------|-----|
|             | Crude model | Adjusted model | Crude model | Adjusted model |
|             | β ± SE | R² | p value | β ± SE | R² | p value | β ± SE | R² | p value |
| BMI         | 0.53±0.09 | 0.084 | ≤0.0001 | 0.50±0.03 | 0.20 | ≤0.0001 | 0.43±0.03 | 0.093 | ≤0.0001 | 0.39±0.03 | 0.13 | ≤0.0001 |
| Waist       | 0.23±0.04 | 0.079 | ≤0.0001 | 0.21±0.03 | 0.19 | ≤0.0001 | 0.18±0.03 | 0.090 | ≤0.0001 | 0.15±0.02 | 0.12 | ≤0.0001 |
| Hip         | 0.26±0.05 | 0.073 | ≤0.0001 | 0.25±0.04 | 0.18 | ≤0.0001 | 0.19±0.03 | 0.067 | ≤0.0001 | 0.19±0.03 | 0.07 | ≤0.0001 |
| Waist-to-hip ratio | 0.24±0.06 | 0.002 | ≤0.0001 | 0.14±0.07 | 0.16 | 0.03 | 0.22±0.06 | 0.030 | ≤0.001 | 0.19±0.04 | 0.10 | ≤0.0001 |
| % Body fat | 0.29±0.05 | 0.070 | ≤0.0001 | 0.25±0.05 | 0.19 | ≤0.0001 | 0.25±0.04 | 0.088 | ≤0.0001 | 0.27±0.03 | 0.12 | ≤0.0001 |
| Waist-to-height ratio | 0.33±0.06 | 0.079 | ≤0.0001 | 0.30±0.05 | 0.17 | ≤0.0001 | 0.28±0.04 | 0.084 | ≤0.0001 | 0.24±0.04 | 0.10 | ≤0.0001 |

R² presented are those from the model; all models were adjusted for age, gender and total cholesterol.
The results of our study also highlighted a group on which public health initiatives should focus: preHTN individuals. With a prevalence similar to that observed in the U.S. (23) (31%, NHANES 1999–2000) and Singapore (34), Inuit in the preHTN group have multiple risk factors for HTN, such as obesity, smoking and alcohol consumption, but they are significantly younger than the HTN group. Consequently, one may speculate that these individuals may develop HTN disease in the near future. Although preHTN was not found to be an independent risk factor for all-cause mortality as well as CVD (34), this condition appears to be associated with mortality when combined with other CVD risk factors, such as diabetes and smoking (34).

The prevalence of obesity among Inuit is higher than among Canadians (23%) (35). This result again supports the conclusion of Young and colleagues on the epidemic of obesity in Inuit (15). Considering the concomitant occurrence of obesity and HTN in that population, a longitudinal evaluation of the relationship between both these cardiovascular factors is needed.

From a cross-sectional view, obesity (BMI ≥30 kg/m²) and especially abdominal obesity measured by WC were strongly associated with arterial HTN in our Inuit cohort. Similar associations were also reported in a study done on Caucasians living in southern Quebec (36). Thus, our results support the predominant role of central obesity assessed by WC in explaining individual differences in BP as already established in different populations (3), and corroborate findings from experimental studies (37). Indeed, a slight over-activity of the sympathetic nervous system has been reported in obese subjects, depicting obesity as a state of chronic desensitization with the impairment of autonomic modulation of sinoatrial activity (37). Even if these findings need to be confirmed prospectively, they support obesity as an etiological factor of HTN.

In our study, WC and BMI were both closely associated with BP parameters while percentage of body fat was weakly associated. In contrast to previous investigations, our results do not clearly favour any specific anthropological measure (36,38–40). Discrepancies in relation to other data are probably related to the fact that our normal population has an elevated weight on average. Nevertheless, as this is the baseline of our cohort study, follow-up will able us to determine which of these anthropological measures is the best indicator of cardiovascular events.

Interestingly, insulin resistance did not appear to be a confounding factor of the relationship between BP parameters and anthropometric measures. This latest finding challenges the relationship between HTN and insulin resistance, and confirms that the association varies widely across ethnic groups, showing no racial difference in the Insulin Resistance Atherosclerosis Study (IRAS) (41), weak associations in African Americans compared to white Americans in the Atherosclerosis Risk in Communities Study (ARIC) (42) and the Coronary Artery Risk Development in (Young) Adults (CARDIA) study (43), and finally a strong relationship in Europeans (44). However, those interesting observations about insulin resistance need to be confirmed or denied with more precise measurement in this population.

It is also noteworthy that no anthropometric measure was linked to cardiovascular param-
eters in postmenopausal women, even after adjusting for insulin resistance. We observed a very strong correlation between anthropological measures and insulin resistance. This was mainly due to the fact that most of these women (55%) were abdominally obese. A similar relationship was already noted in a cross-sectional study which linked central abdominal fat to insulin sensitivity (45).

Our investigation was limited by the nature of the morphological measures which were probably not specific enough to evaluate the deleterious effect of fat deposits on BP parameters in normal populations (without HTN or diabetes). Thus, a fine description of the relative distribution of subcutaneous and visceral fat is needed in the Inuit population. Nevertheless, our study is strengthened by the determination of the HTN group based on crossing information from medical records, BP measurements and self-declared data, thus limiting potential classification biases.

The overall results of this population-based investigation suggest that HTN is a growing health challenge in Nunavik, as a large part of this population is suspected to have a predisposition for cerebrovascular disease. Consequently, the study supports the importance of promoting appropriate lifestyle modifications, such as the conservation of their traditional ways of life. Our study identified a high proportion of people at risk of developing HTN because of the presence of obesity in this population. While all presented factors are modifiable, these individuals should be the focus of interventions to decrease their cardiovascular risk.

Acknowledgements
We wish to thank Nunavik Inuit for their extensive cooperation in this survey. The Nunavik Inuit Health Survey could not have been undertaken without the financial support of the Ministère de la Santé et des Services sociaux du Québec, the Nunavik Regional Board of Health and Social Services, Indian and Northern Affairs Canada, the Canadian Foundation for Innovation (CFI), the Network of Centres of Excellence of Canada (ArcticNet), the Nasivvik Centre for Inuit Health and Changing Environments and the Canadian Institutes of Health Research. The valuable assistance of Inuit representatives – both members of the survey advisory committee and Inuit leaders from each community – is gratefully acknowledged. We are also grateful to all of the professionals, technicians, students, interviewers and clerical staff who worked at each stage of the survey process. Our gratitude is also extended to the staff of the Canadian Coast Guard Ship Amundsen. Finally, Dr. Chateau-Degat is grateful for the financial support provided by Canadian Institutes for Health Research – Institute for Aboriginal People’s Health fellowship program. Dr. Ferland is a Canadian Diabetes Association post-doctoral fellow. Dr. Poirier is a clinical scientist of the Fonds de la recherche en santé du Québec (FRSQ). Dr. Egeland has a Canada research chair on environment, nutrition and health.

Conflict of interest
All authors have no conflict of interest to declare.

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Hypertension and obesity in Nunavik Inuit

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