Using GIS to Investigate the Etiology of Childhood Disease

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Epidemiology

- the study of diseases in populations by collecting and analyzing statistical data. In the field of cancer, epidemiologists look at how many people have cancer; who gets specific types of cancer; and what factors (such as environment, job hazards, family patterns, and personal habits, such as smoking and diet) play a part in the development of cancer.

  www.mesotheliomamonline.com/resources/glossary.php

- Used with human and veterinary diseases for the distribution of disease, factors which cause disease, and the attributes of disease in defined populations; includes incidence, frequency, prevalence, endemic and epidemic outbreaks; also surveys and estimates of morbidity in geographical areas and in specified populations.

  toolkit.dialog.com/intranet/forms/MedDefinitions.html

- The study of the various factors influencing the occurrence, distribution, prevention and control of disease, injury and other health-related events in a defined human population.

  www.med.uwo.ca/ecosystemhealth/education/glossary.htm

- The study of the distribution and causes of disease and injuries in human populations.

  highered.mcgraw-hill.com/sites/0070294267/student_view0/glossary_e-l.html

- The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor is associated with the health effect.

  www.nsc.org/ehe/glossary.htm

- the use of medical science and statistics to track population health and to find causes of disease in groups of people.

  healthresourcesandtools.com/
Epidemiology

An information joining tool to answer questions about – health, disease, illness, death

for the purpose of improving health, reducing disease, relieving illness, avoiding death
GIS - another tool in Epidemiology because

Health has a spatial component:

- Built
- Natural Environment
- Social
Childhood Health Outcomes

- Cancer
- Death
- Stillbirth
- Congenital Anomaly
Cumbrian Births Database
1950-1993

Stillbirths, infant death and leukaemia around Sellafield, Cumbria

- 300,000 live birth registrations
- 4,000 stillbirth registrations
- 3,000 infant death registrations
THE DATABASE

Cumbrian Cohort
251,830 singleton births
3,715 stillbirths

Sellafield fathers
16,496 births
247 stillbirths

non-Sellafield fathers
235,316 births
3,468 stillbirths

before start of employment
10,318 births
151 stillbirths

after start of employment
6,178 births
96 stillbirths

Radiation workers
9,208 births
130 stillbirths

non-radiation workers
1,110 births
21 stillbirths

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Stillbirths and Leukaemia around Sellafield, Cumbria

Figure 1. Cumulative observed and expected numbers of stillbirths by distance from the coast within 10 km of the coast, 1950–89.
Stillbirth rates around the nuclear installation at Sellafield, North West England: 1950–1989

TJB Dummer, HO Dickinson, MS Pearce, ME Charlton, J Smith, J Salotti and L Parker
Incinerators and Crematoria

Adverse pregnancy outcomes around incinerators and crematoriums in Cumbria, north west England, 1966-1993

TJ B Dummer, HO Dickinson, L Parker

JECH 2003; 57: 1-6
PROXIMITY MODELS

Exposure Models

- step - as in 25 km radius
- distance
- $1/(\text{distance}+0.1)^2$
Findings

- No increased risk in stillbirth and neonatal death overall
- Statistically significant increased risk of some specific birth defects with proximity to incinerators and crematoria
- Statistically significant increased risk for stillbirth near crematoria for some time periods only
Incinerators

Biological Plausibility

- Can produce toxic chemicals incl. dioxins, PCBs etc which can contaminate the environment and cause adverse health outcome
Childhood Cancer

Other spatial components in etiology

- Population characteristics:
  - Infection, mobility, population density, ses
- Other environmental factors
  - Roads
  - Railways
  - Hazardous installations
NOVA SCOTIA YOUTH DATABASE

- **Homelessness 12-24**
  - Capital Health District
  - Phoenix House ARK

- **INDIVIDUALS Births 1971-1992**
  - Date of birth
  - Sex
  - Residential location

- **LOCATION**
  - Urban/rural
  - Proximity to care and others
  - Community SES
  - Local environment

- **DEATHS since birth**
  - Date of death
  - Cause of death
  - Location of death
  - Residential location

- **Trauma 12-24**
  - Date of injury
  - Nature of injury
  - Location of injury
  - Residential location

- **Education 12-18**
  - Literacy scores grade 6
  - School location
  - School characteristics
  - Residential location
  - Attendance/truancy
  - Age and grade
  - Special Programmes

- **Youth Health Centre Utilization 12-18**

- **JUSTICE age 12-24**
  - Date of crime
  - Date of verdict
  - Verdict
  - Sentence
  - Location of crime
  - Residential location

- **POLICE age 12-24**
  - Time and date of crime/event
  - Nature and details of crime/event
  - Location of crime/event
  - Residential location

- **COMMUNITY SERVICES since birth**
  - Periods of foster care
  - Episodes of abuse
  - Type of abuse
  - Perpetrator
  - Location – of abuse/care
  - Residential location

- **ATLEE at birth**
  - Gestational age
  - Birth weight
  - Sibships
  - Congenital anomalies
  - Mother’s health in pregnancy
  - Birth order
  - Family size
  - Residential location
  - SES Family

- **HEALTH EPISODES age 12-24**
  - Date of contact
  - Nature of contact
  - Location of contact
  - Specialist
  - Procedures
  - Diagnosis
  - Residential location

- **DATA LINKAGE**
Issues

- Urban/Rural
- SES
- Remote communities
- Gender
Atlantic Arm of Canadian Cancer Cohort Study

- Built environment
- Social environment
- Natural Environment
- Health services infrastructure
Wearable Sensors for Health Research: An Application in Human Exposure Assessment

Daniel Rainham, University of Ottawa
Mark Gibson, Dalhousie University
Judy Guernsey, Dalhousie University
Why use a Geospatial Approach?

• Place as a central tenet in epidemiology, population health and geography, offers clues and opportunities to consider more fully the spatiality of health determinants.

• An essential ingredient of any health research is the constitution of place itself and how it influences health, including:
  
  • the knowledge of the area that demarcates an individual or group’s space in time
  
  • the meaning and significance attached to places that help comprise the reality and experience of life
  
  • implicit acknowledgement of time AND space as the dynamic governing health determinants throughout the lifecourse
Why use a Geospatial Approach?

- Physical
- Demographic
- Social-Economic
- Psychological
- Propinquity
- Environmental

Definitely well defined

Definitely not in definition

Unsure
Improving Exposure Assessment: Linking GPS with Particulate Air Pollution Exposure
Learning from a Geospatial Approach

• Confronted with the necessity to operationalize the concept of place usually through the demarcation of spatial units (space)

• Does not mean that places are intrinsically coupled with the geography – some are – others are associated with individuals who lend collective attributes to a particular area (e.g., stage in lifecourse)

• The geographic scale across which any attribute or variable varies is often wildly dissimilar among attributes (e.g., housing type versus public educational quality)

• The scale of observation can influence inference – the modifiable aerial unit problem

• Boundaries can be identified by individuals or groups as they conceptualize and negotiate movement through – and relationships with – their surroundings
Geospatial Approaches: Advantages

• More accurate assessment of the intra-urban and intra-rural spatial variability of air pollution

• Visualization of data creates powerful tool to discover relationships among data, and between data and characteristics of places

• Multiple surveys can be matched by time and location to develop a comprehensive distribution of exposure

• Incorporates the dynamics of everyday life and activities

• All data are georeferenced meaning they can be easily linked to other environmental attributes and health determinants data
Geospatial Approaches: Challenges and Opportunities

• The concept of health data as having inherently spatial characteristics is not fully understood by the developers, managers and users of health data

• The assignment of geographic coordinates to all health and health determinants information would provide opportunities to explore spatial influences on health and well-being

• Geospatial approaches to the analysis of health and environmental data provide insights absent from more traditional epidemiologic and risk-based approaches

• The use of wearable sensor technologies aim to help researchers understand more fully the influence of place (characteristics of places) on human health and well-being
Tools and methods to investigate the multiple influences of place on individuals require further development. Applications from existing and proposed collaborations include:

1. Investigating features of the built environment as they relate to caloric expenditures and eating habits in youth (GPS linked with accelerometers)

2. Measuring the social activity space of perfectionists and those with other personality traits (GPS Tracking)

3. Assessing how individuals with recent physical disabilities return to usual routines (Wheelchair GPS Project)

4. Community and individual noise exposure assessment associated with landuse (GPS linked with sound level meters)

5. Halifax Healthscapes Study: Linking GPS tracking data to individual data on physical/mental health, social capital, consumption, and demographic information
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Mapping the obesogenic environment of Nova Scotia

Sara Kirk, Tarra Penney, Trevor Dummer, Louise Parker, Daniel Rainham
The “O” word...

“...today’s principal neglected public health problem...” (WHO)

“...one of the most important medical and public health problems of our time...” (Prof. Philip James, IOTF Chairman)

“...today’s children will be the first generation for some time to have poorer health outcomes and a shorter life expectancy than their parents...” (Rob Merrifield, Healthy Weights for Healthy Kids report)
Obesity Trends* Among Canadian Adults

HPS, 1985

(*BMI ≥ 30, or ~30 lbs overweight for 5'4" person)

Obesity Trends* Among Canadian Adults
HPS, 1990

(*BMI ≥ 30, or ~30 lbs overweight for 5'4" person)

Obesity Trends* Among Canadian Adults
NPHS, 1994

(*BMI ≥ 30, or ~30 lbs overweight for 5’4” person)

Obesity Trends* Among Canadian Adults
NPHS, 1996

(*BMI ≥ 30, or ~30 lbs overweight for 5’4” person)

Obesity Trends* Among Canadian Adults
NPHS, 1998

(*BMI ≥ 30, or ~ 30 lbs overweight for 5’4” person)

Obesity Trends* Among Canadian Adults
CCHS, 2000

(*BMI ≥ 30, or ~ 30 lbs overweight for 5’4” person)

Source: P.T. Katzmarzyk, Unpublished Results.
Obesity Trends* Among Canadian Adults

CCHS, 2003

(*BMI ≥ 30, or ~ 30 lbs overweight for 5’4” person)

Source: P.T. Katzmarzyk, Unpublished Results.
Obesity Trends* Among Canadian Adults
CCHS, 2005

(*BMI ≥ 30, or ~30 lbs overweight for 5’4” person)

Source: P.T. Katzmarzyk, Unpublished Results.
Data from: Statistics Canada, Catalogue no. 82-621..
Why use GIS?

- To understand why obesity rates have increased so rapidly in the last 15-20 years
- Enables multiple levels of influence to be explored to characterise the "obesogenic environment"
We aim to...

..map current (or historic) obesity data...

..at geographic scale of interest (e.g. postal sector, census dissemination area)...

..in the population of interest (e.g. adults, children)...

..by relevant environment (e.g. home, school)....
Then...

...explore the relationship between health data...

...to identify types of areas for intervention...

...and spatially defined risk factors (e.g. socio-economic characteristics)...

...and inform policy...
Challenges…

- Finding a consistent definition of what the environment is and is not
- Measuring the environment and its effects in a meaningful way
  - Perceived versus actual
  - Changes over time
- Defining the population
  - Is the environment the same for everybody?
And opportunities...

- Ability to understand factors that contribute to the obesogenic environment in a given area or population group

- Ability to tailor interventions to specific populations
What have we learned?