Measuring the Built Environment Using a Street Segment Instrument

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Presentation Objectives

• Describe Street Segment observational data collection instrument for assessing community-level walkability and bikeability

• Describe protocol for reliability studies

• Summarize results from inter-rater reliability studies

• Describe changes made to instrument and protocols based on study findings

• Describe street segment sampling strategy
Active Living Research Gaps

• Measures of actual environment may differ from measures of perceived environment

• Need ways to measure features of actual built environments
  • To date, primarily archival data and macro-scale analysis (e.g., residential density, traffic zones)
  • Need to understand non-motorized travel, i.e., what features of built environment support walking and biking?
  • There has been some work in matching microscale street measures to PA/walking behavior, but the field is still in its infancy.

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Street Segment Observation Form

• Aid researchers and practitioners in determining which aspects of the built environment are most likely to influence physical activity

• Developed using:
  • Published evidence
  • Existing audit tools
  • Consultation with an expert panel

• Purpose of Current Study:
  1. To develop a tool that could be used across urban, suburban and rural areas.
  2. To test instrument reliability (inter-rater reliability walking study)
  3. To test method reliability (inter-rater reliability walking vs. driving study)

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Street Segment Observation Form Objectives:

Systematic observation of actual physical environment

- Presence, qualities of environmental features potentially linked to physical activity (PA)
  - Land Use
  - Street pattern
  - Traffic Calming Features
  - Walkability/Bikeability
  - Presence of amenities
  - Quality of public spaces
Street Segment Definition

=2 facing sides of street block
In most instances extends from one intersection to the next
Study Design

• 8 trained teams audited a total of 120 street segments each
  • The street segments are divided into sectors of 20 pre-determined street segments located in the Chicagoland area

• A total of 3 catchment areas will be visited in the this study
  • 1 Urban (544 street segments)
  • 1 Suburban (673)
  • 1 Rural (655)

• Each team audited a total of 40 street segments (2 sectors) per catchment area for a total of 120 segments per team
Data Collection Protocol

- Data collection occurred during a two-week period in July 2009
- 4 Teams were assigned to independently walk street segments
- 4 Teams were assigned to first walk street segments and then two weeks later, drive them.
- Walk only teams independently observed/coded street segments
- Walk vs. Drive teams observed/coded street segments together
- A total of 480 randomly selected street segments (4 forms per segment=1920) were observed.
- Average time to complete observation:
  - 8.11 minutes walk/no talk
  - 10.83 minutes walk/talk
  - 7.77 minutes drive/talk
### BTG-COMP • STREET SEGMENT OBSERVATION FORM - 2009

<table>
<thead>
<tr>
<th>SEG ADDRESS RANGE:</th>
<th>SITE ID: □ □ □ □ □ □ □ □ □</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZIP:</td>
<td>SEG ID: □ □ □ □ □ □ □ □ □</td>
</tr>
</tbody>
</table>

| START TIME □ □ □ □ □ □ | GPS ID: □ □ □ □ □ □ □ □ □ | START WAYPOINT □ □ □ □ □ □ |
| END TIME □ □ □ □ □ □ | DATE □ □ □ □ 2009 | END WAYPOINT □ □ □ □ □ □ |

<table>
<thead>
<tr>
<th>WEATHER</th>
<th>FINAL STATUS CODE</th>
<th>SAFETY AND COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunny</td>
<td>1 COMPLETE – BY WALKING</td>
<td>Is the segment safe: NO YES</td>
</tr>
<tr>
<td>Overcast</td>
<td>2 COMPLETE – BY DRIVING</td>
<td>a. for walking? 0 1</td>
</tr>
<tr>
<td>Rain</td>
<td>3 INCOMPLETE - Not safe</td>
<td>b. for biking? 0 1</td>
</tr>
<tr>
<td>Snow</td>
<td>4 INCOMPLETE – Inclement weather</td>
<td></td>
</tr>
<tr>
<td>Fog</td>
<td>5 INCOMPLETE – Not accessible</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6 NOT ELIGIBLE – Segment listing not an on-site match</td>
<td></td>
</tr>
</tbody>
</table>

### A. LAND USES

A1. Scan both sides of the street for presence of:

- a. Housing – Single family | NO | YES, ONE SIDE | YES, BOTH SIDES |
- b. Housing – Multifamily | 0 | 1 | 2 |
- c. Housing – Mobile homes | 0 | 1 | 2 |
- d. Public / Civic | 0 | 1 | 2 |
- e. Office / Professional | 0 | 1 | 2 |
- f. Institutional | 0 | 1 | 2 |
- g. Service | 0 | 1 | 2 |
- h. Retail | 0 | 1 | 2 |
- i. Industrial/ Manufacturing | 0 | 1 | 2 |
- j. Recreation/Leisure/Fitness | 0 | 1 | 2 |
- k. Parking | 0 | 1 | 2 |
- l. Public Space | 0 | 1 | 2 |
- m. Agricultural | 0 | 1 | 2 |
- n. Undeveloped | 0 | 1 | 2 |
- o. Vacant Building or Lot | 0 | 1 | 2 |

A2. Select predominant Land Use and write letter from A1

A3. Parking facilities

- a. On-street angled or parallel | NO | YES |
- b. Small lot (30 or fewer spaces) | 0 | 1 |
- c. Medium to large lot/garage/structure | 0 | 1 |
- d. Visible bicycle parking facilities | 0 | 1 |

A4. Natural Features

- a. Large body of water - lake, river, ocean | NO | YES |
- b. Small body of water - pond, stream | 0 | 1 |
- c. Mountains or canyon | 0 | 1 |

A5. Recreational Facilities

- a. Indoor commercial PA facility | NO | YES |
- b. Park with exercise/sport facilities/equip . | 0 | 1 |
- c. Park, green space without equipment | 0 | 1 |
- d. Stand-alone playing court | 0 | 1 |
- e. Stand-alone playing field | 0 | 1 |
- f. School / school yard (any grade level) | 0 | 1 |
- g. Golf Course | 0 | 1 |
- h. Beach | 0 | 1 |
- i. Outdoor pool | 0 | 1 |
- j. Off-road trails | 0 | 1 |

A6. Tally the number of buildings:

- a. All in segment
- b. With bars on windows
- c. With broken windows
- d. With visible tagging

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### B. TRAFFIC AND PEDESTRIANS

#### B1. Street Type
- Through-street: 1
- Dead end or cul-de-sac with pedestrian thru-way: 2
- Dead end or cul-de-sac without thru-way: 3

#### B2. Number of lanes of vehicular traffic

#### B3. Traffic direction
- One-way: 1
- Two-way: 2
- Don’t Know: 7

#### B4. Traffic features
- Traffic circle / roundabout / rotary: NO 1
- Speed humps: NO 1
- Median with traffic island: NO 1

#### B5. Designated bike lanes
- Designated by lines or reflectors: NO 1
- Designated by physical barrier: NO 1

#### B6. Shoulders / sidewalks
- Street shoulder: NO 1
- Shoulder has major bumps, cracks, holes, or weeds: NO 1
- Curb: NO 1
- Curb extension/bulb-out: NO 1
- Sidewalk: NO 1
- Buffer between street and sidewalk most of the segment: NO 1
- Continuous sidewalk in segment: NO 1
- Sidewalk continuous between segments at both ends: NO 1
- Sidewalk has major bumps, cracks, holes, or weeds: NO 1
- Curb cuts or ramps missing at crossing points: NO 1
- Permanent obstructions block the sidewalk: NO 1
- Street or sidewalk lighting: NO 1

#### B7. Intersection and crossing
- Traffic light: NO 1
- Flashing warning light: NO 1
- Pedestrian signal at traffic light: NO 1
- Stop sign: NO 1
- Marked crosswalk: NO 1

### C. SIGNAGE

#### C1. Signage present
- Bicycle crossing: NO 1
- Other bicycle-related signage: NO 1
- Pedestrian crossing: NO 1
- Children at play / special population: NO 1
- Neighborhood or Community signs: NO 1

#### C2. Regular speed limit (00 if None)

#### C3. Special speed limit (00 if None)

### D. AMENITIES AND LITTER

#### D1. Aesthetics
- Sidewalk and/or shoulder shade: NO 1
- Public gardens, flower beds, planters, or other landscaping: NO 1
- Public art, statue, or monument: NO 1
- Decorative water fountain: NO 1

#### D2. Amenities
- Public trash cans: NO 1
- Street dispensers / vending machines: NO 1
- Benches or other seating: NO 1
- Drinking fountain(s): NO 1
- Outdoor dining area(s): NO 1

#### D3. Transit facilities
- Bus stop: NO 1
- Rail or bus station: NO 1
- Light rail or trolley: NO 1
- Bench or covered shelter at transit stop: NO 1

#### D4. Garbage or litter
- NONE: NO
- SOME: 0
- A LOT: 1

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## Average Reliability Measures for Walk/No Talk

<table>
<thead>
<tr>
<th>Measure</th>
<th>Kappa/ICC</th>
<th>% Agreement</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use (16 items)</td>
<td>0.67</td>
<td>92%</td>
<td>0.19 - 0.99</td>
</tr>
<tr>
<td>Parking Facilities (4)</td>
<td>0.68</td>
<td>95%</td>
<td>0.45 - 0.87</td>
</tr>
<tr>
<td>Natural Features (3)</td>
<td>0.66</td>
<td>99%</td>
<td>0.66 - 1.00</td>
</tr>
<tr>
<td>Physical Activity Venues (10)</td>
<td>0.68</td>
<td>99%</td>
<td>0.41 - 1.00</td>
</tr>
<tr>
<td>Physical Disorder (4)</td>
<td>0.75</td>
<td>--</td>
<td>0.57 - 0.98</td>
</tr>
<tr>
<td>Traffic Calming (6)</td>
<td>0.73</td>
<td>94%</td>
<td>0.40 - 0.88</td>
</tr>
<tr>
<td>Bike Lane Measures (2)</td>
<td>0.96</td>
<td>99%</td>
<td>0.92 - 1.00</td>
</tr>
<tr>
<td>Shoulder/Sidewalk (12)</td>
<td>0.67</td>
<td>91%</td>
<td>0.11 - 0.95</td>
</tr>
<tr>
<td>Traffic Control Devices (5)</td>
<td>0.75</td>
<td>96%</td>
<td>0.21 - 0.96</td>
</tr>
<tr>
<td>Signage (7)</td>
<td>0.77</td>
<td>96%</td>
<td>0.35 - 0.96</td>
</tr>
<tr>
<td>Amenities/Aesthetics (9)</td>
<td>0.62</td>
<td>93%</td>
<td>0.37 - 0.74</td>
</tr>
<tr>
<td>Public Transportation (4)</td>
<td>0.54</td>
<td>98%</td>
<td>0.00 - 0.82</td>
</tr>
<tr>
<td>Litter (1)</td>
<td>.60</td>
<td>71%</td>
<td>--</td>
</tr>
</tbody>
</table>
Average Reliability Measures for Walk Vs. Drive

<table>
<thead>
<tr>
<th>Measure</th>
<th>Kappa/ICC</th>
<th>% Agreement</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use (16 items)</td>
<td>0.80</td>
<td>94%</td>
<td>0.50 - 0.91</td>
</tr>
<tr>
<td>Parking Facilities (4)</td>
<td>0.67</td>
<td>94%</td>
<td>0.47 - 0.82</td>
</tr>
<tr>
<td>Natural Features (3)</td>
<td>0.89</td>
<td>99%</td>
<td>0.66 - 1.00</td>
</tr>
<tr>
<td>Physical Activity Venues (10)</td>
<td>0.76</td>
<td>99%</td>
<td>0.57 - 1.00</td>
</tr>
<tr>
<td>Physical Disorder (4)</td>
<td>0.75</td>
<td>--</td>
<td>0.59 - 0.96</td>
</tr>
<tr>
<td>Traffic Calming (6)</td>
<td>0.78</td>
<td>96%</td>
<td>0.56 - 0.88</td>
</tr>
<tr>
<td>Bike Lane Measures (2)</td>
<td>0.95</td>
<td>99%</td>
<td>0.89 - 1.00</td>
</tr>
<tr>
<td>Shoulder/Sidewalk (12)</td>
<td>0.65</td>
<td>92%</td>
<td>0.01 - 0.96</td>
</tr>
<tr>
<td>Traffic Control Devices (5)</td>
<td>0.87</td>
<td>96%</td>
<td>0.80 - 0.96</td>
</tr>
<tr>
<td>Signage (7)</td>
<td>0.85</td>
<td>98%</td>
<td>0.66 - 1.00</td>
</tr>
<tr>
<td>Amenities/Aesthetics (9)</td>
<td>0.70</td>
<td>94%</td>
<td>0.54 - 1.00</td>
</tr>
<tr>
<td>Public Transportation (4)</td>
<td>0.87</td>
<td>99%</td>
<td>0.72 - 1.00</td>
</tr>
<tr>
<td>Litter (1)</td>
<td>.73</td>
<td>77%</td>
<td>--</td>
</tr>
</tbody>
</table>
Revisions to Street Segment Observation Form Based on Reliability Study

- Revised/tightened definitions for problematic land use measures (undeveloped land vs. vacant building/lot)
- Dropped Physical Disorder tally, now capture presence of physical disorder measures
- Dropped condition of shoulders and sidewalks
- Dropped permanent obstruction on sidewalk
- Retrained on sidewalk/shoulder shade and benches/other seating
Census of Street Segments
Inter-Rater Reliability Results
Data Collection Protocol

• Purpose of street segment census was to determine sampling strategy across communities.

• Data collection occurred during a four-week period in October 2009

• A census of street segments for our three sites were audited (N=1872 segments).

• 4 Teams were also assigned to independently walk a random sample of street segments to test the revised instrument.

• Each team independently observed/coded 45 street segments

• A total of 180 randomly selected street segments were observed.

• Average time to complete the observation was 4.55 minutes
# Average Reliability Measures for Follow Up Inter-Rater Reliability

<table>
<thead>
<tr>
<th>Measure</th>
<th>Kappa/ICC</th>
<th>% Agreement</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use (16 items)</td>
<td>0.88</td>
<td>96%</td>
<td>0.75 - 1.00</td>
</tr>
<tr>
<td>Parking Facilities (3)</td>
<td>0.90</td>
<td>96%</td>
<td>0.78 - 0.97</td>
</tr>
<tr>
<td>Natural Features (3)</td>
<td>0.99</td>
<td>99%</td>
<td>0.98 - 1.00</td>
</tr>
<tr>
<td>Physical Activity Venues (10)</td>
<td>0.98</td>
<td>99%</td>
<td>0.97 - 1.00</td>
</tr>
<tr>
<td>Physical Disorder (4)</td>
<td>0.65</td>
<td>91%</td>
<td>0.53 - 0.76</td>
</tr>
<tr>
<td>Traffic Calming (7)</td>
<td>0.97</td>
<td>99%</td>
<td>0.94 - 1.00</td>
</tr>
<tr>
<td>Bike Lane Measures (2)</td>
<td>1.00</td>
<td>100%</td>
<td>1.00 - 1.00</td>
</tr>
<tr>
<td>Shoulder/Sidewalk (9)</td>
<td>0.75</td>
<td>88%</td>
<td>0.51 - 0.98</td>
</tr>
<tr>
<td>Traffic Control Devices (4)</td>
<td>0.89</td>
<td>97%</td>
<td>0.82 - 0.95</td>
</tr>
<tr>
<td>Signage (6)</td>
<td>0.94</td>
<td>98%</td>
<td>0.85 - 0.99</td>
</tr>
<tr>
<td>Amenities/Aesthetics (7)</td>
<td>0.84</td>
<td>96%</td>
<td>0.55 - 0.95</td>
</tr>
<tr>
<td>Public Transportation (4)</td>
<td>0.94</td>
<td>98%</td>
<td>0.89 - 0.99</td>
</tr>
<tr>
<td>Litter (1)</td>
<td>0.78</td>
<td>84%</td>
<td>--</td>
</tr>
</tbody>
</table>

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Street Segment Sampling Strategy Based on Census of Street Segment Study

- Analyses run separately by urbanization and street classification (arterial vs. residential).
- Draw sample of street segments that provide 90% CI with 20% width.
- Yields a sample size of between 55 to 70 street segments per community.
- Street segment sample drawn using PPS strategy.
- Street segments stratified by: school buffer (2 mile radius), arterial, and residential.
- Street segments randomly drawn from each strata proportionate % of streets that fall within each strata.
Street Segment Observation Form Inter-Reliability Results

• Presence of Street Shoulder still had lower reliability (ICC=0.63, 88% Agreement)
• Sidewalk buffer still had lower reliability (ICC=0.64, 78% Agreement)
• Sidewalk Shade still had lower reliability (ICC=0.51, 63% Agreement)
• Added a measure of yard debris to pick up physical disorder in rural areas
Thanks and Acknowledgements

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• Leah Rimkus
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• Elli Resnick

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• Kelly Clifton, PhD
• Christine Hoehner, PhD
• Rebecca Lee, PhD
• Jim Sallis, PhD
• Marc Schlossberg, PhD

Audit Tools:
• Analytic Audit Tool, Saint Louis University
• Checklist Audit Tool, Saint Louis University
• Active Neighborhood Checklist, Saint Louis University
• Irvine Minnesota Inventory, University of California, Irvine and University of Minnesota
• Pedestrian Environment Data Scan (PEDS), University of Maryland

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