Geographic variation in thyroid cancer incidence in Ontario, Canada: 2003-2007

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Thyroid cancer background

• Relatively rare but most common endocrine malignancy.

• Unusual age and sex distribution:
  • ~ 3:1 female-to-male ratio.
  • Younger age at diagnosis than more common cancers.

• Significant variation in incidence rates worldwide:
  • Female rates vary ~ 5-fold.
  • High rates in certain populations (e.g., Pacific Islanders, Filipino and Middle Eastern immigrants to U.S.).
  • Higher rates in Ontario than all other Canadian provinces (Canadian Cancer Statistics, 2012).
Thyroid cancer incidence has been rising

- Thyroid cancer incidence ↑ worldwide over the past 30 years, especially in females
- Ontario: thyroid cancer ↑ more rapidly than any other cancer.
- 4th most common cancer among Ontario females

Thyroid cancer incidence, Ontario, 1983-2007, by sex

- Male observed: [Graph]
- Female observed: [Graph]
- Male regression: [Graph]
- Female regression: [Graph]

Source: Cancer Care Ontario (Ontario Cancer Registry, 2010)
APC = Annual Percentage Change
What could explain rising rates of thyroid cancer?

1. ↑ detection of thyroid cancer (incidentalomas and small subclinical tumours) resulting from:
   - ↑ use of diagnostic imaging technologies (e.g., Dx ultrasound, fine-needle aspiration biopsy) since mid-1980s

Ontario:
- **1990-2001**: Incidence of small tumours (≤2cm)↑, medium sized tumours ↔ (Kent WDT, et al., CMAJ 2007;177(11):1357-61)
- **1993-2006**: Rate of neck imaging tests (CT, MRI, US) associated with thyroid cancer rate (Hall SF, et al., World J Surg 2009)
What could explain rising rates of thyroid cancer?

2. Changes in exposure to known or emerging risk factors:
   • Ionizing radiation**
   • History of goitre/ or thyroid nodules
   • Hormonal/reproductive factors?
   • Dietary factors/ obesity?
   • Emerging environmental factors?

Ontario:
• Little data on risk factor prevalence over time and across regions available BUT examining demographic factors may give us a clue
Objectives

• To examine geographic variation in female thyroid cancer incidence in Ontario

• To explore the relationship between regional rates of thyroid cancer with:
  a. diagnostic imaging service availability; and
  b. socio-demographic factors (immigration, education, income)

*Note: Ontario has a publicly funded health care system, which covers fees for diagnostic imaging services*
Methods – Data sources

- **Ontario Cancer Registry**
  - New female thyroid cancer cases (ICD-O-3: C73.9)
  - 2003-2007, N= 7,179

- **Ontario Health Insurance Plan physician billings claims**
  - Dx imaging use: head/neck ultrasound; thyroid fine-needle aspiration biopsy (FNAB), females
  - 2003-2007

- **Canadian Census data**
  - Socio-demographic characteristics: immigration, education, income
  - 2006, census division level
## Methods – Data analysis

- **Geographic units:**
  - **Local Health Integration Network (LHIN):** Areas of local health services delivery, N=14
  - **Census Divisions (CD):** Statistics Canada geographic unit, most equivalent to U.S. “county”, N=48

### ASIR for thyroid cancer, 2003-2007 (1991 Canadian standard) by:

<table>
<thead>
<tr>
<th>LHIN</th>
<th>Census Division</th>
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- **2003-2007 average rate:**
  - Ultrasound head/neck
  - FNAB of thyroid

- **2006 Census characteristics:**
  - % immigrant
  - Median household income
  - % University degree or higher

- Spearman rank correlation
Results - Female thyroid cancer incidence, Ontario, 2003-2007, by Local Health Integration Network (LHIN)
Results - Female thyroid cancer incidence, Ontario, 2003-2007, by census division (CD)

Statistical significance
++ Higher than Ontario
* Lower than Ontario

Rate per 100,000 (Quintiles)
Ontario = 21.25
- 5.73 - 10.31
- 10.32 - 13.52
- 13.53 - 16.52
- 16.53 - 20.49
- 20.50 - 35.75
Insuff. data

Moran's I: 0.46, p<0.001
The geographic pattern of incidence rates by Census Division is significantly clustered.

GTA

Notes:
*ICD-O-3 C73.9 (Thyroid).
†Rates are per 100,000 and age-standardized to the 1991 Canadian population.
‡Excluding unknown CD (N=147).

Report date: May 2012, Data source: Cancer Care Ontario (Ontario Cancer Registry, 2011)
Prepared by: Cancer Care Ontario, Prevention and Cancer Control (Surveillance and Research)
Why are female thyroid cancer rates so high in the Greater Toronto Area (GTA)?

The GTA is unique:

- ~ 46% of Ontario’s population
- Ethnically diverse: nearly 50% of the population are immigrants
- Ontario’s largest teaching hospitals and academic centres
- Almost 50% of Ontario’s active endocrinologists

Does greater access to health services contribute to the high rates in the GTA?
Results – Relationship between rate of head/neck ultrasound procedures and thyroid cancer incidence in Ontario females, 2003-2007, by LHIN

$r=0.938, p<0.001$

Source: Ontario Health Insurance Plan (OHIP); Cancer Care Ontario (Ontario Cancer Registry, 2010)
Results – Relationship between rate of FNAB procedures of the thyroid and thyroid cancer incidence in Ontario females, 2003-2007, by LHIN

Source: Ontario Health Insurance Plan (OHIP); Cancer Care Ontario (Ontario Cancer Registry, 2010)
Results – Relationship between selected socio-demographic factors and thyroid cancer incidence in Ontario females, 2003-2007, by CD

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<tr>
<th>Socio-demographic characteristic</th>
<th>All Census Divisions</th>
<th>Census Divisions outside of GTA*</th>
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<tbody>
<tr>
<td></td>
<td>Correlation</td>
<td>P-value</td>
</tr>
<tr>
<td>% Immigrant population</td>
<td>0.507</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Median household income ($)</td>
<td>0.346</td>
<td>0.018</td>
</tr>
<tr>
<td>% University degree or higher</td>
<td>0.315</td>
<td>0.033</td>
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* Excludes: Durham, York, Toronto, Peel, Halton
Limitations

• Exploratory analysis: potential factors examined separately but are likely related and interact with each other.

• Unable to readily access automated info on important tumour characteristics (e.g., size, disease stage).

• Lack of risk factor exposure data (e.g., radiation, history of thyroid disease).

• Lack of info on ethnicity/immigration for individual cases.
Conclusions

• Substantial geographic variation of female thyroid cancer incidence exists across Ontario; likely due to differences in:
  • Detection
  • Population demographics

• Findings support the hypothesis that both groups of factors are driving thyroid cancer incidence in Ontario.

• Future research needed to examine the role of risk factor exposure and combined effect of multiple factors.
Acknowledgements

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References


Questions?