Nutrition, Metabolism & Cardiovascular Diseases (2015) **25**, 85–92

Available online at www.sciencedirect.com

Nutrition, Metabolism & Cardiovascular Diseases

journal homepage: www.elsevier.com/locate/nmcd

Quality of diet is associated with insulin resistance in the Cree (*Eeyouch*) indigenous population of northern Québec

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Received 31 January 2014; received in revised form 7 August 2014; accepted 9 August 2014
Available online 28 August 2014

KEYWORDS
Insulin;
Dietary patterns;
Hyperinsulinemia;
Diabetes

Abstract *Background and aims:* Indigenous people worldwide have a greater disease burden than their non-aboriginal counterparts with health challenges that include increased obesity and higher prevalence of diabetes. We investigate the relationships of dietary patterns with nutritional biomarkers, selected environmental contaminants and measures of insulin resistance in the Cree (*Eeyouch*) of northern Québec Canada.
Methods and results: The cross-sectional 'Nituuchischaayihitaau Aschii: A Multi-Community Environment-and-Health Study in Eeyou Istchee' recruited 835 adult participants (≥18 y) from 7 communities in the James Bay region of northern Québec. The three dietary patterns identified by principal component analysis (PCA) were: inland and coastal patterns with loadings on traditional foods, and a junk food pattern with high-fat and high-sugar foods. We investigated dietary patterns scores (in quantiles) in relation with nutritional biomarkers, environmental contaminants, anthropometry, blood pressure, fasting plasma glucose and insulin, and insulin resistance.
Homeostatic model assessment (HOMA-IR) was used as surrogate markers of insulin resistance. ANCOVA ascertained relationships between dietary patterns relationship and outcomes. Greater scores for the traditional patterns were associated with higher levels of n-3 fatty acids, mercury and polychlorinated biphenyls (PCBs) (P trend <0.001). Higher scores for the junk food pattern were associated with lower levels of PCBs and Vitamin D, but higher fasting plasma insulin and HOMA-IR.
Conclusion: Our results suggest that poor diet quality accompanied greater insulin resistance. Impacts of diet quality on insulin resistance, as a sign of metabolism perturbation, deserve more attention in this indigenous population with high rates of obesity and diabetes.

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http://dx.doi.org/10.1016/j.numecd.2014.08.002
0939-4753/

Introduction

Indigenous people worldwide have a greater disease burden than their non-native counterparts [1]. Health challenges include increased incidence of obesity [2] and a high prevalence type 2 diabetes (T2D) [3].

The Cree (*Eeyouch*) of the northern Québec area of Canada are not exempt from the health challenges facing indigenous people in North America [2]. The prevalence of obesity in Cree adults is 71.5% [2] and it is accompanied by high rates of elevated insulin [4]. A subset of this population without diabetes had impaired fasting glucose (IFG) in 35% of adults [5]. The consequences of insulin resistance and obesity are of particular concern in this population for whom the crude prevalence of T2D is 17.3%, a 300% increase over the previous 16 years [6].

A reduction in traditional hunting and gathering activities [7] and the introduction of better road access has led to increased intake of store-bought foods. It is difficult to evaluate the resultant dietary changes and it is the more challenging because the diet was traditionally high in meat and fat [8]. But unlike Western diets — which are elevated in industrial meat, refined grains, sweets, etc. — higher traditional food (TF) intake has been associated with better fatty acid profiles, consistent with better health in individuals [9]. The Cree TF includes game (moose, caribou, etc.), birds (geese and ducks), fish and wild berries [6].

In Northern populations, high concentrations of environmental contaminants in the food chain (especially TF) raise important public health concerns. These indigenous populations are vulnerable to the body burden of mercury, lead and polychlorinated biphenyls (PCBs). Higher mercury adversely impacts cardiovascular health [10]. Exposure to lead can have multiple effects on cardiovascular, neurological and developmental health [11]. PCBs are human carcinogens and may also be harmful to the immune, reproductive and endocrine systems [12].

Patterns of food consumption are associated with diabetes and obesity in aboriginal Canadian communities [13,14]. Unlike studies investigating single nutrients or food, investigations of dietary patterns consider prevailing dietary characteristics that reflect diet complexity [15]. Examining overall diet can also help guide formulation of dietary interventions [16]. Among indigenous populations, few studies — in Alaska [17], Ojibwa-Cree of Ontario, Canada [1] and Greenlandic Inuit [18] — have examined the association between dietary patterns and health indicators.

To our knowledge, dietary pattern analysis has never been examined in the Cree of northern Québec. We investigated dietary patterns associated with nutritional biomarkers, selected environmental contaminants and measures of insulin resistance.

Methods

Study population

The cross-sectional '*Nituuchischaayihitaau Aschii*: A Multi-Community Environment-and-Health Study in *Eeyou Istchee*' was a collaboration of the Cree Board of Health and Social Services of James Bay (CBHSSJB) with McMaster, Laval, and McGill Universities. Eight hundred thirty five participants were recruited from 7 northern Québec communities of latitude greater than 49.6°. An age-stratified random sample was used representing 12% of the total population (target size of 929 men and non-pregnant women $\geq$ 18 y). Informed consent was obtained from all participants and the ethics approval was obtained from all participating institutions [19].

Physical measures

Height was measured to the nearest cm. Weight was measured using a Tanita digital scale (Tanita Corp., Arlington Heights, Ill, USA). Waist circumference (WC) was assessed at the end of exhalation with an inelastic tape located midway between the last floating rib and the iliac crest [20]. The systolic (SBP) and diastolic blood pressure (DBP) were assessed according to the Canadian Hypertension Education Program recommendations [21]. SBP$\geq$140 mm Hg indicated high SBP and DBP$\geq$90 mm Hg indicated high DBP.

Socio-demographic and diet-assessment

Socio-demographic and diet-assessment questionnaires were administered by bilingual community interviewers [5,19]. The qualitative food frequency questionnaires (FFQ) included 53 questions investigating past-year TF intake and 53 questions on past-month intake of store-bought foods [5,19]. The market FFQ was abbreviated to capture high-sugar drinks and indicators of diet quality.

Biochemical and contaminant measures

Erythrocyte membrane blood concentrations of fatty acids were determined by gas–liquid chromatography as described by Zhou et al. [22]. Fasting plasma glucose was measured enzymatically and fasting plasma insulin concentrations were measured with a commercial double-antibody radioimmunoassay (RIA) as described by Dewailly et al. [23]. Limits of fasting plasma glucose (normal $<$5.6, IFG = 5.6 to 6.9, diabetes $\geq$7.0 mmol/L) were defined as per the guidelines of the American Diabetes Association [24]. Calculations of HOMA-IR used the formula fasting plasma glucose (mmol/L) X fasting plasma insulin (*m*U/L)/22.5 [25].

Mercury and lead concentrations were determined in whole blood samples and PCBs were measured in plasma as reported by Valera et al. [10]. Competitive RIA was used to determine serum 25(OH)D as described by Del Gobbo et al. [5].

Dietary patterns

Frequency of food intake data from store-bought and TF reported on the FFQ were collapsed into 19 groups respectively as outlined in Table 1. Items were categorized into food groups based on nutritional composition and