

## **bridging the gap**

Research Informing Policies & Practices  
for Healthy Youth

# 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.

# 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)

# Street Segment Observation Form Objectives:

## Systematic observation of actual physical environment

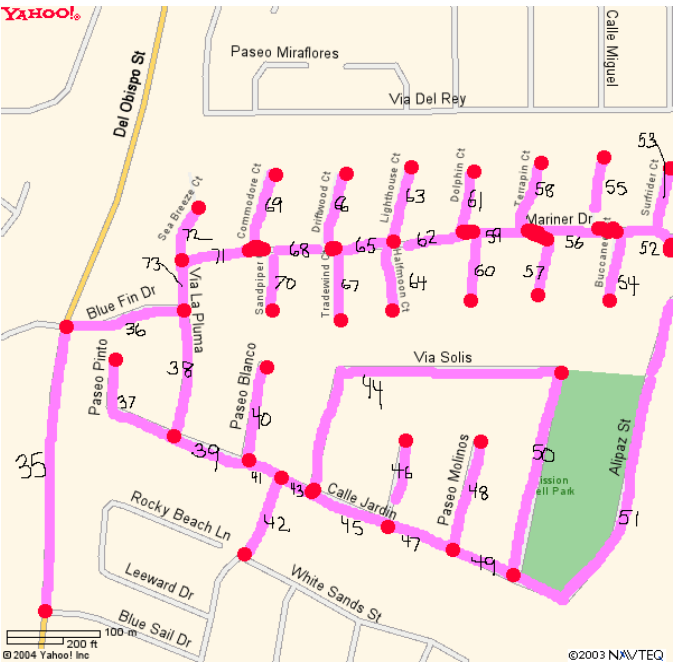
- Presence, qualities of environmental features potentially linked to physical activity (PA)
  - Land Use
  - Street pattern
  - Traffic Calming Features
  - Walkability/Bikeability
  - Presence of amenities
  - Quality of public spaces



# Street Segment Definition

=2 facing sides of street block

In most instances extends from one intersection to the next



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# 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

SEG ADDRESS RANGE:  -  ZIP:  SEG ID:   
 START TIME :  am/pm GPS ID  START WAYPOINT  END WAYPOINT   
 END TIME :  am/pm DATE --2009 STAFF ID 1  ID 2

| WEATHER  |   | FINAL STATUS CODE                                   |    | SAFETY AND COMMENTS         |    |     |
|----------|---|---|----|-----------------------------|----|-----|
| Sunny    | 1 | COMPLETE – BY WALKING                               | 01 | <i>Is the segment safe:</i> | NO | YES |
| Overcast | 2 | COMPLETE – BY DRIVING                               | 02 | a. for walking?             | 0  | 1   |
| Rain     | 3 | INCOMPLETE - Not safe                               | 03 | b. for biking?              | 0  | 1   |
| Snow     | 4 | INCOMPLETE – Inclement weather                      | 04 |                             |    |     |
| Fog      | 5 | INCOMPLETE – Not accessible                         | 05 |                             |    |     |
| Other    | 6 | NOT ELIGIBLE – Segment listing not an on-site match | 96 |                             |    |     |

**A. LAND USES**

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

|                               | NO | YES, ONE SIDE | YES, BOTH SIDES |
|-------------------------------|----|---------------|-----------------|
| a. Housing – Single family    | 0  | 1             | 2               |
| 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**

|   | NO | YES |
|---|----|-----|
| a. On-street angled or parallel         | 0  | 1   |
| 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**

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

**A5. Recreational Facilities**

|  | NO | YES |
|--|----|-----|
| a. Indoor commercial PA facility               | 0  | 1   |
| 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:**

|                         | TALLY                | TOTAL                |
|-------------------------|----------------------|----------------------|
| a. All in segment       | <input type="text"/> | <input type="text"/> |
| b. With bars on windows | <input type="text"/> | <input type="text"/> |
| c. With broken windows  | <input type="text"/> | <input type="text"/> |
| d. With visible tagging | <input type="text"/> | <input type="text"/> |

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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**

|   | NO | YES |
|---|----|-----|
| a. Traffic circle / roundabout / rotary | 0  | 1   |
| b. Speed humps                          | 0  | 1   |
| c. Median with traffic island           | 0  | 1   |

**B5. Designated bike lanes**

|                                      | NO | ONE SIDE | BOTH SIDES |
|--------------------------------------|----|----------|------------|
| a. Designated by lines or reflectors | 0  | 1        | 2          |
| b. Designated by physical barrier    | 0  | 1        | 2          |

**B6. Shoulders / sidewalks**

|   | NO | ONE SIDE | BOTH SIDES |
|---|----|----------|------------|
| a. Street shoulder  | 0  | 1        | 2          |
| b. Shoulder has major bumps, cracks, holes, or weeds      | 0  | 1        | 2          |
| c. Curb   | 0  | 1        | 2          |
| d. Curb extension/bulb-out                                | 0  | 1        | 2          |
| d. Sidewalk   | 0  | 1        | 2          |
| e. Buffer between street and sidewalk most of the segment | 0  | 1        | 2          |
| f. Continuous sidewalk in segment                         | 0  | 1        | 2          |
| g. Sidewalk continuous between segments at both ends      | 0  | 1        | 2          |
| h. Sidewalk has major bumps, cracks, holes, or weeds      | 0  | 1        | 2          |
| i. Curb cuts or ramps missing at crossing points          | 0  | 1        | 2          |
| j. Permanent obstructions block the sidewalk              | 0  | 1        | 2          |
| k. Street or sidewalk lighting                            | 0  | 1        | 2          |

| <b>B7. Intersection and crossing</b>  | NO | YES |
|---------------------------------------|----|-----|
| a. Traffic light                      | 0  | 1   |
| b. Flashing warning light             | 0  | 1   |
| c. Pedestrian signal at traffic light | 0  | 1   |
| d. Stop sign                          | 0  | 1   |
| e. Marked crosswalk                   | 0  | 1   |

**C. SIGNAGE**

| <b>C1. Signage present</b>               | NO | YES |
|--|----|-----|
| a. Bicycle crossing                      | 0  | 1   |
| b. Other bicycle-related signage         | 0  | 1   |
| c. Pedestrian crossing                   | 0  | 1   |
| d. Children at play / special population | 0  | 1   |
| e. Neighborhood or Community signs       | 0  | 1   |

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

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

**D. AMENITIES AND LITTER**

| <b>D1. Aesthetics</b>  | NO | YES |
|--|----|-----|
| a. Sidewalk and/or shoulder shade                              | 0  | 1   |
| b. Public gardens, flower beds, planters, or other landscaping | 0  | 1   |
| b. Public art, statue, or monument                             | 0  | 1   |
| c. Decorative water fountain                                   | 0  | 1   |

| <b>D2. Amenities</b>                   | NO | YES |
|--|----|-----|
| a. Public trash cans                   | 0  | 1   |
| b. Street dispensers/ vending machines | 0  | 1   |
| c. Benches or other seating            | 0  | 1   |
| d. Drinking fountain(s)                | 0  | 1   |
| e. Outdoor dining area(s)              | 0  | 1   |

| <b>D3. Transit facilities</b>               | NO | YES |
|---|----|-----|
| a. Bus stop                                 | 0  | 1   |
| b. Rail or bus station                      | 0  | 1   |
| c. Light rail or trolley                    | 0  | 1   |
| d. Bench or covered shelter at transit stop | 0  | 1   |

| <b>D4. Garbage or litter</b> | NONE | SOME | A LOT |
|------------------------------|------|------|-------|
|                              | 0    | 1    | 2     |

## Average Reliability Measures for Walk/No Talk

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

## Average Reliability Measures for Walk Vs. Drive

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

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## 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

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# 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

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

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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

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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