GIS and Cervical Cancer Screening: The Contribution of Spatial Analysis.

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GIRAS: Giving some space to health population research…
Presentation Outline

• Research Background
• Cervical Cancer Screening in Canada
• Study area
• Geocoding Health Data in Canada
• Cervical Cancer Screening Data
• A Few Descriptive Statistic about Screening
• Geographical Variation of Screening Rate
• Spatial Analysis
• Conclusion
Research Background
Why it matters…

• Statistics widely known
  - Cervical cancer is in second rank in the world
    - After breast cancer
    - 1300 cases in Canada yearly
  - Best means to control cervical cancer
    - HPV vaccination
    - Cancer screening (PAP test)
    - Screening need to be optimized
    - From opportunistic screening to organized screening
    - Develop means to assess screening efficiency
    - Measure population response to solicitation
Cervical Cancer Screening in Canada

Screening in Canada*

*Data based on a self-declared survey from Statistics Canada
Cervical Cancer Screening in Quebec

• Low participation rate of women to screening
  - Facts:
    - No organized screening program in the province
    - Data on screening based on self-declaration
    - Overestimation of participation rates
    - No fine scale data (at geographical scale)

• Project
  - Assess actual screening rate
  - Map geographical variation of screening rates
  - Focus on a specific region (Mauricie region)
GIS and Population Health Research

• GIS can *integrate* and *link* databases from different sources and help study those data on a common base: *Geographical location*

- **Statistics Canada**
  - Census data
  - Income
  - Education
  - Etc.

- **Health Surveys**
  - Canadian Communities Health Survey
  - Cancer Register
  - National Health Expenditure Database
  - Etc.

- **Hospital & Agencies**
  - TDHC (Cervical Cancer Screening)
  - STD (Sexually transmitted Diseases)
  - Deprivation Indices database
  - Etc.

- **Other Data**
  - In House Surveys
  - Derived data
  - Etc.
Geocoding Health Data in Canada

- Spatial Key ➔ Postal Code
  - Advantages
    - Usually coded in all databases (hospital, agencies, patients record)
    - Data remain anonymous
    - No need to obtain patient authorization
    - Easier to get research ethic certificate
    - Good spatial precision in urban areas
  - Disadvantages
    - Design for mail delivery, not health population research!
      - Same postal code repeated along a mail delivery road
    - Low precision in rural areas (1 postal code per municipality)
Geocoding Health Data in Canada

• Health data geocoding:

Postal codes with X,Y coordinates

845,990 postal codes in Canada (Jan. 2014)

Postal code are located within dissemination areas

Dissemination areas: Statistics Canada smallest unit
Study area
Mauricie Region
Study area
Pilot study (CSSS de l’Énergie)

- Located in the Mauricie Region
- 16 municipalities
- Shawinigan, largest city, (51,905 in 2011), 66.7% of CSSS
- In 2011:
  - 40,000 women in CSSS territory
  - 35,035 women of 15 years and over
Cervical Cancer Screening Data

• For each woman who at least one PAP test between 2008-2010:
  - Postal Code
  - City
  - Birthdate
  - Screening dates
  - Screening results
  - Quality of samples
  - Doctor name

• From 1 to 15 test results for each record
  - Guidelines are 1 for each 3 years period.
A Few Descriptive Statistics

Women's Age at PAP Test

- Self-declared screening rate: 58.5%
- Real screening rate: 55.0%
- Mean age: 43.9 years old
- Youngest: 14 years old
- Oldest: 92 years old
A Few Descriptive Statistics

• Age is a good indicator of screening rates:

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Screened Women 2008-2010</th>
<th>Total Number of Women 2010 (ISQ)</th>
<th>Screening Rate 2008-2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-24</td>
<td>1656</td>
<td>1770</td>
<td>93.6%</td>
</tr>
<tr>
<td>25-34</td>
<td>3632</td>
<td>3675</td>
<td>98.8%</td>
</tr>
<tr>
<td>35-44</td>
<td>3019</td>
<td>3840</td>
<td>78.6%</td>
</tr>
<tr>
<td>45-54</td>
<td>4686</td>
<td>6910</td>
<td>67.8%</td>
</tr>
<tr>
<td>55-64</td>
<td>3386</td>
<td>6590</td>
<td>51.4%</td>
</tr>
<tr>
<td>65-74</td>
<td>1365</td>
<td>4430</td>
<td>30.8%</td>
</tr>
<tr>
<td>75 &amp; over</td>
<td>384</td>
<td>5190</td>
<td>7.4%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>18128</td>
<td>32405</td>
<td>55.0</td>
</tr>
</tbody>
</table>

• But, what about geography?
Mapping cervical cancer screening rate (Municipalities level)
Mapping cervical cancer screening rate (Dissemination Areas Level)
Mapping cervical cancer screening rate (Downtown Shawinigan)
Mapping cervical cancer screening rate
Urban Core – Rural Areas Comparison

### Urban – Rural Comparison

<table>
<thead>
<tr>
<th></th>
<th>Urban Core</th>
<th>Rural Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of D.A.</td>
<td>94</td>
<td>43</td>
</tr>
<tr>
<td>Lowest screening rate</td>
<td>19.4%</td>
<td>16.3%</td>
</tr>
<tr>
<td>Highest screening rate</td>
<td>97.0%</td>
<td>84.7%</td>
</tr>
<tr>
<td>Mean screening rate</td>
<td>49.5%</td>
<td>49.4%</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>12.5</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Sources: Statistics Canada (2011), TDHC Databases (2011)
Mapping cervical cancer screening rate
(Getis-Ord Hot Spot/Cold Spot)
Can socio-economic factors explain screening rates?

• We used deprivation indices to assess the impact of socio-economic factors on screening rates;
  - Material deprivation index
    - Principal component analysis of Statistic Canada variables related to income, unemployment, education, etc.
  - Social deprivation index (social network)
    - Principal component analysis of Statistic Canada variables related to single people, single parenthood, divorced, etc.
• Each dissemination area got two scores (one for each index)
  - We studied the spatial relationship between screening rates and deprivation indices using the «Exploratory regression» function
Can socio-economic factors explain screening rates?

- **Explanatory Regression**
  - **Dependent variable**
    - Screening rate
  - **Candidate explanatory variables**
    - Material deprivation index score
    - Social deprivation index score
    - Median age of women in D.A.
    - Mean total income in D.A.
    - Median total income in D.A.
    - Unemployment rate in D.A.
    - Percentage of dwelling with less than 20K income
    - Percentage of dwelling with 20k-60K income
Can socio-economic factors explain screening rates?

- We got a limited relationship…
- $R^2 = 0.34$
  - Significant variables
    - Median age of women in D.A. (make sense!)
    - Material deprivation index
    - Percentage of dwelling with 20k – 60k income
  - Social deprivation index
    - No significant contribution to screening rate explanation
- Need to explore other spatial relationships
  - Multifactorial explanation to undergo a PAP test
Conclusion

- Real screening rates are lower than self-declared in the study area
- Women’s age is a key factor to undergo a PAP test
- Geographical variations of screening rates are observed at all scales
- There is no significant differences in screening rates between urban and rural areas
- Getis-Ord analysis allowed us to locate hot spots/cold spots in the study region
Conclusion

• Exploratory regression confirmed that:
  - Women median age
  - Material deprivation index
  - Percentage of dwelling income between 20k-60k

explain 34% of screening rate in the study area

• ArcGis is a powerful tool for the integration and spatial analysis of data coming from different sources.
• Maps & analysis produced with ArcGis can help locate areas where screening must be increased
Conclusion

What I did not tell you:

Another team of researchers had meetings with women in some of the low screening rate areas.

It appears that women don’t undergo PAP test because:

- Of their lack of knowledge about cervical cancer
  - Find new means to reach them
- Cervical cancer is asymptomatic in the first stages
  - Find new means to inform them
- The clinics opening hours are the same as working hours
  - Extend opening hours of clinics offering screening
- They forget to take appointments
  - Send a reminder to women after a 3 years period