Neighborhood Greenness, Walkable Destinations and Health

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Purpose

To examine influence of:

1) Destinations within walking distance
2) The natural environment

on self-reported walking trips, BMI and quality of life measures.
Study Design

GIS Network Analysis
(objective walkability measurement)

Normalized Difference Vegetation Index (NDVI)
(objective greenness measurement)

Survey to Seattle Residents
(subjective walkability and greenness, QOL, BMI, walking trips)
1) Calculated a service area of 0.4 miles network distance around each destination.

2) Selected residential parcels found in that service area.

3) Overlayed all service areas for every destination.
Walkability Map of Seattle, Washington

Number of services within 0.4 mile path distance

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
Normalized Difference Vegetation Index (NDVI)

- Remotely-sensed spectral vegetation index

- Related to the amount green, i.e., vegetation, in survey pixel
  - higher values (lighter on map) generally associated with more vegetation

- NDVI varies among different zoning categories (Wilson et al., 2003)
Walkable Destinations and NDVI

<table>
<thead>
<tr>
<th>Walkability</th>
<th>NDVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (0-2)</td>
<td>Yellow</td>
</tr>
<tr>
<td>Medium (3-5)</td>
<td>Light Green</td>
</tr>
<tr>
<td>High (6-12)</td>
<td>Red</td>
</tr>
</tbody>
</table>

1 mile
Residential Survey

• Self-reported walking trips to destinations (within 0.5 mile distance)
• Self-reported natural features in the neighborhood (within 0.5 mile distance)
• Quality of Life
• Sense of Community
• Importance of Destinations
• BMI
• Demographics (age, sex, income and education)
Respondent Population

- Response Rate = 17.5%
- Female = 57%
- Age over 51 = 52.6%
- College Education or above = 80%
- Income, 50K or above = 57.7%
- NDVI mean = 0.360 (non-respondent mean = 0.336)
- GIS Destination mean = 4.18 (non-respondent mean = 4.16)
## Results

Walking trips were correlated with number of destinations in walking distance ($r=.329$, $p=.01$).

<table>
<thead>
<tr>
<th>Destinations</th>
<th>Walking Trips Per Month</th>
</tr>
</thead>
</table>
|              | Destination within 0.4 mile walking distance | Destination not within 0.4 mile walking distances | $P^*$  
| Grocery Stores | Men=26.45 | Men=19.01 | .0014  
| | Women=26.07 | Women=19.45 | .0013  
| P-Patches | Men=29.58 | Men=21.50 | .0087  
| | Women=31.88 | Women=20.72 | .0002  
| Libraries | Men=26.42 | Men=22.10 | .1882  
| | Women=29.45 | Women=21.10 | .0047  
| Banks | Men=30.21 | Men=20.35 | .0003  
| | Women=28.72 | Women=20.69 | .0023  
| Restaurants | Men=24.61 | Men=19.10 | .0262  
| | Women=23.70 | Women=19.90 | .0699  
| | Women=25.84 | Women=16.98 | .0001  
| Schools | Men=26.11 | Men=19.79 | .0068  
| | Women=24.90 | Women=19.55 | .0088  
| Beaches | Men=45.21 | Men=22.72 | .0651  
| | Women=37.78 | Women=21.65 | .0024  

* P values represent t-test on regression coefficient for each destination
Walking trips per month are positively associated with the following Quality of Life Measurements:

- **Quality of life** ($r^2 = .16$, $p < .0001$ (model); t-test on regression coefficient for walking trips $p = .0003$)
- **Sense of Community** ($r^2 = .15$, $p < .0001$ (model); t-test on regression coefficient for walking trips $p < .0001$)
- **Importance of destinations** ($r^2 = .34$, $p < .0001$ (model); t-test on regression coefficient for walking trips $p < .0001$)
### Perception of Walkable Destinations

<table>
<thead>
<tr>
<th>Destinations</th>
<th>Subjective Destinations (Self-report)</th>
<th>Objective Destinations (GIS Network Analysis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks</td>
<td>415 (79%)</td>
<td>327 (62%)†</td>
</tr>
<tr>
<td>Grocery stores/ markets</td>
<td>420 (80%)</td>
<td>241 (46%)†</td>
</tr>
<tr>
<td>Restaurants</td>
<td>421 (80%)</td>
<td>322 (61%)†</td>
</tr>
<tr>
<td>Play areas and playgrounds</td>
<td>428 (81%)</td>
<td>260 (49%)†</td>
</tr>
<tr>
<td>Banks</td>
<td>286 (54%)</td>
<td>107 (20%)†</td>
</tr>
<tr>
<td>Bars or pubs</td>
<td>347 (66%)</td>
<td>65 (12%)*</td>
</tr>
<tr>
<td>Libraries</td>
<td>274 (52%)</td>
<td>76 (14%)†</td>
</tr>
<tr>
<td>Post Office</td>
<td>236 (45%)</td>
<td>25 (5%)†</td>
</tr>
<tr>
<td>Beaches</td>
<td>197 (37%)</td>
<td>13 (3%)†</td>
</tr>
<tr>
<td>Community Center</td>
<td>290 (55%)</td>
<td>50 (10%)†</td>
</tr>
<tr>
<td>Schools</td>
<td>320 (61%)</td>
<td>254 (48%)†</td>
</tr>
<tr>
<td>Theaters</td>
<td>145 (28%)</td>
<td>46 (9%)†</td>
</tr>
<tr>
<td>Churches or places of worship</td>
<td>275 (52%)</td>
<td>321 (61%)†</td>
</tr>
<tr>
<td>P-patches</td>
<td>163 (31%)</td>
<td>81 (15%)†</td>
</tr>
<tr>
<td>Public swimming pools</td>
<td>122 (23%)</td>
<td>8 (2%)*</td>
</tr>
</tbody>
</table>

* Pearson Correlation significant at the p < 0.05 level (2-tailed)
† Pearson Correlation significant at the p < .01 level (2-tailed)
Vegetation and Walkable Destinations

- Respondents in low NDVI areas overestimated destinations within 0.4 mile ($F_{1,499} = 10.15$, $p = .002$).

- Respondents in low NDVI areas did not make more walking trips per month ($F_{1,451} = .682$, $p = .409$).
Perception of Vegetation and Walkable Destinations

• Subjective greenness is moderately correlated with walking trips per month ($r = .155$, $p = .01$).

• Subjective greenness of vegetation is moderately correlated with the NDVI ($r = .230$, $p = .01$).

<table>
<thead>
<tr>
<th>Natural Features</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunities to see birds, squirrels, rabbits</td>
<td>493 (93%)</td>
</tr>
<tr>
<td>Opportunities to see larger wildlife</td>
<td>221 (42%)</td>
</tr>
<tr>
<td>Large trees in neighborhood</td>
<td>488 (92%)</td>
</tr>
<tr>
<td>Lakes or streams</td>
<td>315 (60%)</td>
</tr>
<tr>
<td>Street trees</td>
<td>470 (89%)</td>
</tr>
<tr>
<td>View of nature from your home</td>
<td>448 (85%)</td>
</tr>
<tr>
<td>Natural vegetation in yards (e.g. ferns, shrubs, pine trees and little or no lawn)</td>
<td>460 (87%)</td>
</tr>
<tr>
<td>Scenic vistas or views</td>
<td>445 (84%)</td>
</tr>
</tbody>
</table>
NDVI, BMI and Walkability

![Graph showing BMI across different NDVI and walkability levels.]

- Low NDVI, High Walkability
- High NDVI, High Walkability
Conclusions

Destinations within walking distance from homes

Walking Trips

Quality of Life
Sense of Community
Importance of destinations

Importance of vegetation in the built environment

- Defensible space and safety (Kuo et al., 2001)
- Social well being (Kearney, 2005; Coley et al., 1997)
- Attention restoration (Kaplan, 1995)
- Air and water quality (Dwyer et al., 1992)
- Sidewalk preservation (McPherson et al., 2005)

BMI

NDVI

Subjective Greenness

Vegetation
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