Diagnostic Microbiology and Infectious Disease 78 (2014) 404–410

Contents lists available at ScienceDirect

Diagnostic Microbiology and Infectious Disease

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

Parasitology

Seroprevalence of parasitic zoonoses and their relationship with social factors among the Canadian Inuit in Arctic regions ☆

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ARTICLE INFO

Article history:
Received 28 June 2013
Received in revised form 20 August 2013
Accepted 23 August 2013
Available online 22 January 2014

Keywords:
Seroepidemiologic studies
Toxocara
Trichinella
Echinococcus
Toxoplasma
Inuit

ABSTRACT

Residents of Arctic communities are at increased risk of contracting infectious diseases transmitted by wildlife. Data collected from the International Polar Year Inuit Health Survey were used to determine the seroprevalence of 4 parasitic zoonoses in three Inuit jurisdictions of the Canadian Arctic and to assess risk factors of infection. To date, this is the most comprehensive survey of its kind. Immunoenzymatic methods were used for the detection of antibodies against *Toxocara canis*, *Echinococcus granulosus*, *Trichinella* sp., and *Toxoplasma gondii*. We determined the weighted prevalence of parasitic infections in 36 Inuit communities across the Inuvialuit settlement region, Nunavut, and Nunatsiavut. Our results indicate infrequent exposure to *Toxocara* and *Echinococcus* (1.7 and 6.3%, respectively). Exposure to *T. gondii* (27.2%) and *Trichinella* (18.6%) was more prevalent and was generally higher in Nunavut compared to other northern regions. Overall, seropositivity was related to age, education, and consumption of marine mammals and seafood.

1. Introduction

The majority of indigenous people living in the Canadian Arctic are Inuit (Hotez, 2010). The Inuit population comprises 50,000–60,000 individuals (King et al., 2009; Simeone, 2008), roughly half of whom live in the Arctic territory of Nunavut (representing 84% of the population of the territory) (Goodman et al., 2008; Wilkins et al., 2008). The rest are divided between Nunavik in northern Quebec (approximately one quarter), Nunatsiavut in Labrador, and the Inuvialuit Settlement Region (ISR) in the Northwest Territories (Goodman et al., 2008). With limited employment options due to isolated living conditions, the majority of northern indigenous people engage in traditional food gathering methods (fishing and hunting) leading to increased risk for zoonotic infections (Simeone, 2008). In addition, treated drinking water is often not accessible during certain parts of the year resulting in the consumption of naturally contaminated surface water (King et al., 2009).

Parasitoses (caused by both helminths and protozoa) are relatively common infections in Arctic communities around the world including the Inuit in Canada (Hotez, 2010). These are usually the result of living in close proximity to wildlife food sources (*e.g.* caribou), or from eating undercooked meat from both land and sea mammals (e.g., walrus or seal) as well as fish and birds (Hotez, 2010). *Toxoplasma gondii* is the most prevalent protozoan parasite affecting indigenous populations in the Canadian arctic (McDonald et al., 1990; Messier et al., 2009), while *Trichinella* and *Echinococcus* are among the most common helminthic infections in the arctic (Hotez, 2010). Arctic indigenous peoples' historical and cultural relationship with dogs also puts them at greater risk of *Toxocara canis* infection (Jenkins et al., 2011).

A modest amount of information on the prevalence of zoonotic parasites is available for the Inuit of Northern Quebec (Messier et al., 2009; Messier et al., 2012), but prevalence rates for these infections are largely unknown in other Inuit regions of Canada, including Nunavut where the largest proportion of the population is found. With the exception of trichinellosis, there is no surveillance system in place to determine the scope of the problem. These infections often go undiagnosed and un-reported because they present with mild or non-specific symptoms.

We performed a cross-sectional survey (the International Polar Year Inuit Health Survey 2007–2008) across all Inuit communities in ISR, Nunavut, and Nunatsiavut to determine the seroprevalence of four zoonotic parasites: *Trichinella* sp., *T. gondii, T. canis*, and *E. granulosus*. Information on food behavior and household socio-demographic characteristics were also collected and used to identify risk factors associated with infection.

2. Methods

2.1. Study design and data collection

The International Polar Year Inuit Health Survey for adults 2007–2008 was a cross-sectional study designed to assess health issues

☆ Author Disclosure Statement: No competing financial interests exist.

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http://dx.doi.org/10.1016/j.diagmicrobio.2013.08.026

facing Inuit communities in ISR, Nunavut, and Nunatsiavut (Egeland et al., 2011; Egeland et al., 2010; Saudny et al., 2012). Data were collected from a total of 36 Inuit communities, during the summer and fall of 2007 and 2008 (Fig. 1). All communities in the land claim areas were included. The vast majority of communities were coastal (33 out of 36). The coastal communities were reached with the help of the Canadian Coast Guard Ship *Amundsen,* while different land teams approached the 3 inland communities by air. Most communities provided lists of households, which were then assigned sequential numbers. These lists were used to randomly select households, using either a random numbers table or a computerized random number generator. All individuals 18 years of age or older were eligible to participate. Pregnant women were excluded. An "audio-visual consent form" on a DVD presented in the appropriate Inuit dialect was shown to the participants who, following viewing, signed a written informed consent form. Of the 2796 households visited, 1901 (68%) agreed to participate, resulting in 2595 individual subjects participating in the study.

After providing informed consent, a principal respondent, usually the person who was most familiar with the household, completed the household composition questionnaire and the home-based questionnaire. All participants completed an individual questionnaire, a community and personal wellness questionnaire, a 24-hour food recall, and a food frequency questionnaire. The questionnaires gathered information on socio-demographic characteristics (age, sex, level of education); general health; medical history; the home environment; living conditions; smoking behavior; mental wellness; employment; income; and frequency of consumption of traditional food (in contrast to commercial/processed foods not acquired locally), seafood, game, and marine mammals. Bilingual interviewers (English and Inuit dialects) conducted the surveys. Nurses collected fasting venous blood for serological analysis. Positive results were reported to the local health authorities with recommendations for follow-up diagnostic imaging of the liver and lungs in the case of suspected echinococcosis.

Ethical approval for this work was obtained from the McGill University Faculty of Medicine Institutional Review Board. Scientific Research Licenses were obtained from the Nunavut Research Institute for Nunavut and from the Aurora Research Institute for ISR.

2.2. Serological methods

Blood samples were allowed to clot, tubes were centrifuged at 2,400 rpm for 20 minutes at 4 °C within 1 hour of collection, and serum aliquots were maintained at −80 °C until tested for antibodies against 4 zoonotic parasites. Commercial immunoenzymatic assays (ELISAs) were carried out for the detection of IgG antibodies against *T. canis* and *E. granulosus, Trichinella* sp., (Scimedx Corporation, Denville, NJ), and *T. gondii* (AxSYM, Abbott Diagnostics, Abbott Park, IL). According to the product inserts, sensitivity and specificity for each assay were 87.5% and 93.3%, respectively, for *T. canis*, 97.9%, and 91.7% for *E. granulosus*, 94.4%, and 93.8% for *Trichinella* sp., and 99.7% and 99.1% for *T. gondii*. Subjects were classified as 'positive', 'negative' or 'equivocal' according to manufacturers' instructions, based on duplicate absorbance readings and internal standards.

2.3. Statistical analysis

Weighted prevalence and 95% confidence intervals of seropositivity for zoonotic infections were calculated. Weight 1 was based on the total number of households in each community and the number of participating households per community; weight 2 was based on the total number of people in each household and the number of people

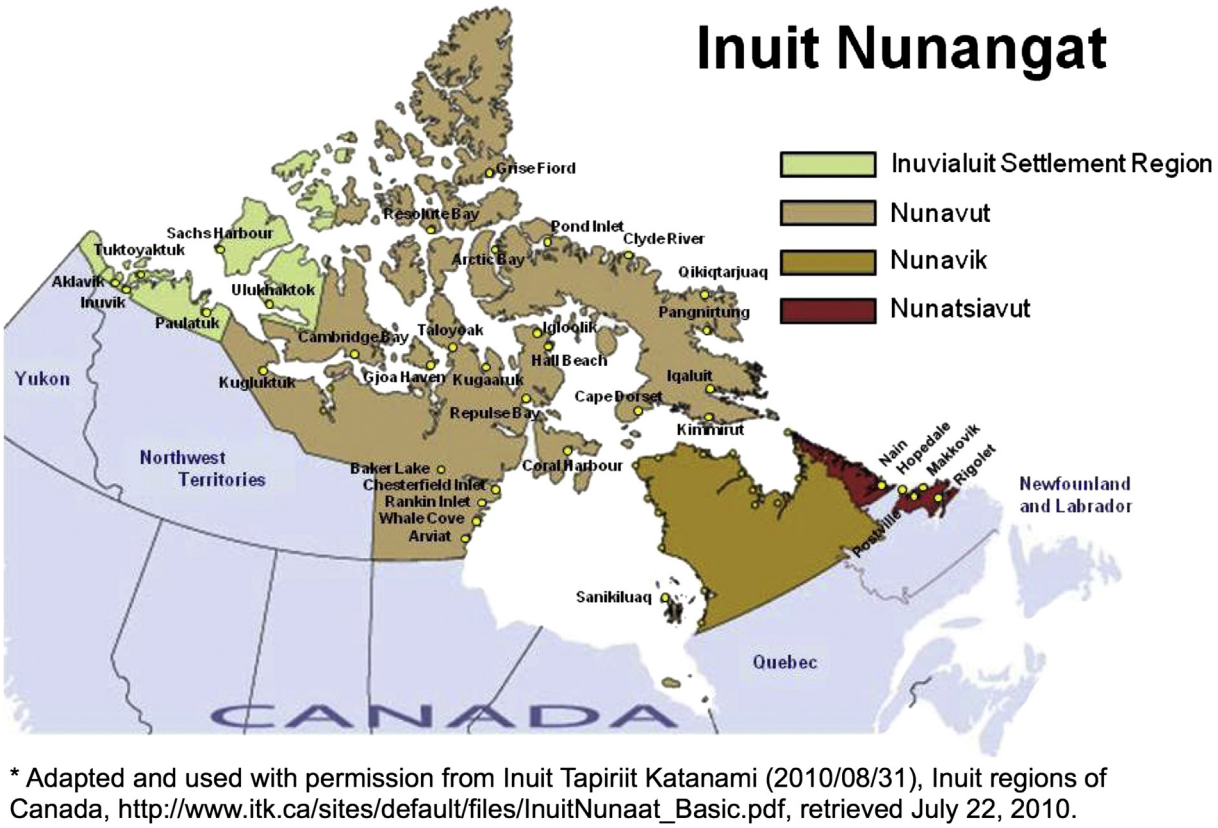

Fig. 1. Map of the Inuit Homeland (Nunangat). The communities that participated in the International Polar Year Inuit Health Survey 2007–2008 are identified (yellow circles). Thirty-three of the 36 communities included in the study were located in coastal regions.