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Street-scale Green Infrastructure and Physical Activity

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Abstract

Introduction: Urban roadside nature provides an important opportunity for individuals to experience the natural world while going about their everyday lives. Urban trees and green space have been shown to improve mental health, facilitate social interaction, and encourage physical activity; however, their distribution may vary across a city. This study assessed the association between neighborhood street green infrastructure and both recreational exercise and active transportation.

Methods: Data on self-reported physical activity were derived from a prospective cohort of participants residing in Milwaukee and Green Bay, WI (n=752). Percent green space and tree cover along walkable roads were calculated using 1-meter resolution land cover data within 500 and 1000 meter network buffers around study participants' homes. Logistic regression was used to assess the association between neighborhood environment and physical activity, controlling for socio-demographics and neighborhood characteristics.

Results: Having more than 35% street green space along walkable roads within 500 and 1000 meter buffers increased the odds of recreational physical activity by 2.1 and 2.5 times, controlling for socio-demographics (odds ratio (OR) =2.1, 95% confidence interval (CI) [1.1, 3.9] and OR=2.5, 95% CI [1.2, 5.5] respectively). Study participants with greater than 15% tree cover along walkable roads within 500 and 1000 meters of their homes were approximately one and a half times more likely to choose active transportation once within a 30 day window than those with less than 15% tree cover, adjusting for socio-demographics (OR=1.5, 95% CI [0.8, 2.9] and OR=1.4, 95% CI [0.3, 3.2] respectively).

Conclusions: These findings suggest that the proximate neighborhood environment may influence an individual's decision to exercise for recreation or transportation; however, more work on neighborhood preference is needed.

Background

Trees and green spaces benefit health in many ways.

Street trees:

- ↑ health perceptions[1]
- ↑ stress recovery[2]
- ↑ recreational walking[3,4,5]
- ↑ traffic safety[6]
- ↓ antidepressant prescriptions[7]
- ↓ child obesity[8]
- ↓ crime[9,10]

Total green space:

- ↑ mental health[11,12,13,14,15]
- ↓ mortality[16,17,18]
- ↓ cardiovascular disease[19]

Green exercise:

- ↑ emotional health[20]
- ↑ mental health[14,21]
- ↑ pulmonary function[22]
- ↑ restoration, self-esteem, tension, anxiety, memory, happiness, mood[23,24,25,26,27]

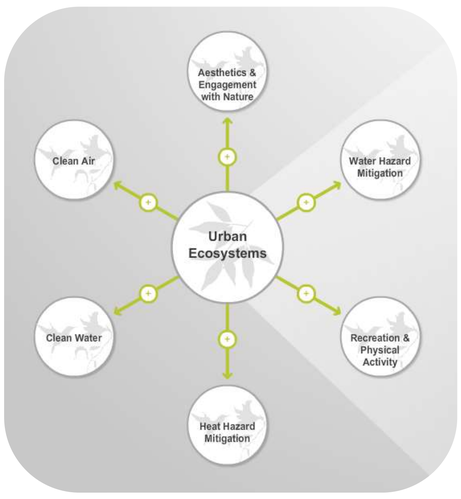

Figure 1. Screenshot of the EnviroAtlas Eco-Health Relationship Browser interactive literature review

Methods

Data:

Survey of the Health of Wisconsin (SHOW):

- 800-1000 sampled across Wisconsin annually
- Two-stage, probability-based cluster sampling approach
- Our study pulled Milwaukee and Green Bay data from 2008-2013; n=752
- → 3 measures of physical activity
  - Recreational walking
  - Recreational moderate or vigorous physical activity (MVPA-R)
  - Active transportation

U.S. EPA EnviroAtlas:

- USDA 2010 NAIP aerial photography and supplemental data
- → 1-meter resolution classified land cover: free and publicly available in 16 cities
- → Our study used 5 measures of tree cover and green space
  - Sidewalk tree cover
  - Street tree cover
  - Street green space
  - Overall tree cover
  - Overall green space

Figure 2. Eastern U.S. (left) and state of Wisconsin (right) with the study area outlined in orange.

Methods (continued)

Assessment:

Physical Activity:

"Over the past 30 days have you…"

- Walked
- Walked, run, jogged, biked, roller bladed (MVPA-R)
- Walked or bicycled as part of getting to and from work or school, or to do errands

Tree Cover and Green Space:

a) 1-meter resolution green space.
b) Sidewalk area.
c) 25 meter street buffer.
d) Sidewalk area (orange) over green space (green, orange + green) in street buffer (yellow).

Figure 3. Aerial imagery of a Milwaukee intersection, with colored overlays

Residential Exposure:

- Network buffers of 500m and 1000m for street measures
- Circular buffers for overall tree cover and green space

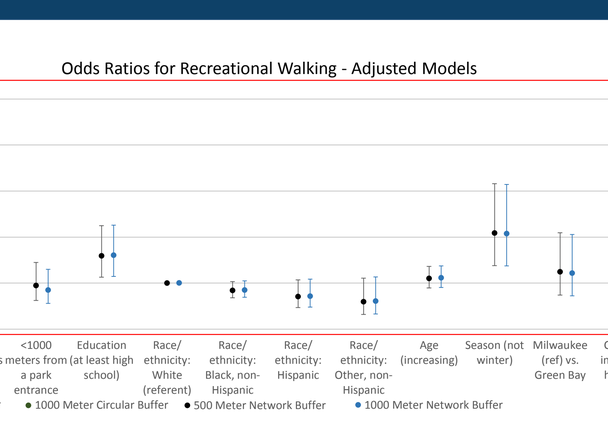

Figure 4. 500m network (L) and circular (R) buffers.

Analysis:

Logistic regression – odds of physical activity at least once in the past 30 days given tree cover or green space exposure.

- Maximum likelihood imputation for missing data
- Backwards selection to eliminate non-significant variables
- Assessed interaction based on *a priori* hypotheses
- Sensitivity analyses – overall tree cover and green space

Results

Table 1. Descriptive statistics of the study population.

	N	%‡
Milwaukee, WI	683	90.8
Green Bay, WI	69	9.2
Age		
>21, ≤40	276	36.7
>40, ≤60	345	45.9
>60	131	17.4
Education: at least high school (missing=1)	524	69.8
Race/ethnicity (missing=2)		
Non-hispanic white	478	63.7
Non-hispanic black	202	26.9
Hispanic	43	5.7
Other	27	3.6
≥ 1 year in residence (missing=32)	608	84.4
Above twice the poverty level (missing=35)	448	62.5
Has a job (missing=2)	461	61.5
Can walk to store in 10 minutes (missing=146)	376	62.0
<1000 meters from a park entrance	495	65.8
Season of survey		
Winter (Dec, Jan, Feb)	127	16.9
Not winter	625	83.1
Census Block Group Economic Hardship Index		
1st quartile - least hardship	202	26.9
2nd quartile	181	24.1
3rd quartile	190	25.3
4th quartile - most hardship	179	23.8
Street Green Infrastructure		
≤15% sidewalk tree cover (500 meter)	57	7.6
≤15% sidewalk tree cover (1000 meter)	36	4.8
≤15% street tree cover (500 meter)	60	8.0
≤15% street tree cover (1000 meter)	41	5.5
≤35% street green space (500 meter)	45	6.0
≤35% street green space (1000 meter)	34	4.5
Overall Neighborhood Greenness		
≤20% neighborhood tree cover (500 meter)	63	8.4
≤20% neighborhood tree cover (1000 meter)	51	6.8
≤41% neighborhood green space (500 meter)	43	5.7
≤43% neighborhood green space (1000 meter)	32	4.3
Built Environment		
>25 intersections/sq km (500 meter)	421	56.0
>25 intersections/sq km (1000 meter)	359	47.7
Physical activity		
Participated in active transport (missing=1)	290	38.6
Participated in MVPA-R	465	61.8
Walked for recreation	375	49.9

‡Percentage of available data, before imputation

Figure 5a-c. Odds ratios for physical activity given street green space or street tree cover, and circular buffer sensitivity results.

a) Recreational walking and street green space
b) Recreational physical activity (MVPA-R) and street green space
c) Active transportation and street tree cover

Conclusions

- Strongest associations were seen between street green space and MVPA-R
  - → Aesthetics may be more important than other benefits (e.g., shade)
- Location of trees may be important
  - Street measures had stronger associations than overall tree cover and green space
  - Especially for active transport
- Slight, inconsistent differences between 500m and 1000m sized buffers
- Correlates of active transportation and recreational physical activity differ
- Causal pathway is uncertain
- More research is needed in additional cities and to control for neighborhood self-selection

References

1. Kardan, O., Gozdyra, P., Misic, B., Moola, F., Palmer, L. J., Paus, T., Berman, M. G., 2015, Neighborhood greenspace and health in a large urban center, *Sci. Rep.* **5**.
2. Jiang, B., Chang, C.-Y., Sullivan, W. C., 2014a, A dose of nature: Tree cover, stress reduction, and gender differences, *Landscape and Urban Planning* **132:**26-36.
3. Forsyth, A., Hearst, M., Oakes, J. M., Schmitz, K. H., 2008, Design and destinations: factors influencing walking and total physical activity, *Urban Studies* **45**(9):1973-1996.
4. Boruff, B. J., Nathan, A., Nijënstein, S., 2012, Using GPS technology to (re)-examine operational definitions of 'neighbourhood'in place-based health research, *International journal of health geographics* **11**(1):1.
5. Chaix, B., Simon, C., Charreire, H., Thomas, F., Kestens, Y., Karusisi, N., Vallée, J., Oppert, J.-M., Weber, C., Pannier, B., 2014, The environmental correlates of overall and neighborhood based recreational walking (a cross-sectional analysis of the RECORD Study), *Int J Behav Nutr Phys Act* **11**(1):20.
6. Naderi, J., 2003, Landscape design in clear zone: Effect of landscape variables on pedestrian health and driver safety, *Transportation Research Record: Journal of the Transportation Research Board* (1851):119-130.
7. Taylor, M. S., Wheeler, B. W., White, M. P., Economou, T., Osborne, N. J., 2015, Research note: Urban street tree density and antidepressant prescription rates—A cross-sectional study in London, UK, *Landscape and Urban Planning* **136:**174-179.
8. Lovasi, G. S., Schwartz-Soicher, O., Quinn, J. W., Berger, D. K., Neckerman, K. M., Jaslow, R., Lee, K. K., Rundle, A., 2013, Neighborhood safety and green space as predictors of obesity among preschool children from low-income families in New York City, *Prev Med* **57**(3):189-93.
9. Troy, A., Nunery, A., Grove, J. M., 2016, The relationship between residential yard management and neighborhood crime: An analysis from Baltimore City and County, *Landscape and Urban Planning* **147:**78-87.
10. Bogar, S., Beyer, K. M., 2016, Green Space, Violence, and Crime: A Systematic Review, *Trauma Violence Abuse* **17**(2):160-71.
11. Alcock, I., White, M. P., Wheeler, B. W., Fleming, L. E., Depledge, M. H., 2014, Longitudinal effects on mental health of moving to greener and less green urban areas, *Environmental science & technology* **48**(2):1247-1255.
12. Astell-Burt, T., Mitchell, R., Hartig, T., 2014, The association between green space and mental health varies across the lifecourse. A longitudinal study, *J Epidemiol Community Health* **68**(6):578-83.
13. Beyer, K. M., Kaltenbach, A., Szabo, A., Bogar, S., Nieto, F. J., Malecki, K. M., 2014, Exposure to neighborhood green space and mental health: evidence from the survey of the health of Wisconsin, *International journal of environmental research and public health* **11**(3):3453-3472.
14. Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., Pullin, A. S., 2010, A systematic review of evidence for the added benefits to health of exposure to natural environments, *BMC Public Health* **10**(1):1-10.
15. Cohen-Cline, H., Turkheimer, E., Duncan, G. E., 2015, Access to green space, physical activity and mental health: a twin study, *J Epidemiol Community Health*.
16. Donovan, G. H., Butry, D. T., Michael, Y. L., Prestemon, J. P., Liebhold, A. M., Gatziolis, D., Mao, M. Y., 2013, The relationship between trees and human health: evidence from the spread of the emerald ash borer, *Am J Prev Med* **44**(2):139-45.
17. James, P., Hart, J. E., Banay, R. F., Laden, F., 2016, Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women, *Environmental health perspectives*.
18. Villeneuve, P. J., Jerrett, M., G. Su, J., Burnett, R. T., Chen, H., Wheeler, A. J., Goldberg, M. S., 2012, A cohort study relating urban green space with mortality in Ontario, Canada, *Environmental Research* **115:**51-58.
19. Pereira, G., Foster, S., Martin, K., Christian, H., Boruff, B. J., Knuiman, M., Giles-Corti, B., 2012, The association between neighborhood greenness and cardiovascular disease: an observational study, *BMC Public Health* **12**(1):1.
20. Aspinall, P., Mavros, P., Coyne, R., Roe, J., 2013, The urban brain: analysing outdoor physical activity with mobile EEG, *British journal of sports medicine*:bjsports-2012-091877.
21. Gladwell, V. F., Brown, D. K., Wood, C., Sandercock, G. R., Barton, J. L., 2013, The great outdoors: how a green exercise environment can benefit all, *Extreme Physiology & Medicine* **2**(1):1-7.
22. Lee, J.-Y., Lee, D.-C., 2014, Cardiac and pulmonary benefits of forest walking versus city walking in elderly women: A randomised, controlled, open-label trial, *European Journal of Integrative Medicine* **6**(1):5-11.
23. Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., Gärling, T., 2003, Tracking restoration in natural and urban field settings, *Journal of environmental psychology* **23**(2):109-123.
24. Pretty, J., Peacock, J., Sellens, M., Griffin, M., 2005, The mental and physical health outcomes of green exercise, *International journal of environmental health research* **15**(5):319-337.
25. Bratman, G. N., Daily, G. C., Levy, B. J., Gross, J. J., 2015, The benefits of nature experience: Improved affect and cognition, *Landscape and Urban Planning* **138:**41-50.
26. Song, C., Ikei, H., Tsunetsugu, Y., Lee, J., Kagawa, T., 2013, Physiological and Psychological Impacts of Walking Stress in an Urban Environment on Young Males, *J Geogr Nat Disast* **3**(113):2167-0587.1000113.
27. Teas, J., Hurley, T., Ghumare, S., Ogoussan, K., 2007, Walking outside improves mood for healthy postmenopausal women, *Clinical Medicine Insights. Oncology* **1:**35.

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