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An Environmental Scan of Built Environment Data Related to Walkability & Environmental Exposures in Urban Ontario

PHO Grand Rounds, January 8, 2012

Presenters:
Popy Dimoulas-Graham, Epidemiologist Consultant
Helen Doyle, York Region Public Health
OUTLINE

- Public Health mandate
- Built Environment LDCP
  - Walkability (W)
  - Air Quality (AQ)
  - Extreme Heat (EH)
- Research question
- Methodology
- Findings
- Recommendations
Health Hazard Prevention & Management

Increase awareness of health risk factors & assist community partners to develop healthy public policies related to the built environment

Chronic Disease Prevention

Work with municipalities to support healthy public policies related to the built environment and physical activity
LDCP: LOCALLY DRIVEN COLLABORATIVE PROJECTS

- Began in 2011
- Funded and supported by Public Health Ontario
- Collaborative priority setting process with PHUs to identify research projects
- Criteria for funding: min. of 2 health units participating; outcomes transferable across Ont.
- The ‘built environment’ identified as a priority funding area in 2011
THE ‘BUILT ENVIRONMENT’ LDCP COLLABORATIVE TEAM

Multidisciplinary Team:
- Epidemiologists; Environmental Health & Chronic Disease Managers; Environmental Health Specialists; GIS Experts

Public Health Units/Agencies:
- Kingston, Frontenac, Lennox & Addington Public Health
- York Region Public Health
- Niagara Region Public Health
- Sudbury & District Health Unit
- Public Health Agency of Canada

Consultants:
- Research coordinator: Popy Dimoulas-Graham
- Environmental Health consultants: Kim Perrotta, Kevin Behan
What measures of walkability and environmental exposures [air quality & extreme heat] are in current use and what data are available and necessary to assess the urban built environment in Ontario?
Why did we choose these 3 factors?

- Walkability
- Extreme Heat
- Safety
STUDY OBJECTIVES

1. Identify existing measures & indices of urban walkability and environmental exposures

2. Identify built environment data necessary for the construction of the measures and indices

3. Determine data & sources currently collected by Ontario PHUs

4. Identify gaps between necessary and available data collected in Ontario

5. Develop policy recommendations
METHODOLOGY - STUDY DESIGN

- Literature review
- Key informant interviews (KIIIs)
- Survey
- Gap Analysis
LITERATURE REVIEW

- Peer-reviewed articles and grey literature
- Primary research studies and secondary source articles
- Articles were included regardless of geography
- Recently published

- Key words reflective of topic area and common themes e.g. Variable term + “indicator, indices, or measure(s)”
SUMMARIZING LIT. REVIEW FINDINGS

- 250+ articles reviewed
  - Walkability, Air Quality, Extreme Heat (~80 per topic)
- Summary table with descriptors

<table>
<thead>
<tr>
<th>Reference</th>
<th>Location</th>
<th>Purpose</th>
<th>Population</th>
<th>Health Outcome</th>
<th>Indicator</th>
<th>Methods/Data Components</th>
<th>Data Source</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toronto, Ontario, Canada</td>
<td>143 field measurements of nitrogen dioxide, an inorganic gas marker of TRAP, were applied to a cohort of patients from a respiratory clinic in Toronto to assess the association between TRAP and mortality.</td>
<td>Subjects for this study were drawn from a respiratory disease clinic in the Toronto Western Hospital.</td>
<td>Prehospital mortality</td>
<td>NO2 and CO</td>
<td>Collected NO2 samples using a two-sided oxygen passive diffusion sampler at 90 locations across Toronto. Selected sampling locations with a location-identification model based on pollution variability, space, and an industrial population density framework.</td>
<td>PM2.5 from the Environment of Ontario (ENO) stations, O3 from the O3 stations, and an Environment Canada site, NO2 from two-sided oxygen passive diffusion samplers at 159 locations across Toronto.</td>
<td>TRAP was associated with significant elevations in mortality from all causes and from chronic lung disease. Exposure contrasts for PM2.5 and O3 were small in Toronto. No definitive conclusions can be drawn about these associations with PM2.5 and CO.</td>
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KEY INFORMANT INTERVIEWS

- 22 key informants interviewed including: Public Health Units; Federal and Provincial agencies; and Academia

Questions focused on:
- Data sources
- Data coverage, quality and accessibility
- Challenges of current data infrastructure
- Capacity
- Dissemination
SURVEY OF PUBLIC HEALTH UNITS

Purpose
 Determine data and sources used by PHUs to assess: W, AQ, & EH

Content
 Drafted by project team
 Ethics review through Queen’s University

Delivery
 On-line survey July 2012
 Letters sent to each PHU (MOH, EH Director, CD Director)
SURVEY QUESTIONS

- 3 sections to survey: W, AQ, EH
- Qs on....
  - Measures used
  - Data components
  - Available data sources
  - Challenges
- Some Qs required input from municipalities or other departments (e.g. GIS, Planning)
Assessed gaps between data requirements and data availability by analyzing:

- **Measurement approaches:**
  - Types, inputs required, current use in Ontario, theoretical operation, usefulness

- **Data sources:**
  - Source, current use in Ontario, access and availability of data source
RESULTS

- TOPIC SPECIFIC
  - WALKABILITY
  - AIR QUALITY
  - EXTREME HEAT

- COMMON THEMES
FINDINGS: WALKABILITY
# LITERATURE REVIEW

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Categories of Measures</th>
<th>Data Components (examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Geographic Information System (GIS)</td>
<td>• Density &amp; Diversity (including proximity)</td>
<td>• No. of residential units (housing units) per residential acre or census tract</td>
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<tr>
<td>• Interview or self-administered questionnaires</td>
<td>• Street pattern connectivity</td>
<td>• Distance from home to the nearest park, retail, transit stop, etc.</td>
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<td>• Systematic observations or audits</td>
<td>• Pedestrian-oriented design</td>
<td>• No. of intersections per unit of area</td>
</tr>
<tr>
<td></td>
<td>• Walkability Index</td>
<td>• Index (Frank et al): retail floor area/residential &amp; intersection density/LUM</td>
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<td></td>
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<td>• Demographics</td>
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GIS EXAMPLE
Supermarket access in London, Ontario (2005)

Population per census tract with access
- <10%
- 10-25%
- 25-50%
- >50%

A) Walking access
FINDINGS FROM KEY INFORMANTS

- Walkability indices have been applied in major urban areas across Ontario
- Toronto has been extensively researched and has established indices
- Limited collaboration across health jurisdictions
- Desire for standardization re: measures and sources
- Planners involved indirectly

Challenges
- Data availability, quality and accessibility
- Variations by municipality
- Capacity (time, resources, technical competencies)
EXAMPLE: Diabetes and Activity Friendly Index, Toronto 2007
SURVEY FINDINGS

- 25/36 PHUs completed the walkability survey
- 68% of those surveyed assess walkability in urban environments
- Methods include self-administered surveys (67%); systematic observations (61%); GIS (39%); index or composite measures (47%)
- Challenges identified:
  - Human resource capacity, data availability, variations between municipalities
GAP ANALYSIS

- Similar measures used (e.g. density, diversity, connectivity) but different methods and data sources
- Lack of standardized terminology
- Biases noted with self-administered surveys and observations (audit tools)
- Variability in how GIS variables constructed
- Core data sets available but other ‘high value’ sets cost prohibitive e.g. MPAC, DMTI, RRFSS
- Challenges: PHU capacity, variations across municipalities
FINDINGS: AIR QUALITY
### Methodology
- Air monitoring station networks
- Estimating exposure using emissions data
- Modelling spatial distribution of pollutants

### Measure or Output
- Air Quality Health Index
- Air Quality Index
- Spatially-mapped pollutant levels

### Data Components
- Individual pollutant concentrations (e.g. NO$_x$, O$_3$, PM)
- Traffic levels and distance to roadways
- Land use designation (e.g. industrial, residential)
Land Use Regression Model

• Considers 55 built environment variables
• Correlates BE variables with air pollution measurements
• Can provides high resolution maps (10m)

FINDINGS FROM KEY INFORMANTS

- Science is still evolving re: spatial distribution of pollutants
- No common methodologies or indicators for local air quality
- Modelling tools still being developed for fine-scale situations
- Potential indicators for local air quality
  - Direct: Nitrogen oxide/dioxide a measure for traffic
  - Indirect: Setback distances from traffic areas, height of residences
EXAMPLE: Ottawa Air Quality Study
Street Level Exposure Model
28 PHUs completed the air quality survey

14 (50%) assess urban air quality using:
- AQI (93%), AQHI (50%);
- Data/estimates from modeling (50%);
- portable monitoring (43%);
- emission estimates (43%);
- non-MOE monitoring stations (29%)

Challenges identified:
- Human resource capacity; financial capacity; data availability
GAP ANALYSIS

- Most AQ indices are generalized to large region and do not specifically address high risk areas.
- MOE air monitoring stations assess ambient air quality; not reflective of how air quality can vary across a community.
- Spatial distribution of pollutants is influenced by chemical and physical properties; met conditions, and urban structures.
- Community level monitoring combined with modelling can better capture pollutant variation.
- Remote sensing (satellites) has potential for assessing pollutant distribution at a neighbourhood level.
GAP ANALYSIS (cont’d)

- Research on pollutant gradients from traffic corridors could be further developed to inform land use planning.
- Emissions estimates from transportation sources requires data on traffic volumes & composition.
- Industrial emissions data (NPRI) does not capture smaller point source emissions.
- Some potential indicators proposed e.g. (NO\textsubscript{2}, proximity to traffic corridors) but, more research needed to understand pollutant distribution and influences.
- Challenges: human & financial capacity, data availability.
FINDINGS: EXTREME HEAT
<table>
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| • Direct monitoring (weather station network)  
  • Remote sensing  
  • Community vulnerability | • Humidex  
  • Wet Globe Bulb Temperature  
  • Urban Heat Island  
  • Heat vulnerability index | • Temperature  
  • Humidity  
  • Wind speed  
  • Solar load  
  • Green space  
  • Impervious surfaces  
  • Socio economic & demographic variables |
FINDINGS FROM KEY INFORMANTS

- Met variables (temp., humidity, wind) available from Environment Canada’s weather stations across Ont.
- Thermal imagery
  - Easiest, most cost effective data source available but there are limitations
- Syndromic surveillance
  - Real time data
  - Limitations: financing, community capacity, symptoms limitations
EXAMPLE: THERMAL IMAGERY

- No fees, open data
- “Moderate” level of end-user expertise required

- Limitations
  - Surface temperatures only
  - Shots taken every 16 days → normalization required
  - Cannot infer temperature indoors e.g. AC use
Source: Natural Resources Canada
SURVEY FINDINGS

- 29 PHUs completed the heat survey
- 15 (52%) identified having access to BE data (e.g. land use, forest cover etc.)
- 2 PHUs had access to thermal imagery
- 18 (62%) assess extreme heat
  - Common measures used included: temperature (89%) and Humidex (89%)
  - 2 PHUs used models to predict EHE
- Challenges: Human resource capacity; data availability; financial capacity
GAP ANALYSIS

- Environment Canada met data is generalized to a large geographic area
  - Limited local met data restricts ability to assess heat within communities
- Individual met variables are limited in assessing health impacts as heat is comprised of temperature, humidity, wind and solar load
Some measures have complex data requirements and may not be appropriate for PHUs to assess heat exposure.

Satellite-based thermal imagery has potential for complete coverage.

Financial capacity and internal expertise limit PHU ability to collect and analyze heat data.
COMMON THEMES

- Lack of standardization of BE measurement approaches
- Limited evidence of validity and applicability of BE measures in current use
- Limited availability and accessibility of BE data
- Challenges related to human resource and financial capacity
GUIDING PRINCIPLES AND RECOMMENDATIONS

Several overarching principles were identified to help guide the development of the study recommendations.
1. STRENGTHEN MULTI-DISCIPLINARY COOPERATION

- Engage in multidisciplinary collaboration across all sectors, including government, academia and private sectors.
- Areas of focus could include built environment assessments re:
  - Walkability
  - Air Quality
  - Extreme Heat
2. PROVIDE METHODOLOGICAL GUIDANCE

- Standardize built environment measures using a multidisciplinary approach across all sectors
- Put built environment research into practice
3. IMPROVE DATA AVAILABILITY AND ACCESSIBILITY

- Increase access to high quality data across Ontario
- Empower local agencies to engage in built environment data initiatives
- Identify and evaluate the use of current data sources and sets
- Explore the creation of new data sets
- Address the need for data auditing and validation
4. ENGAGE IN SYSTEMATIC KNOWLEDGE TRANSFER & EXCHANGE

- Facilitate engagement of expertise outside of the public health sector
5. STRENGTHEN CAPACITY

- Support Public Health Units in a technical capacity to assess the built environment
- Enhance education and training for public health professionals
6. STRENGTHEN BUILT ENVIRONMENT & HEALTH RESEARCH

- Increase research funding opportunities for exploring the relationship between the built environment and health
CONCLUSION

- Standardized, relevant and realistic measures are needed to understand the impact of the built environment on health; and inform public health, transportation and land use planning

- More work needs to be done to ensure that measures are valid and applicable

- Collaboration needed across many sectors to improve data availability & accessibility
LIMITATIONS of RESEARCH STUDY

- Definitions and terminology
- Key words for literature review
- Key informant selection
- Survey response rate and results
- Core data sets covered
QUESTIONS?
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