

# Hospitalization for Trichinellosis and Echinococcosis in Canada, 2001-2005: The Tip of the Iceberg?

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## ABSTRACT

**Objectives:** This study was undertaken to measure the incidence of echinococcosis and trichinellosis hospitalization in Canada, and to compare these incidence rates between residents of northern regions and the rest of the Canadian population.

**Methods:** Cases hospitalized in 2001-2005 for either echinococcosis or trichinellosis were retrieved from the hospital morbidity database (HMDB) held by the Canadian Institute for Health Information. Crude and standardized incidence rates were calculated by province and by latitude range.

**Results:** A total of 108 echinococcosis and 14 trichinellosis hospitalizations were found, yielding incidence rates of 0.72 and 0.09 per million per year, respectively. There was a clear south-north gradient in the incidence of echinococcosis hospitalization, the highest incidence (2.9 per million per year) being found north of the 55<sup>th</sup> parallel. The risk of echinococcosis hospitalization was also significantly higher in women than in men (RR 1.92, 95% CI 1.29-2.87). For trichinellosis, the highest incidence (42 per million per year) was found in Nunavut and Northern Québec.

**Conclusion:** Incidence of hospitalization for echinococcosis and trichinellosis is low at the national level. However, significantly higher rates have been measured in northern regions of Canada despite the fact that both diseases are theoretically preventable and that a *Trichinella* control program is in place in Nunavik. Further efforts, probably educational in nature, will be required to reduce the incidence of these infections in high-risk areas.

**Key words:** Echinococcosis; trichinellosis; hospitalization; Canada

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This study was undertaken to quantify geographic variations in the occurrence of echinococcosis and trichinellosis, two infections that are to a large extent autochthonous (i.e., acquired within the country).

Currently, no helminth infection is reportable nationally in Canada. Trichinellosis used to be but was removed from the list in 2000, though it is still notifiable in most provinces and territories. For both diseases, non-specific clinical signs make diagnosis difficult and result in under-reporting.<sup>1,2</sup> Most cases of echinococcosis and trichinellosis are treated without hospitalization but some complications may require hospitalization for investigation or treatment.

Echinococcosis is caused by *Echinococcus* spp. tapeworms (class Cestoda). The definitive hosts of the tapeworms are wild or domesticated canids, and humans acquire infection from contact with contaminated faeces from these species.<sup>3</sup> Natural intermediate hosts range from rodents to cervids, but in Canada echinococcosis is thought to be most commonly caused by the sylvatic variant of *Echinococcus granulosus*, for which caribou, elk and moose are the main natural intermediate hosts.<sup>4</sup> Infection with *E. granulosus* eggs results in the development of characteristic hydatid cysts in the liver, lungs or other organs, while infection with eggs of the less common *E. multilocularis* results in the more invasive 'alveolar echinococcosis' that may spread metastatically through major organs.<sup>5</sup> Treatment is difficult, combining careful surgical removal of cysts and anthelmintic therapy,<sup>6</sup> but is usually successful for infections occurring in Canada.<sup>2</sup>

Trichinellosis in Canada is attributable to three *Trichinella* species of nematodes – *T. spiralis*, *T. pseudospiralis* and *T. nativa* – that can cause two distinct syndromes. Encapsulation of larvae in muscles causes inflammatory responses leading to pain in muscles, eyelids and the face, and in some instances more severe complications such as myocarditis.<sup>5</sup> Reinfection in sensitized individuals causes immune-mediated gastroenteritis, a syndrome referred to as "secondary trichinellosis", which has been observed in the Canadian Arctic in individuals infected by *T. nativa*.<sup>7,8</sup>

The annual number of human cases of trichinellosis reported in Canada between 1970 and 1997 ranged between 3 to 49, with a mean of 18.2.<sup>1</sup> Several outbreaks that occurred in Inuit communities of Nunavik and Nunavut in the 1980s and 1990s were traced to consumption of raw or fermented walrus meat, which are common meals in these communities.<sup>7-10</sup> Domestic swine, the main reservoir of *Trichinella* worldwide, is no longer a source of infection in Canada where domestic swine is virtually free from this parasite.<sup>11,12</sup>

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**Conflict of Interest:** None to declare.

**Table 1.** Compatible Conditions for Trichinellosis and Echinococcosis

Infection	Compatible Condition		
	Condition	ICD-9	ICD-10
Trichinellosis (ICD-9 code 124, ICD-10 code B75)	Diarrhoea and gastroenteritis of presumed infectious origin	009.1	A09
Echinococcosis (ICD-9 code 122, ICD-10 code B67)	Infective myocarditis	422.92	I40.0
	Cholangitis	576.1	K83.0

Note: only compatible conditions found in our cases are listed here.

Most of the current knowledge of the epidemiology of echinococcosis and trichinellosis is based on outbreak investigations and case studies, and therefore restricts the possibility of estimating or comparing disease rates. The objectives of this study were to quantify the occurrence of those trichinellosis and echinococcosis cases sufficiently severe to require hospitalization in Canada, and to compare the incidence of hospitalization between residents of northern regions and the rest of the Canadian population. A higher incidence in the north was expected for both diseases based on published case and outbreak reports.<sup>1,2,4,6-10</sup>

## METHODS

Case records were extracted from the hospital morbidity database (HMDB) held by the Canadian Institute for Health Information (CIHI). All hospitalizations occurring in Canada are included in this database and discharge diagnoses are coded using either the ninth or the tenth revision of International Classification of Diseases (ICD-9 and ICD-10) of the World Health Organization,<sup>13,14</sup> depending on jurisdictions.

All cases for which the first discharge diagnosis was either trichinellosis (ICD-9 code 124, ICD-10 code B75) or echinococcosis (ICD-9 codes 122.0 to 122.9, ICD-10 codes B67.0 to B67.9) were included. In addition, cases whose second discharge diagnosis was one of these diseases were included if their first discharge diagnosis was a symptom or condition likely caused by one of these infections (Table 1).

The HMDB contains encrypted health card numbers that were used to find duplicate cases (two or more hospitalizations for the same individual in the same year). Such duplicate entries were merged, i.e., lengths of hospital stays were summed up. When this encrypted number was missing, two individuals with the same age, sex and postal code and hospitalized for the same disease in the same year were assumed to be the same individual (this only occurred for two echinococcosis cases).

The province of residence of cases was determined based on their postal code or the province that issued their health card. When both of these were missing, the province of hospitalization was assumed to be the province of residence. The latitude at the centroid of forward sortation areas (FSA), i.e., the first three digits of cases' postal codes, was determined using commercial digitalized maps (DMTI Spatial Inc, Markham, Ontario), and then latitude categories were created (<50°, 50°-54°, and ≥55°).

Data were analyzed using SAS Enterprise Guide 4 (SAS Institute Inc.). Crude and standardized annual incidence rates were determined by province and territory and by latitude categories, using population numbers from the 2001 Census<sup>15</sup> as denominators. Relative risks and binomial 95% confidence intervals (CI) were calculated. For echinococcosis, comparisons were made between latitude categories; for trichinellosis, Northern Québec (defined as postal code starting with J0M, which includes Nunavik and James Bay)

and Nunavut, i.e., regions where Inuit represent a large proportion of the population, were compared to the rest of Canada.

## RESULTS

In 2001-2005, 108 hospitalizations related to echinococcosis were found. Nineteen cases (15%) were aged less than 20, including two children aged less than 2 years. Most cases (67%) were women, and their risk of hospitalization was significantly greater than that of men (RR 1.92, 95% CI 1.29-2.87). The incidence of echinococcosis hospitalization across Canada was 0.72 per million per year. There was a clear south-north gradient in the incidence of hospitalization for echinococcosis, the highest incidence (2.9 per million per year) being measured north of the 55<sup>th</sup> parallel (Table 2).

There were 14 hospitalizations related to trichinellosis. All cases were adults (≥21 years) and most of them (9/14) were aged 40 or over. Most cases were males and the risk of hospitalization was greater in males than in females (RR 3.81, 95% CI 1.06-13.67). The incidence of trichinellosis hospitalization across Canada was 0.09 per million per year. However, a much higher incidence, 42 per million per year, was found in Nunavut and northern Québec: the risk of hospitalization for trichinellosis was more than two orders of magnitude higher in those regions compared to the rest of the country (Table 3).

## DISCUSSION

This study confirms that while the national incidence of echinococcosis and trichinosis may be low, the inhabitants of northern regions of Canada are at much higher risk of hospitalization due to these infections than are other Canadians. These two infections rarely require hospitalization, so hospitalized cases likely represent only the most severe cases. Therefore, incidence based on hospitalization data is most likely a considerable underestimation of the true incidence, and the number of cases identified in our study may represent only the tip of the iceberg in terms of burden of disease.

As trichinellosis usually presents as an acute disease within two weeks after ingestion of infective larvae, geographical and temporal variations in hospitalization may reflect those of disease incidence. In contrast, as *Echinococcus* cysts typically grow for years or decades before they come to medical attention, variations in hospitalization rates may rather reflect past trends in disease incidence.

We included only cases with either trichinellosis or echinococcosis as the first discharge diagnosis, or cases for which these diseases were identified as the second discharge diagnosis and for which the first diagnosis was a condition most likely related to these diseases. We therefore excluded several cases with echinococcosis as a secondary diagnosis, in which the disease was either already known, or asymptomatic and discovered by accident. We may therefore have excluded some cases for which the primary cause of hospitalization was caused by *Echinococcus* infection.

**Table 2.** Echinococcosis Hospitalization by Latitude

Latitude*	Population in 2001	Echinococcosis Hospitalization 2001-2005	Crude Incidence (per 1,000,000)	Standardized Incidence (per 1,000,000)	RR	95% CI
<50°	24,931,045	74	0.59	0.59	1.00	
50°-54°	4,518,930	24	1.06	1.08	1.83	1.16-2.90
≥55°	556,785	10	3.59	2.87	4.88	2.52-9.44

\* At the centroid of the forward sortation area, i.e., the first three digits of postal code (e.g., K1A).

**Table 3.** Trichinellosis Hospitalization: Nunavut and Northern Québec Compared to Rest of Canada

Region	Population in 2001	Trichinellosis Hospitalization 2001-2005	Crude Incidence (per 1,000,000)	Standardized Incidence (per 1,000,000)	RR	95% CI
Nunavut and northern Québec*	44,030	6	27.25	41.65	780	271-2248
Rest of Canada	29,963,075	8	0.05	0.05	1	

\* Northern Québec is defined as postal code starting with J0M (which includes Nunavik and James Bay).

On the other hand, the use of a national hospital database allowed us to search cases hospitalized across the country for a given period, which would not have been possible through chart reviews, and to investigate geographic variations in the incidence of hospitalization. In the absence of national surveillance data, these results may provide a baseline that will allow the monitoring of temporal variations in the occurrence of these diseases. It is anticipated that climate change may impact the epidemiology of zoonotic infectious diseases in the Arctic through a variety of mechanisms, in particular changes in the ecology of natural hosts.<sup>16</sup>

Echinococcosis is not uncommon in Canada. Seventeen patients with symptomatic *E. granulosus* infection apparently acquired in Manitoba or in Northern Ontario were recorded in two Winnipeg hospitals from 1987 to 1997,<sup>6</sup> while 22 symptomatic cases were recorded in Edmonton hospitals from 1991 to 2001.<sup>2</sup> Our findings that women and inhabitants of northern regions are at higher risk of being hospitalized for echinococcosis are consistent with previous observations: of the 22 symptomatic echinococcosis cases investigated in Edmonton,<sup>2</sup> 77% were female, 41% were resident of the Northwest Territories (Edmonton hospitals serve as reference centre for NWT), and 41% were either self-declared Aboriginals or resident of First Nation reserves. The higher incidence of echinococcosis hospitalization in residents of northern communities may result from more frequent contact with the parasite. Country foods are particularly important for Dene/Métis and Inuit communities in the Canadian Arctic,<sup>17</sup> so hunting, house or sled dogs are likely to have a diet with a high proportion of offal from hunted game. Indeed, *E. granulosus* infection prevalence in these dogs is high.<sup>3</sup>

*Echinococcus multilocularis* is endemic in Central Europe, Central Asia and China,<sup>18</sup> and *E. granulosus* is endemic in parts of South America, East Africa, Central Asia and China.<sup>19</sup> Therefore, some of the cases may be immigrants from or people who traveled to these areas.

Cystic echinococcosis control programs have been put in place in various parts of the world, and some were indeed successful.<sup>20</sup> All of these programs took place in countries where the main intermediate hosts of *E. granulosus* were livestock species, therefore approaches targeting these species may not be applicable in Canada where intermediate hosts are wildlife species. On the other hand, in Iceland, a control strategy centered on the education of dog owners and the prevention of dogs feeding from offal led to the elimination of cystic echinococcosis.

That northern communities, particularly Inuit, are at risk of trichinellosis is well known: several trichinellosis outbreaks caused by the consumption of raw or undercooked walrus meat have been reported in Inuit communities in Nunavut and Nunavik in the 1990s.<sup>7-10</sup> Findings on trichinellosis hospitalization in this study confirm those from outbreak investigations: the fact that cases are mostly older adults is consistent with similar observations by MacLean et al.<sup>8</sup> and with their finding that the frequency of walrus meat consumption among Inuit increases with age.

Seven patients from northern Québec and Nunavut were hospitalized for trichinellosis in 2001-2005, compared to 11 from only two villages of Nunavik in 1982-1984.<sup>7</sup> This decrease is likely attributable to the trichinellosis prevention program initiated in Nunavik in 1992. This program is based on the testing of walrus before distributing its meat.<sup>10</sup>

Most trichinellosis hospitalizations identified in this study occurred in people who were not resident of northern regions. The source of these infections remains unknown. *Trichinella* has been detected in several wildlife species,<sup>1</sup> including black bear which has also been identified as the source of an outbreak in Saskatchewan in 2000.<sup>21</sup> As mentioned earlier, pork meat is an unlikely source of *Trichinella* infection in Canada.

In conclusion, the incidence of hospitalization for echinococcosis and trichinellosis is low at the national level. However, significantly higher rates have been measured in northern regions of Canada despite the fact that both diseases are theoretically preventable and that a *Trichinella* control program is in place in Nunavik. Further efforts, probably educational in nature, will be required to reduce the incidence of these infections in high-risk areas.

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## RÉSUMÉ

**Objectifs :** Cette étude a été entreprise pour mesurer l'incidence des hospitalisations causées par la trichinose et l'échinococcose au Canada et pour comparer les taux mesurés chez les habitants des régions nordiques à ceux mesurés chez les autres Canadiens.

**Méthode :** Les cas hospitalisés de 2001 à 2005 pour l'échinococcose ou la trichinose ont été extraits de la base de données sur la morbidité hospitalière (BDMH) de l'Institut canadien d'information sur la santé. Les taux d'incidence bruts et standardisés ont été calculés par province et par intervalle de latitude.

**Résultats :** En tout, 108 hospitalisations causées par l'échinococcose et 14 par la trichinose ont été trouvées. Les taux d'incidence de ces deux maladies étaient respectivement de 0,72 et 0,09 par million par année. Il y avait un clair gradient sud-nord pour l'incidence des hospitalisations causées par l'échinococcose, l'incidence la plus élevée (2,9 par million par année) ayant été mesurée au nord du 55<sup>e</sup> parallèle. Le risque d'hospitalisation causée par l'échinococcose était aussi plus élevé chez les femmes que chez les hommes (RR 1,92, IC 95% 1,29-2,87). Pour la trichinose, l'incidence la plus élevée (42 par million par année) a été mesurée au Nunavut et dans le nord du Québec.

**Conclusion :** L'incidence des hospitalisations causées par la trichinose et l'échinococcose est faible au niveau national. Toutefois, des taux significativement plus élevés ont été mesurés dans les régions nordiques du Canada, et ce bien que les deux maladies soient théoriquement évitables et qu'un programme de prévention de la trichinose soit en place au Nunavik. Des efforts accrus, probablement de nature éducative, seront nécessaires pour réduire l'incidence de ces deux maladies dans les régions à risque.

**Mots clés :** échinococcose; trichinose; hospitalisations; Canada

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