Geographical Analysis of Sexually Transmitted Diseases: A Space, Time, Age and Gender Encounter.

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

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• Geocoding Health Data in Canada
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Research Background
Why it matters…

- Sexually transmitted diseases (STD) and blood-borne infections (BBI)
  - Social burden
    - In Canada, reported rates of chlamydia, gonorrhea and syphilis have been steadily rising since the late 1990s.
    - Many of those infections are asymptomatic.
    - Among STD & BBI adverse outcomes
      - Ectopic pregnancy, miscarriage, infertility, cervical cancer, death
  - Research traditionally based on individual risk behaviors. However:
    - Incidence rates are not uniform over regions
    - Incidence rates are not uniform in subpopulations
STD & BBI: A few trends in Canada

Steadily increasing rates since 2000…

Source: Public Health Agency of Canada, 2013
Geocoding Health Data in Canada

• Spatial Key → Postal Code

- Advantages
  - Often coded in all databases (hospitals, 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 can be 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
- Postal code are located within dissemination areas

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

Dissemination areas: Statistics Canada smallest unit
Study area: Quebec’s Health regions

- 7,903,001 inhabitants in 2011
- Quebec’s population located in the southern part of the province
- Province divided in 17 health regions
Study area: Mauricie & Centre-du-Quebec region

Region demography:
- Population (2010): 494,726
- Municipalities: 126
- Older age structure than the province
- Lower income than the province
- Lower education level
- Native reserves in the north
- 4 urban centers:
  - Trois-Rivières (129,886)
  - 59% of the population
  - Younger age structure in urban areas
Problem and Objectives

- In the Mauricie & Centre-du-Quebec region
  - We had
    - No idea about STD incidence rates in sub-regions (CSSS)
    - No clear idea about geographical distribution of STD cases
    - No clear idea if there is clustering in space of cases
  - Region had access to data but
    - No tools to make geographical information out of it
    - Database was a “consulting tool” for monthly cases
      - Monthly report for doctor and nurses
- But
  - Decision makers were aware of GIS
    - Previous project on cervical cancer screening
Problem and Objectives

• Objectives

- The main objective of this study was to provide reliable statistical and geographical information to decision makers about STD and BBI cases in the Mauricie & Centre-du-Québec region.
  - Study the temporal variations of STD and BBI in the region;
  - Map geographical distribution of STD cases and compare distributions in rural and urban areas;
  - Study the effect of age and gender on STD rates and the geographical distribution of cases according to these criterias;
  - Use geostatistics to locate in space significant geographical clusters of STD cases, specially chlamydia.
Methodology & Data

• Methodology
Methodology & Data

Data

**Major Sexually Transmitted Diseases & Blood-borne infections queried from MADO**

1. Chlamydia
2. Hépatitis « C »
3. Gonococcal infections
4. Syphilis
5. Hepatitis « B »

**Data downloaded for each record**

1. Record number (Id)
2. Postal Code (6 digits)
3. City
4. Gender
5. Diagnostics date (YYYYMMDD)
6. Birthdate (YYYYMMDD)
7. Age of patient when diagnosed
8. STD or BBI type
9. RLS (Réseau local de services)
10. RUIS (Réseau universitaire intégré de santé)
11. CLSC (Centre local de service de santé)
12. Validation code
STD & BBI: A Few Statistics

- As in the province of Quebec, chlamydia cases come first in the region (89.6%), followed by hepatitis “C” (6.7%) and gonococcal infections (2.5%).

Sexually Transmitted Diseases and Blood-borne Infection Cases in Mauricie Centre-du-Québec (2007-2011)

Source: MADO database
STD & BBI: A Few Statistics

Temporal evolution of STD & BBI

- **Chlamydia Cases in Maurice & Centre-du-Québec (2007-2011)**
  - 2007: 966
  - 2008: 1034
  - 2009: 1040
  - 2010: 1044
  - 2011: 1418
  - Source: MADO database

  - 2007: 98
  - 2008: 95
  - 2009: 96
  - 2010: 65
  - 2011: 59
  - Source: MADO database

- **Gonococcal Infections Cases in Maurice & Centre-du-Québec (2007-2011)**
  - 2007: 27
  - 2008: 31
  - 2009: 41
  - 2010: 23
  - 2011: 30
  - Source: MADO database

- **Syphilis Infections in Maurice Centre-du-Québec (2007-2011)**
  - 2007: 6
  - 2008: 7
  - 2009: 7
  - 2010: 12
  - 2011: 15
  - Source: Requête MADO
STD & BBI: A Few Statistics

Age & Gender: Two majors characteristics of STD & BBI

Chlamydia cases...

- 66.7% of all **declared** cases are women
- Women mean age (at declaration): 22.1
- Men mean age (at declaration): 25.6
- Highest incidence rate (women): 19 years old
- Highest incidence rate (men): 20 years old
- 15-24 years old: 69.1% of all cases
- Steady decrease after 20 years old
- Range 12 to 69 years old
STD & BBI: A Few Statistics

Age & Gender: Two majors characteristics of STD & BBI

Hepatitis “C” cases...

- 66.8% of all declared cases are men
- Men mean age (at declaration): 42.7
- Women mean age (at declaration): 37.0
- Highest incidence rate (men): 48 years old
- Highest incidence rate (women): 30 years old
- Different age distribution for men and women
- Range 6 to 80 years old
STD & BBI: A Few Statistics

Age & Gender: Two majors characteristics of STD & BBI

Age & Gender Distribution of Gonococcal Infections Cases. Mauricie & Centre-du-Québec (2007-2011)

Gonococcal Infections cases...

- 71.7% of all declared cases are men
- Men mean age (at declaration): 30.3
- Women mean age (at declaration): 25.2
- Highest incidence rate (men): 20 & 29 years old
- Highest incidence rate (women): 24 years old
- Different age distribution for men and women
- Range from 14 to 64 years old
The Geography of STD & BBI

- Many studies show that STD and BBI are clustered in space.

Chlamydia at municipal scale:

- Lower incidence rates in rural areas.
The Geography of STD & BBI

- Chlamydia cases at dissemination areas level

Chlamydia at dissemination area scale:

- Higher heterogeneity
The Geography of STD & BBI

• Chlamydia cases in urban areas
The Geography of STD & BBI

• Chlamydia cases among young adults (15 to 24 years old)
The Geography of STD & BBI

- Chlamydia cases among young adults (15 to 24 years old)
Grouping analysis

• Is there significant clustering in space?
Grouping analysis

- Clustering for young adults?
Chlamydia & Social determinants

• STD are often associated with socio-economic problems in population
• Many indices can be used to measure socio-economic problems. Among them:
  - Social deprivation index
  - Material deprivation index
• We paired each dissemination area chlamydia incidence rate with deprivation indices
  - Is there a correlation between deprivation and incidence rate?
Chlamydia & Socio-economic determinants

• Correlation

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Type</th>
<th>Social Deprivation</th>
<th>Material Deprivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mauricie &amp; Centre-du-Québec</td>
<td>874</td>
<td>Whole region</td>
<td>0.298**</td>
<td>-0.073*</td>
</tr>
<tr>
<td>CSSS de Trois-Rivières</td>
<td>225</td>
<td>Urban</td>
<td>0.384*</td>
<td>0.070</td>
</tr>
<tr>
<td>CSSS de Drummond</td>
<td>179</td>
<td>Mostly urban</td>
<td>0.314*</td>
<td>-0.029</td>
</tr>
<tr>
<td>CSSS De l’Énergie</td>
<td>103</td>
<td>Rural</td>
<td>0.247*</td>
<td>0.176</td>
</tr>
<tr>
<td>CSSS de la Vallée-de-la-Batiscan</td>
<td>50</td>
<td>Rural</td>
<td>0.191</td>
<td>-0.324*</td>
</tr>
<tr>
<td>CSSS du Haut-Saint-Maurice</td>
<td>172</td>
<td>Rural</td>
<td>0.197</td>
<td>0.299</td>
</tr>
<tr>
<td>CSSS de Bécancour et Nicolet-Yamaska</td>
<td>83</td>
<td>Rural</td>
<td>0.152</td>
<td>-0.071</td>
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<tr>
<td>CSSS d’Arthabaska-et-de-l’Érable</td>
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<td>Rural</td>
<td>0.099</td>
<td>-0.064</td>
</tr>
<tr>
<td>CSSS de Maskinongé</td>
<td>39</td>
<td>Rural</td>
<td>0.061</td>
<td>0.094</td>
</tr>
</tbody>
</table>

(* Significant at 0.05 level,  ** Significant at 0.01 level)

• Social deprivation with highest correlation
  - Urban areas vs rural areas

• Material deprivation
  - Limited to 2 regions with opposite results (?)
Chlamydia & Socio-economic determinants

• Geographically-weighted regression (GWR)
  - Dependant variable
    - Chlamydia incidence rate
  - Independent variables
    - Percentage of young adults
    - Social deprivation percentile
    - Material deprivation percentile

• $R^2 = 0.39$
• $P < 0.01$

• But… this model is not good!
  - Residuals are clustered in urban areas
Chlamydia & Socio-economic determinants

- Does social deprivation make a real difference?
- Comparison between:
  Population with highest social deprivation (20%) vs Rest of population

- Student’s T test & Levene’s test
  - Significant difference between means ($p < 0.01$)

- Population with highest deprivation
  - Mean incidence rate of 334 for 100 000 person-years

- Rest of population
  - Mean incidence rate of 198 for 100 000 person-years
Conclusion

• STD are increasing in industrialized countries
• Chlamydia infections rank first in number of cases each year (89.6% in study area)
• Age and gender are major characteristics of STD
• We found geographical variations of STD:
  - Higher incidence rates of chlamydia in urban areas
  - Clustering in space for young adults living in the largest cities
• Chlamydia incidence rate can be linked to
  - Social deprivation index
Conclusion

• What’s next?
  - Use the whole database (2002-2011)
    - Enable us to work on temporal aspect of STD
    - More cases for “rare” STD (not just chlamydia)
  - Focus on urban areas
    - Trois-Rivières (largest city)
  - More geostatistics
    - GWR (build a good predictive model)
    - Find appearing/disappearing clusters in time
  - Study potential spatial relationship between
    - Cervical cancer & STD
Thank You!