Enhancing Walk Score's Ability to Predict Physical Activity and Active Transportation

Dr. Lawrence Frank, PhD

Professor in Population and Public Health and Urban Planning

University of British Columbia

Mr. Jared Ulmer, Senior Scientist

Urban Design 4 Health, Inc.

URBAN DESIGN 4 HEALTH

Outline

- Background & purpose
- Phase I: Implementing network-based distance measurement
- Phase II: Calibration & validation

URBAN DESIGN 4 HEALTH

Background on use of Walk Score

- Health researchers have been regularly using Walk Score as a measure of the built environment for study participants
- Strengths:
  - Cheap & easy to acquire
  - Available using a consistent methodology for any location in the United States
- Weaknesses:
  - Has never been calibrated/validated against objectively measured physical activity data
  - Lack of transparency regarding changes in underlying data (threatens validity of longitudinal comparisons)

URBAN DESIGN 4 HEALTH

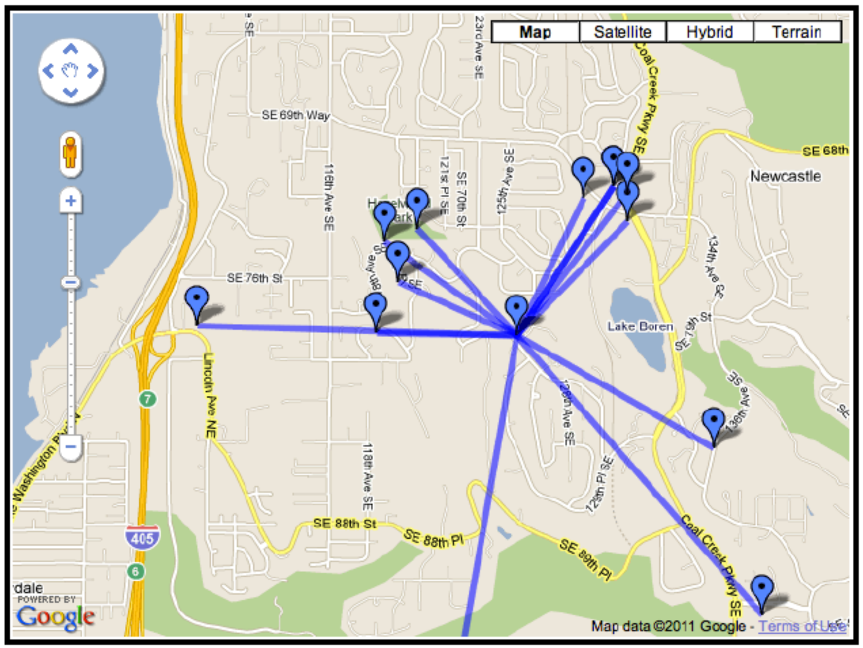
Purpose of this research

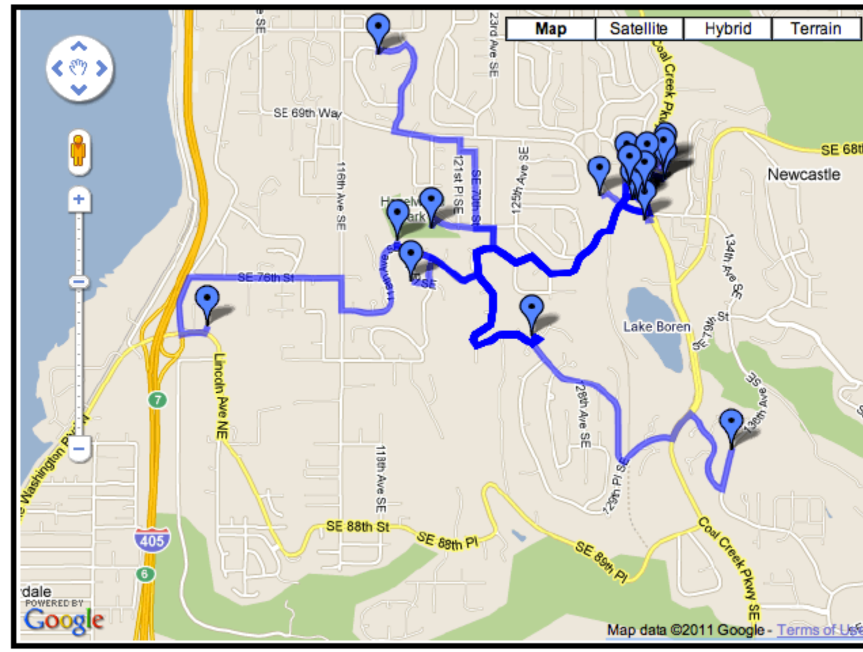
- Improve methods used to measure distances used in the Walk Score calculation (Phase I)
- Calibrate Walk Score Algorithm using National Institutes of Health data from the Neighborhood Quality of Life Studies (Phase II)
  - Four age cohorts: seniors 66+, adults 20-65, teens 12-16, children 6-11
  - Multi-region NIH funded data (NQLS & TEEN PI Sallis; SNQLS PI King; NIK PI Saelens): Seattle, Baltimore, San Diego
- Validate results using external data when possible (Phase II)
  - Strategies for Metropolitan Atlanta's Regional Transportation and Air Quality (SMARTRAQ) data for seniors and adults
- Compare ability of Walk Score to Walkability Index to predict physical activity (Phase II)

URBAN DESIGN 4 HEALTH

Phase I

- Implemented and tested airline versus network distance measurement for Walk Score:





- Network method resulted in stronger bivariate association (as compared to airline method) with daily minutes of moderate or vigorous physical activity**, body mass index*, obesity, overweight**, and daily time spent in an automobile**

** = $p < 0.01$, * = $p < 0.05$

Phase II

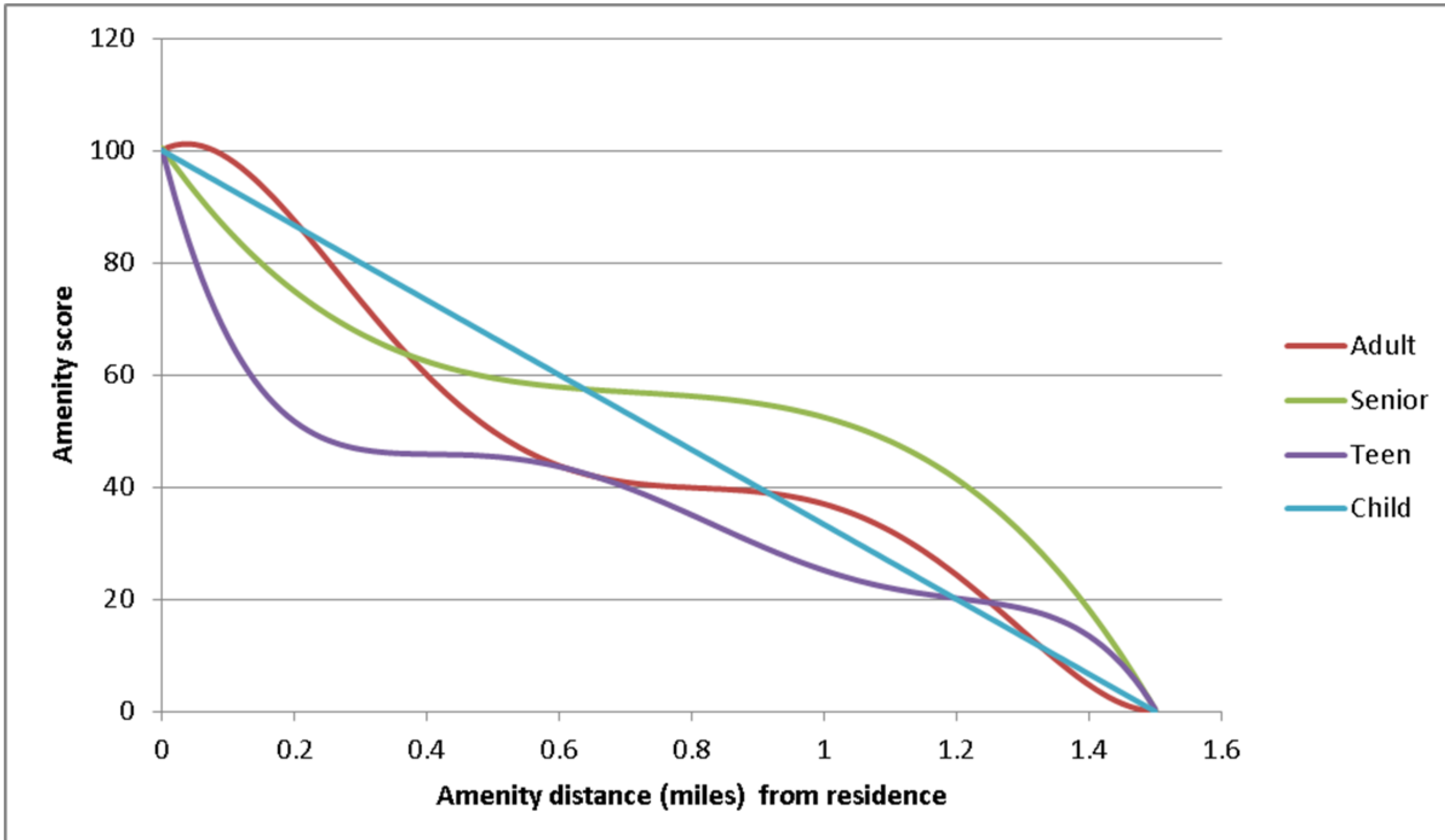
- Calibration focused on maximizing Walk Score's ability to predict objectively-measured moderate & vigorous physical activity (MVPA) data for each age cohort
- Components of Walk Score algorithm calibrated:
  - Distance decay function
  - Relative weights assigned to different destinations of interest
  - Potential inclusion of street connectivity variables in Walk Score
  - Potential inclusion of Transit Score in Walk Score
- All distances were calculated using network-based measurement

URBAN DESIGN 4 HEALTH

Distance decay functions

- Used to convert distance from home-to-destination to a 0-100 "amenity scores."
- Simple linear example:
  - Amenity score = 100 - 66.67*d, where d is a distance between 0-1.5 miles.
- Polynomial distance decay function estimated based on association between participants' MVPA and the distance from each participants' home to nearest destinations in nine categories

Distance decay functions



Note: Child data were inconclusive, so a simple linear distance decay function was employed

Walk Score component selection and weighting method

- Final Walk Score value is a weighted average of nine amenity scores. Original weights based roughly on published evidence.
- Weights re-calibrated for this project based on:
  - Strength of association between distance to each destination and MVPA, after adjusting for demographic and socioeconomic (SES) characteristics
  - Uniqueness of each destination (i.e. destinations that tend to be co-located are weighted lower)
- Destinations fell into two general categories:
  - Frequently co-located: restaurants, cafes, shops, grocery stores, book stores, banks
  - Uniquely located: schools, parks, entertainment

Street connectivity

- Currently implemented only as a penalty to the Walk Score for locations with poor street connectivity.
- Three street connectivity measures were re-scaled to 0-100 scores and tested for inclusion in Walk Score.
- Only the single best connectivity measure was recommended and assigned a weight.

Transit Score

- Transit Score already measured on 0-100 scale.
- Including Transit Score as a Walk Score component seems to increase MVPA predictive ability, **BUT…**
  - Transit Score is not available for every address
  - No automatic way to differentiate between "missing transit data" and "no transit service."

URBAN DESIGN 4 HEALTH

Adult component weighting example

Walk Score component	p-value	F-value	F_i / $\sum F_i$	uniqueness	raw weight	final weight
Banks	0.0537	3.7253	0.04	0.31	0.013	.04
Books	0.0017	9.8279	0.11	0.50	0.056	.18
Parks	0.0067	7.3633	0.08	0.65	0.054	.18
Coffee	5.2E-08	29.8803	0.34	0.23	0.078	.26
Entertainment	0.0338	4.5120	0.05	0.56	0.029	.10
Grocery	0.0705	3.2750	0.04	0.34	0.013	.04
Restaurants/bars	0.0001	15.1355	0.17	0.07	0.013	.04
Schools*	0.4328	n/a	n/a	n/a	n/a	n/a
Shopping	0.0046	8.0318	0.09	0.17	0.016	.05
Link:node ratio	0.0146	5.9785	0.07	0.46	0.031	.10
Intersection density*	0.1702	n/a	n/a	n/a	n/a	n/a
Average block length*	0.9136	n/a	n/a	n/a	n/a	n/a
Transit score*[1]	0.0055	n/a	n/a	n/a	n/a	n/a
Transit score*[2]	0.0002	n/a	n/a	n/a	n/a	n/a

*Dropped from consideration for final Walk Score
[1] Calculated only for participants where Transit Score was available
[2] Missing Transit Scores assumed to be equal to 0.

UD4H URBAN DESIGN 4 HEALTH

Recommended Walk Score components and weights

Walk Score component	Adult	Senior	Teen	Child
Banks	.04	.12	.09	-
Books	.18	.04	.10	-
Parks	.18	.24	.08	.16
Coffee	.26	.26	.23	-
Entertainment	.10	.11	.13	.12
Grocery	.04	.08	.08	-
Restaurants/bars	.04	.01	.04	-
Shopping	.05	.08	.08	.09
Link:node ratio	.10	.06	.17	-
Average block length	-	-	-	.63

Note: weights sum to 1.00 for each age cohort

MVPA prediction

- Revisions to Walk Score algorithm improves MVPA prediction for all age cohorts, after adjusting for demographic and SES characteristics:

WS model		Adult	Senior	Teen	Child
Original Walk Score	p-value	0.0054	0.0043	0.0074	0.8274
	Increase in MVPA per 1 SD increase in SSWS	2.00	1.75	1.64	-0.22
Revised Walk Score	p-value	2.52E-07	2.74E-05	0.0011	0.1198
	Increase in MVPA per 1 SD increase in SSWS	3.55	2.51	1.99	1.55

URBAN DESIGN 4 HEALTH

Comparison of Walk Score and Walk Index

- Strength of association (p-value) between Walk Score or Walkability Index and MVPA for each age cohort, after adjusting for demographic and SES characteristics:

Walk Score model	Adult	Senior	Teen	Child*
Original Walk Score	0.0054	0.0043	0.0074	4.59E-06
Revised Walk Score	2.52E-07	2.74E-05	0.0011	1.31E-06
Walk Index (standard)[1]	9.35E-09	0.0009	2.98E-06	3.41E-05
Walk Index (enhanced)[2]	-	-	2.19E-06	1.21E-08

* The variable "frequency of walking/biking to specific places" was used instead of MVPA for the child analysis.

[1] Standard walkability index included residential density, retail floor:area ratio, land use mix index, and intersection density

[2] Enhanced walkability index added variables describing school, park, and retail food access

UD4H URBAN DESIGN 4 HEALTH

Adult Walk Score algorithm validation using SMARTRAQ data

	Original Walk Score		Revised Walk Score	
	p-value	Increase in outcome per 1 SD increase in SSWS	p-value	Increase in outcome per 1 SD increase in SSWS
Self-reported minutes of transportation-related walking	1.13E-19	3.16	5.39E-20	3.29
Minutes driving/riding in a car	1.00E-49	-12.22	2.24E-54	-12.29
Body mass index	5.12E-06	-0.24	1.66E-10	-0.34
Overweight status	1.01E-05	-2.4%	3.97E-10	-3.4%
Obese status	0.003542	-1.3%	3.82E-05	-1.8%
Self-reported minutes of leisure moderate physical activity	0.02159	1.55	0.009089	1.75

URBAN DESIGN 4 HEALTH

Walkability Index by age cohort

- p-values for the association between each Walkability Index component and MVPA, after adjusting for demographics and socioeconomic status:

Walkability component	Child	Teen	Adult	Senior
Residential density	0.77*	8.50E-05	3.53E-07	0.31
Intersection density	0.64*	0.19	0.026	0.57
Retail FAR	0.82	0.00022	1.68E-05	0.0012
Land use mix	0.13*	0.00043	0.0018	0.01
Walkability Index**	0.14*	2.98E-06	9.35E-09	0.0009

* Coefficient was negative

** Components weighted by p-value and uniqueness to calculate Walkability Index

Implications and next steps

- Existing Walk Score is significantly associated with MVPA for seniors, adults, and teens, but not for children.
- Proposed revised Walk Score improves the strength of association with MVPA for all age cohorts, but association with child MPVA is still not statistically significant.
- The revised Walk Score provides researchers with a more valid measure of walkability for use in health and physical activity studies.
- Recommendations for Walk Score algorithm improvements were delivered to ALR and Walk Score and will be available to Walk Score researchers on www.walkscore.com.

Near term recommendations

- Revise the distance decay formula to better account for actual walking distances.
- Adjust the Walk Score destination weights to better favor the most likely walking destinations and to reduce the amount of "non-unique" information caused by the current high level of multicollinearity between Walk Score destinations.
- Remove schools from the Walk Score, as their inclusion may actually reduce the ability of Walk Score to predict physical activity outcomes.
- Include the link:node ratio in the Walk Score algorithm to account for street connectivity, rather than using the current intersection density and average block length penalties.

URBAN DESIGN 4 HEALTH

Long term recommendations

- Incorporate age specific Walk Scores on www.walkscore.com.
- Include the Transit Score in the Walk Score algorithm, but that will not be possible until more complete transit data can be provided to Walk Score and/or more extensive data analysis can be completed in regions where transit data is missing.
- Include additional variables in Walk Score that may be feasible to measure nationwide, such as population density, urban form (e.g. building height and lot coverage), traffic volume, pedestrian/cycling infrastructure, topography.
- Investigate a comprehensive set of factors that predict physical activity in children and evaluate ways to incorporate and display these results in Walk Score.

ud4h
URBAN DESIGN 4 HEALTH