

<http://mc.manuscriptcentral.com/jph>

**Associations of social cohesion and quality of life with
objective and perceived built environments: A latent profile
analysis among seniors**

Journal:	<i>Journal of Public Health</i>
Manuscript ID	JPH-20-0296
Manuscript Type:	Original Article
Date Submitted by the Author:	23-Apr-2020
Complete List of Authors:	<p>Hua, Jenna; Stanford University School of Medicine, Stanford Prevention Research Center</p> <p>Mendoza-Vasquez, Andrea; Stanford University School of Medicine, Stanford Prevention Research Center</p> <p>Chrisinger, Benjamin; University of Oxford, Department of Social Policy and Intervention</p> <p>Conway, Terry; University of California San Diego, Department of Family Medicine and Public Health</p> <p>Todd, Michael; Arizona State University, College of Nursing and Health Innovation</p> <p>Adams, Marc; Arizona State University, School of Nutrition and Health Promotion</p> <p>Sallis, James; University of California San Diego, Department of Family Medicine and Public Health</p> <p>Cain, Kelly; University of California San Diego, Department of Family Medicine and Public Health</p> <p>Saelens, Brian; University of Washington, Department of Pediatrics; Seattle Children's Research Institute</p> <p>Frank, Lawrence; The University of British Columbia, Schools of Population and Public Health and Community and Regional Planning</p> <p>King, Abby; Stanford University School of Medicine, Department of Epidemiology and Population Health, and Stanford Prevention Research Center</p>
Keywords:	Environment, Older people

SCHOLARONE™
Manuscripts

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

Associations of social cohesion and quality of life with objective and perceived built environments: A latent profile analysis among seniors

Hua, J., *Postdoctoral Fellow, Stanford Prevention Research Center, Department of Medicine, Stanford University School of Medicine, Stanford, CA 94305 United States*

Mendoza Vasconez, A.S., *Postdoctoral Fellow, Stanford Prevention Research Center, Department of Medicine, Stanford University School of Medicine, Stanford, CA 94305 United States*

Chrisinger, B. W., *Associate Professor, Department of Social Policy and Intervention, University of Oxford, Oxford OX1 2ER, United Kingdom*

Conway, T. L., *Assistant Professor, Department of Family Medicine and Public Health, University of California San Diego, La Jolla, CA 92093, United States*

Todd, M. W., *Research Professor, College of Nursing and Health Innovation, Arizona State University, Phoenix, AZ, 85004, United States*

Adams, M. A., *Associate Professor, School of Nutrition and Health Promotion, Arizona State University, Phoenix, AZ, United States*

Sallis, J. F., *Distinguished Professor, Department of Family Medicine and Public Health, University of California San Diego, La Jolla, CA 92093, United States*

Cain, K. L., *Senior Research Manager, Department of Family Medicine and Public Health, University of California San Diego, La Jolla, CA 92093, United States*

Saelens, B. E., *Professor, Department of Pediatrics, University of Washington & Seattle Children's Research Institute, Seattle, Washington, 98121, United States*

Frank, L. D., *Professor, Schools of Population and Public Health and Community and Regional Planning, University of British Columbia, Vancouver, BC, Canada V6T 1Z2*

King, A. C., *Professor, Department of Epidemiology and Population Health, and Stanford Prevention Research Center, Department of Medicine, Stanford, CA, 94305, United States*

Corresponding author: Andrea S. Mendoza-Vasconez

E-mail address: amenvasc@stanford.edu

ABSTRACT

Background: Healthy aging requires support from local built and social environments. Using latent profile analysis, this study captured the multi-dimensionality of the built environment and examined relations between objective and perceived built environment profiles, neighborhood social cohesion, and quality of life among seniors.

Methods: 693 participants aged 66-97 were sampled from two US locales in 2005-2008 as part of the Senior Neighborhood Quality of Life Study (SNQLS). Perceived social cohesion and quality of life were assessed using validated surveys. Six objective (GIS-based) and seven perceived built environment latent profiles generated in previous SNQLS publications were used for analyses. Mixed-effects models estimated social cohesion and quality of life separately as a function of the built environment profiles.

Results: More walkable and destination-rich perceived built environment profiles were associated with higher social cohesion and quality of life. Objective built environment profiles were not associated with social cohesion and only positively associated with quality of life in only one locale (Baltimore/DC).

Conclusions: Latent profile analysis offered a comprehensive approach to assessing the built environment. Seniors who perceived their neighborhoods to be highly walkable and recreationally dense experienced higher neighborhood social cohesion and quality of life, which may set the stage for healthier aging.

1 Successful aging encompasses absence of disease and disability, maintenance of physical and mental
2 functioning, and sustained engagement in social and productive activities,¹ resulting in increased quality of life
3 for seniors²⁻⁵ and reduced healthcare costs for society at large.⁶⁻⁸ Successful aging and improved quality of life
4 for seniors requires support from both built environments and social environments.⁹ Moreover, individuals who
5 experience higher quality of life are more likely to be active and to choose to live in more activity-friendly
6 neighborhoods, which in turn determines the available neighborhood assets that are related to their quality of
7 life.¹⁰

12 Elements and characteristics of the social environment, such as social cohesion, are important enablers of
13 successful aging.⁹ Neighborhood social cohesion has been associated with seniors' cognitive function,¹¹
14 psychological distress,¹² hypertension,¹³ stroke,¹⁴ self-reported health¹⁵ and various health behaviors.¹⁶
15 Neighborhood influences may be particularly important for older adults who, after occupational retirement,
16 often spend much of their time within their neighborhoods.¹²

22 There is also considerable evidence for associations between built environment assets, such as access to green
23 space and neighborhood walkability, and seniors' physical activity levels, weight status, mental health, and
24 general wellbeing.¹⁷⁻²¹ Despite the importance of the social as well as built environments for successful aging,
25 there is limited research on the interplay between both, and how they may be associated with each other.
26 Furthermore, assets of the built environment are typically measured subjectively by self-report or derived
27 objectively using Geographic Information System (GIS); objective and perceived (subjective) measures of the
28 built environment are often not considered together. Some studies that have simultaneously examined both have
29 found a mismatch between self-reported and objectively measured built environment.¹⁸ For example, a
30 systematic review of the neighborhood physical environment and active travel in older adults found that
31 perceived measures of land use mix and access to recreational features generated stronger evidence of positive
32 associations than did objective measures.²² Understanding the discrepancies between perceived and objectively
33 measured built environment features could assist in developing intervention strategies aimed at changing
34 individuals' perceptions of the built environment to achieve better health.

45 The majority of the built environment literature typically focuses on only one or a few built environment assets,
46 without considering the diversity and multi-dimensionality of the built environment; different features of the
47 built environment may not be independent and could correlate in complex ways.¹⁷⁻²⁰ In studying the built
48 environment and its associations with different outcomes, including social cohesion and quality of life, one of
49 the remaining challenges thus concerns how to capture complex and coexisting patterns of the built
50 environment. Latent profile analysis is a multivariate analysis method that is useful for identifying common
51 patterns among numerous variables and classifying individuals into subgroups based on their response patterns.
52 Based on inputs of potential indicators, latent profile analysis yields a discrete set of model-derived clusters of

observations with distinctive patterns (profiles) of indicator (built environment feature) scores in each model, and allows for statistical comparison of models of differing complexity. Furthermore, latent profile analysis maximizes between-profile variance and minimizes within-profile variance across the set of indicators.²⁰

Based on these considerations, the goals of this paper were to examine the cross-sectional relations between objectively measured and perceived built environment profiles, generated using a latent profile analysis approach, and social cohesion and quality of life in seniors from two U.S. regions. We hypothesized that individuals with more activity-supportive built environment profiles (both GIS-derived and perceived) would experience higher levels of social cohesion and quality of life. To test our hypothesis, we used data gathered from the Senior Neighborhood Quality of Life Study (SNQLS), an observational study that was originally designed to evaluate relations of the built environment with physical activity and body weight in older adults living in neighborhoods differing in walkability and income levels.²³

Methods

As part of SNQLS, 719 free-living participants aged 66-97 years (52.2% women, 30% racial/ethnic minority) were sampled from Seattle-King County, WA and Baltimore, MD-Washington, DC regions in 2005-2008 with the goals of maximizing variability in neighborhood walkability and income at the Census block group level. Inclusion criteria included ages 66 and older, and able to complete surveys in English and walk at least 10 feet continuously. Details on the sampling and recruitment of the original study can be found in King et. al.²³ All human subject activities were approved by the Institutional Review Boards of Stanford University, San Diego State University, and University of California San Diego.

Participants' sociodemographic information, quality of life, and neighborhood social cohesion were assessed using self-reported surveys. Quality of life was measured by the following four questions: 1) In general, would you say your health is excellent, very good, good, fair, or poor? 2) All things considered, how satisfied are you with your life as a whole? (very satisfied, moderately satisfied, no feels either way, moderately dissatisfied, or very dissatisfied); 3) During the past 4 weeks, how much did pain interfere with your normal work, including both work outside the home and housework? (not at all, a little bit, moderately, quite a bit or extremely); and 4) How often do you feel isolated from others? (hardly ever, some of the time, or often).²⁴ An average total Z-score was then generated to summarize the measure.

Neighborhood social cohesion was measured by five Likert-type survey questions, as follows: 1) People around my neighborhood are willing to help their neighbors; 2) This is a close-knit neighborhood; 3) People in this neighborhood can be trusted; 4) People in this neighborhood generally don't get along with each other; and 5) People in this neighborhood do not share the same values.²⁵ The questions were rated on a 5-point scale (strongly disagree, somewhat disagree, neutral, somewhat agree, strongly agree), and the average of these responses was the summary measure.

1 In terms of built environment assessments, previous research on SNQLS data²⁰ identified the three objective
2 and four perceived built environment profiles that are used in the present study. The objective (GIS-based)
3 profiles were derived based on 1-km street network buffers around participants' home addresses. The profile
4 elements included net residential density, land-use mix, retail floor area ratio, intersection density, public transit
5 density, and public park and private recreation facility density. Descriptions of these profile elements can be
6 found in Todd et al. (2016). Profiles were selected based on model fit criteria (i.e., sample size-adjusted
7 Bayesian Information Criterion or BIC and model log likelihood values), within-profile sample sizes (i.e.,
8 profiles with >5% of the sample were considered viable), and interpretable neighborhood profiles, in terms of
9 built environment characteristics and elements.²⁶ Three profiles each were generated for both Seattle/King
10 County and Baltimore/DC including low (L-L-L), moderate (M-M-M) and high (H-H-H)
11 walkability/transit/recreation features, with letters referring to walkability, transit, and recreation features,
12 respectively.²⁰

21 Perceived built environment features were derived from the Neighborhood Environment Walkability Scale
22 (NEWS),²⁷ which consists of 8 subscales--residential density, land-use mix diversity, land-use mix access, street
23 connectivity, walking and cycling facilities, aesthetics, pedestrian/traffic safety, and crime safety. Other
24 perceived built environment items that were measured separately in addition to the NEWS included distances to
25 the nearest point of interest (i.e. bus or train stop, park, recreation center or gym or fitness facility), and time to
26 walk to these places (measured on a 5-point scale from 31 minutes or more to 1-5 minutes); the scales were
27 computed as the mean of responses. Similar to the GIS-based profile generation, perceived built environment
28 profiles were generated and selected based on model fit criteria, sample sizes per profile and interpretable
29 neighborhood profiles.²⁶ Three profiles were generated for both the Seattle/King County and the Baltimore/DC
30 regions, including low walkability transit and recreation (LWTR); moderate walkability/moderately recreational
31 (MWMR); and high walkability/recreationally dense (HWRD). Additionally, a fourth profile was generated for
32 the Baltimore/DC region: low walkability/recreationally sparse (LWRS).¹⁸

42 Multilevel mixed linear models were used to estimate social cohesion and quality of life separately as a function
43 of the individual objective and perceived built environment latent profiles. Analyses were limited to only those
44 participants with both social cohesion and quality of life scores and built environment profiles. In order to
45 account for clustering, individual participants were nested within neighborhoods defined by Census block group
46 in a two-level data structure, with Census block group incomes treated as a random effect. Basic descriptive
47 statistics were calculated for all primary indicator and outcome variables as well as other covariates. Stata 15.0
48 (Stata Corp, College Station, Texas) was used for all data analysis.

Results

A total of 693 participants had the above data of interest and were included in the analyses. They were ages 66-97 years (45.9% Seattle/King County, 54.1% Baltimore/DC) with 52.2% women and 30% reporting being part of a racial/ethnic minority group. Detailed participant characteristics can be found in **Table 1**. Objective built environment profiles included 62.7% low (L-L-L), 29.3% moderate (M-M-M), and 5.8% high (H-H-H) walkability/transit/recreation. Perceived built environment profiles for Seattle/King County and Baltimore/DC, respectively, included 20.4% and 18.8% low walkable, transit and recreation (LWTR); 32.1% and 37.4% moderately walkable/moderately recreational (MWMR); and 47.2% and 15.3% high walkable/recreationally dense (HWRD)]. Additionally, 28.5% of participants in Baltimore/DC were classified under a fourth profile: low walkable/recreationally sparse (LWRS).

Associations between built environment profiles and social cohesion

The objectively-derived built environment profiles were not significantly associated with social cohesion (**Table 2**). Alternatively, as illustrated in **Table 2** and **Figure 1** (electronic version only), the perceived built environment profiles were found to have positive relations with social cohesion. In general, the better the perceived profiles (more walkable and more recreationally dense neighborhoods), the higher the social cohesion experienced by participants in both Seattle/King County and Baltimore/DC regions. Specifically, participants in each region with MWMR profiles experienced 30% higher social cohesion than participants with LWTR profiles. In the Baltimore/DC region, participants with HWRD profiles experienced 61% higher social cohesion than participants with LWTR. As shown in the detailed mixed-effect model outputs in **Table 2**, there were additional significant covariates in the model; in the Baltimore/DC region, for example, years at current address had a positive relationship with social cohesion. Alternatively, participants with higher education levels experienced higher social cohesion in Seattle/King County, while this relationship was not observed in the Baltimore/DC region.

Associations between built environment profiles and quality of life

The examination of GIS-based built environment profiles and quality of life (**Table 3**) revealed no associations in the Seattle/King County region. In the Baltimore/DC region, participants living in M-M-M neighborhoods experienced 22% higher quality of life compared to those living in L-L-L neighborhoods (**Figure 2**, electronic version only). Additional significant covariates are shown in **Table 3**.

The relations between perceived built environment profile and quality of life are illustrated in **Table 3** and **Figure 3** (electronic version only). In Seattle/ King County, participants living in MWMR neighborhoods experienced 24% higher quality of life compared to those living in LWTR neighborhoods, whereas in Baltimore/DC, participants who lived in HWRD neighborhoods experienced 45% higher quality of life compared to those who lived in LWTR neighborhoods. Additional significant covariates are shown in **Table 3**.

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

Discussion

Main finding of this study

In our analysis of older participants sampled from Seattle/King County, WA and Baltimore, MD-Washington, DC, objective built environment profiles were not associated with neighborhood social cohesion and were only associated with quality of life in Baltimore/DC, but not in Seattle/King County. Alternatively, perceived built environment profiles that were seen as more walkable and destination-rich were associated with higher social cohesion and higher quality of life.

What is already known on this topic

In previous research, elements of more walkable, destination-rich, activity-friendly built environments have been related to physical activity^{19,28,29} and have been shown to have additional co-benefits.^{30,31} Sallis et al.³¹ extensively reviewed the literature and summarized the evidence on co-benefits of activity-friendly environments. The authors defined five physical activity settings (e.g. parks/open space/trails, schools). For each setting, evidence-based activity-friendly features were identified, along with six potential outcomes/co-benefits consisting of physical health, mental health, social benefits, safety/injury prevention, environmental sustainability, and economics. It was concluded that the multi-dimensionality of the built environment and combination of multiple environmental features produced stronger impacts on physical activity and other co-benefits than any single feature.^{30,31}

What this study adds

To the best of our knowledge, this was the first investigation using latent profile analysis to examine and compare both objective (GIS-based) and perceived built environment profiles to neighborhood social cohesion and quality of life. Prior studies have often focused on a few built environment features without considering the complexity of the built environment. Latent profile analysis can offer a more comprehensive approach to assessing the built environment. Using latent profile analysis and building on previous work from SNQLS, the present investigation captured the multi-dimensionality of the built environment, including walkability, transit, and recreational resources.

Based on the results of this study, it appears that designing activity-supportive built environments could have additional co-benefits regarding social cohesion and quality of life in older adults. This investigation also indicates the importance of considering both objectively-measured and perceived built environment profiles, with perceptions of existing built environment resources likely playing an essential role in understanding older adults' assessments of social cohesion in their neighborhood and of their quality of life. Previous research using the same SNQLS dataset also demonstrated the relevance of built environment perceptions for other outcomes.^{32,33} Hong et al., for example, examined the moderating effect of perceived safety on the association between green space and neighborhood social capital in older adults. They showed that parks and tree-lined

streets, elements of green space, may be less advantageous to those who perceived their neighborhoods as unsafe for pedestrians.³³

Clear differences were observed between the models generated for Seattle/King County and Baltimore/DC. Specifically, we observed regional differences in the associations between social cohesion and quality of life and demographic or individual-level variables, including race/ethnicity, education, income, employment status and driving capability. Despite the differences found in these individual-level variables, the models consistently showed perceived built environment profiles to be related to quality of life and social cohesion.

Limitations and strengths of this study

This study had several limitations as well as strengths. Strengths included the use of latent profile analysis to examine objectively-measured and perceived built environment profiles of the same cohort, and the use of validated self-report measures of neighborhood social cohesion and quality of life. Limitations included the cross-sectional nature of the study, which prevents causal inference. Longitudinal research is indicated, which would allow investigation of mediational and moderator effects of the variables being studied. In addition, the sample lacked substantial diversity, with 30% racial/ethnic minorities (as opposed to 40% across the US population),³⁴ and the sample was relatively highly educated, which limits the generalizability of study results. Given that we documented differential results by region, results of this investigation may not generalize to other locales. Moreover, some of the identified built environment profiles had small sample sizes. For example, only 1.9% and 9.3% of the participants in Baltimore/DC, but not in Seattle/King County, respectively, were categorized under the H-H-H objective profile, which may have hindered our ability to find statistical significance despite positive association trends. Finally, there are likely other unmeasured environmental variables, such as air pollution and noise, as well as other unmeasured individual-level variables, such as personal social networks and perceived stress, that could have impacts on the relationships between the built environment and social cohesion and quality of life.

Conclusion

Healthy aging can increase seniors' quality of life and reduce society's healthcare costs, but it requires support from both built and social environments.⁹ In the present study, no association was found between objective built environment profiles and social cohesion. Alternatively, more walkable and destination-rich perceived built environment profiles were associated with higher social cohesion and quality of life. These variables have been related to physical activity among older and younger age groups in prior studies;^{17,22,28,29,31,35} thus, it appears that designing activity-supportive environments could have additional co-benefits regarding social cohesion and quality of life for older adults in addition to other age groups. Latent profile analysis offers an arguably more comprehensive approach to assessing the built environments than more commonly used analytic approaches that examine one or two built environment assets at a time. The finding that seniors who perceived their

1 environments as highly walkable and recreationally dense experienced higher neighborhood social cohesion and
2 quality of life may set the stage for future interventions and eventually contribute to healthy aging.
3
4

5 **Conflicts of interests**
6

7
8
9 None.
10

11
12 **Authors' contributions**
13

14
15
16 Design and methods: JH, AK, JS, TC, BS, LF, MA

17 Data analysis: JH, MT, MA

18 Interpretation of results: JH, BC, AK, AM

19 Manuscript writing: JH, BC, AM, AK

20 Manuscript editing: BC, AM, AK, TC, MT, MA JS, KC, BS, LF

21 Final version approval: BC, TC, MT, MA, JS, KC, BS, LF, AM, AK
22
23
24
25
26
27
28
29

30 **Funding**

31 This work was supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health
32 [grant numbers R01 HL077141, T32 HL007034]. Dr. King also was supported in part by the Robert Wood
33 Johnson Foundation [grant number 7334], the National Cancer Institute of the National Institutes of Health
34 [grant numbers 5R01CA211048, P20CA217199], the Nutrilite Health Institute Wellness Fund provided by
35 Amway to the Stanford Prevention Research Center, Silicon Valley Community Foundation [award number
36 101518], the Discovery Innovation Fund Grant in Basic Biomedical Sciences from Stanford University, and US
37 Public Health Service [grant numbers 1U54EB020405, 1U54MD010724]. The above funding sources were not
38 involved in design, execution, analysis, and interpretation of results preparation and submission of the
39 manuscript.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

References:

1. Rowe JW, Kahn RL. Successful aging. *Gerontologist*. 1997;37(4):433-440.
2. Choi M, Lee M, Lee MJ, Jung D. Physical activity, quality of life and successful ageing among community-dwelling older adults. *Int Nurs Rev*. 2017;64(3):396-404.
3. Li CI, Lin CH, Lin WY, et al. Successful aging defined by health-related quality of life and its determinants in community-dwelling elders. *BMC Public Health*. 2014;14(1):1013.
4. Montross LP, Depp C, Daly J, et al. Correlates of self-rated successful aging among community-dwelling older adults. *Am J Geriatr Psychiatry*. 2006;14(1):43-51.
5. Reichstadt J, Sengupta G, Depp CA, Palinkas LA, Jeste DV. Older adults' perspectives on successful aging: qualitative interviews. *Am J Geriatr Psychiatry*. 2010;18(7):567-575.
6. Daskalopoulou C, Stubbs B, Kralj C, Koukounari A, Prince M, Prina AM. Physical activity and healthy ageing: a systematic review and meta-analysis of longitudinal cohort studies. *Ageing Res Rev*. 2017;38:6-17.
7. Friedman SM, Mulhausen P, Cleveland ML, et al. Healthy aging: American Geriatrics Society white paper executive summary. *J Am Geriatr Soc*. 2019;67(1):17-20.
8. Jeste DV, Blazer DG II, Buckwalter KC, et al. Age-friendly communities initiative: public health approach to promoting successful aging. *Am J Geriatr Psychiatry*. 2016;24(12):1158-1170.
9. Hernandez DC, Johnston CA. Individual and environmental barriers to successful aging: the importance of considering environmental supports. *Behav Med Rev*. 2017;11(1):21-23.
10. Engel L, Chudyk AM, Ashe MC, McKay HA, Whitehurst DG, Bryan S. Older adults' quality of life - Exploring the role of the built environment and social cohesion in community-dwelling seniors on low income. *Soc Sci Med*. 2016;164:1-11.
11. Zhang W, Liu S, Sun F, Dong X. Neighborhood social cohesion and cognitive function in U.S. Chinese older adults-findings from the PINE study. *Aging Ment Health*. 2019;23(9): 1113-1121.
12. Choi YJ, Matz-Costa C. Perceived neighborhood safety, social cohesion, and psychological health of older adults. *Gerontologist*. 2018; 58(1): 196-206.
13. Lagisetty PA, Wen M, Choi H, Heisler M, Kanaya AM, Kandula NR. Neighborhood social cohesion and prevalence of hypertension and diabetes in a South Asian population. *J Immigr Minor Health*. 2016;18(6):1309-1316.
14. Kim ES, Park N, Peterson C. Perceived neighborhood social cohesion and stroke. *Soc Sci Med*. 2013;97:49-55.
15. Dong X, Bergren SM. The associations and correlations between self-reported health and neighborhood cohesion and disorder in a community-dwelling U.S. Chinese population. *Gerontologist*. 2017;57(4):679-695.
16. Kim ES, Kawachi I. Perceived neighborhood social cohesion and preventive healthcare use. *Am J Prev Med*. 2017;53(2):e35-e40.
17. Adams MA, Ding D, Sallis JF, et al. Patterns of neighborhood environment attributes related to physical activity across 11 countries: a latent class analysis. *Int J Behav Nutr Phys Act*. 2013;10(1):34.
18. Adams MA, Sallis JF, Conway TL, et al. Neighborhood environment profiles for physical activity among older adults. *Am J Health Behav*. 2012;36(6):757-769.
19. Adams MA, Sallis JF, Kerr J, et al. Neighborhood environment profiles related to physical activity and weight status: a latent profile analysis. *Prev Med*. 2011;52(5):326-331.
20. Todd M, Adams MA, Kurka J, et al. GIS-measured walkability, transit, and recreation environments in relation to older Adults' physical activity: a latent profile analysis. *Prev Med*. 2016;93:57-63.
21. Barnett A, Zhang CJP, Johnston JM, Cerin E. Relationships between the neighborhood environment and depression in older adults: a systematic review and meta-analysis. *Int Psychogeriatr*. 2018;30(8):1153-1176.
22. Cerin E, Nathan A, Van Cauwenberg J, et al. The neighbourhood physical environment and active travel in older adults: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act*. 2017;14(1):15.

23. King AC, Sallis JF, Frank LD, et al. Aging in neighborhoods differing in walkability and income: associations with physical activity and obesity in older adults. *Soc Sci Med.* 2011;73(10):1525-1533.

24. Szende A, Oppe M, Devlin NJ. *EQ-5D Value Sets: Inventory, Comparative Review and User Guide.* Dordrecht, Netherlands: Springer, 2007.

25. Parker EA, Lichtenstein RL, Schulz AJ, et al. Disentangling measures of individual perceptions of community social dynamics: results of a community survey. *Health Educ Behav.* 2001;28(4):462-486.

26. Collins LM, Lanza ST. *Latent class and latent transition analysis: with applications in the social, behavioral, and health sciences.* Hoboken, NJ: John Wiley & Sons, Inc.; 2010.

27. Cerin E, Saelens BE, Sallis JF, Frank LD. Neighborhood Environment Walkability Scale: validity and development of a short form. *Med Sci Sports Exerc.* 2006;38(9):1682-1691.

28. Cain KL, Millstein RA, Sallis JF, et al. Contribution of streetscape audits to explanation of physical activity in four age groups based on the Microscale Audit of Pedestrian Streetscapes (MAPS). *Soc Sci Med.* 2014;116:82-92.

29. Sallis JF, Bowles HR, Bauman A, et al. Neighborhood environments and physical activity among adults in 11 countries. *Am J Prev Med.* 2009;36(6):484-490.

30. Glonti K, Mackenbach JD, Ng J, et al. Psychosocial environment: definitions, measures and associations with weight status--a systematic review. *Obes Rev.* 2016;17:81-95.

31. Sallis JF, Spoon C, Cavill N, et al. Co-benefits of designing communities for active living: an exploration of literature. *Int J Behav Nutr Phys Act.* 2015;12(1):30.

32. Chrisinger BW, King AC, Hua J, et al. How Well Do Seniors Estimate Distance to Food? The Accuracy of Older Adults' Reported Proximity to Local Grocery Stores. *Geriatrics.* 2019;4(1):11.

33. Hong A, Sallis JF, King AC, et al. Linking green space to neighborhood social capital in older adults: the role of perceived safety. *Soc Sci Med.* 2018;207:38-45.

34. Schaeffer K. The most common age among whites in the U.S. is 58 - more than double that of racial and ethnic minorities. Washington, DC: Pew Research Center; July 30, 2019 [cited 2020 April 22]. Available from: <https://www.pewresearch.org/fact-tank/2019/07/30/most-common-age-among-us-racial-ethnic-groups/>.

35. Giles-Corti B, Foster S, Shilton T, Falconer R. The co-benefits for health of investing in active transportation. *N S W Public Health Bull.* 2010;21(6):122-127.

Figure Legends

Fig. 1. Social cohesion and perceived BE profiles, Seattle/King County and Baltimore/DC

Fig. 2 (electronic version only). Quality of life and GIS-based BE profiles, Seattle/King County and Baltimore/DC Regions

Fig. 3 (electronic version only). Quality of life and perceived BE profiles, Seattle/King County and Baltimore/DC

For Peer Review

Table 1. Participant Characteristics

Participant Characteristics (Categorical)	Seattle/King County region (n = 318, 45.9%)		Baltimore/DC region (n = 375, 54.1%)	
	n	%	n	%
Gender				
Male	164	51.6	167	44.5
Female	154	48.4	208	55.5
Race/ethnicity				
Non-Hispanic white/Caucasian	268	84.3	217	57.9
Racial/ethnic minority	50	15.7	158	42.1
Education Level				
High school or less	60	18.9	94	25.1
Some college or vocational training	105	33.0	96	25.6
Completed college or university	95	29.9	79	21.1
Completed graduate degrees	58	18.2	106	28.3
Type of residence				
Single family house	236	74.2	244	65.1
Apartment/condominium/townhouse or other	82	25.8	131	34.9
Valid driver's license holder				
Yes	296	93.1	346	92.3
No	22	6.9	29	7.2
Comfortable driving distance from home				
10 miles or less	52	16.4	73	19.5
more than 10 miles	266	83.7	301	80.5
Marital status				
Married or living with a partner	190	59.8	208	55.5
Widowed	79	24.8	92	24.5
Divorced/separated or single	49	15.4	75	20.0
Employment Status				
Employed	64	20.1	98	26.1
Unemployed/retired and not currently working	249	78.3	272	72.5
Disabled or on temporary medical leave	5	1.6	5	1.3
Annual household income				
<\$30,000	106	35.9	104	29.8
\$30,000-\$49,000	83	28.1	81	23.2
\$50,000-\$79,000	67	22.7	100	28.7
>\$80,000	39	13.2	64	18.3
GIS-based latent profile membership				
Low walkability/transit/recreation (L-L-L)	188	59.9	247	67.9
Mean walkability/transit/recreation (M-M-M)	120	38.2	83	22.8
High walkability/transit/recreation (H-H-H)	6	1.9	34	9.3
Perceived latent profile membership				
Low walkability, transit and recreation (LWTR)	65	20.5	70	18.8
Low walkability/recreationally sparse (LWRS)			106	28.5
Moderately walkability/moderately recreational (MWMR)	102	32.2		
Moderately walkability/recreationally dense (MWRD)			139	37.4
High walkability/recreationally dense (HWRD)	150	47.3	57	15.3
Participant Characteristics (Continuous)	Mean	SD	Mean	SD
Age (years)	74.8	6.6	73.6	5.8
BMI (kg/m ²)	26.3	4.8	26.9	4.8
Duration at current address (years)	25.0	16.6	25.0	14.4
Number of people living in the same household	1.8	0.8	1.8	0.7
Quality of life Z-score	0.0	0.7	0.0	0.7
Average social cohesion score	3.7	0.7	3.7	0.8

Table 2. Latent profiles and social cohesion

VARIABLES	GIS-based latent profiles				Perceived latent profiles			
	Seattle/King County		Baltimore/DC		Seattle/King County		Baltimore/DC	
	region		region		region		region	
	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI
Latent profile membership								
L-L-L / LWTR								
LWRS	N/A		N/A		N/A		-0.00	-0.25 - 0.24
M-M-M / MWMR	0.09	-0.12 - 0.30	-0.11	-0.36 - 0.15	0.33*	0.06 - 0.59	0.31*	0.06 - 0.56
H-H-H / HWRD	-0.08	-0.71 - 0.56	-0.01	-0.45 - 0.42	0.17	-0.07 - 0.40	0.61**	0.23 - 0.99
Gender								
Male								
Female	0.02	-0.16 - 0.21	-0.03	-0.22 - 0.15	0.05	-0.13 - 0.24	0.01	-0.17 - 0.18
Race/ethnicity								
Non-Hispanic white								
Racial/ethnic minority	-0.27*	-0.52 - -0.02	0.07	-0.12 - 0.26	-0.26*	-0.50 - -0.03	0.09	-0.09 - 0.27
Education Level								
High school or less								
Some college/vocational training	0.18	-0.07 - 0.42	0.12	-0.11 - 0.35	0.16	-0.08 - 0.40	0.15	-0.07 - 0.37
Completed college or university	0.33*	0.07 - 0.60	0.03	-0.23 - 0.29	0.29*	0.03 - 0.54	-0.04	-0.29 - 0.21
Completed graduate degrees	0.41*	0.12 - 0.71	0.18	-0.08 - 0.44	0.36*	0.07 - 0.65	0.15	-0.09 - 0.40
Type of residence								
Single family house								
Apartment/condominium/ townhouse or other	0.00	-0.27 - 0.28	-0.14	-0.36 - 0.09	-0.08	-0.34 - 0.18	-0.19	-0.41 - 0.04
Valid driver's license holder								
Yes								
No	0.33	-0.11 - 0.77	-0.36*	-0.71 - -0.00	0.29	-0.13 - 0.71	-0.28	-0.62 - 0.06
Comfortable driving distance from home								
10 miles or less								
more than 10 miles	-0.03	-0.31 - 0.26	0.33*	0.08 - 0.59	-0.05	-0.34 - 0.23	0.25*	0.00 - 0.49
Marital status								
Married or living with a partner								
Widowed	-0.20	-0.48 - 0.08	-0.03	-0.28 - 0.22	-0.18	-0.46 - 0.09	-0.05	-0.28 - 0.19
Divorced/separated or single	-0.26	-0.56 - 0.04	-0.03	-0.30 - 0.24	-0.24	-0.53 - 0.06	-0.02	-0.28 - 0.23
Employment Status								
Employed							0.39	-0.10 - 0.87
Unemployed/retired/not working	-0.07	-0.28 - 0.14	-0.01	-0.19 - 0.17	-0.09	-0.29 - 0.12	0.00	-0.17 - 0.17
Annual household income								
<\$30,000								
\$30,000-\$49,000	0.10	-0.13 - 0.33	0.13	-0.10 - 0.36	0.12	-0.10 - 0.35	0.15	-0.07 - 0.37
\$50,000-\$79,000	0.10	-0.17 - 0.38	0.09	-0.16 - 0.34	0.14	-0.13 - 0.41	0.06	-0.18 - 0.30
>\$80,000	-0.05	-0.37 - 0.26	-0.02	-0.32 - 0.28	-0.06	-0.37 - 0.25	-0.05	-0.34 - 0.24
Age (years)	0.00	-0.01 - 0.02	0.00	-0.02 - 0.02	0.01	-0.01 - 0.02	0.00	-0.01 - 0.02

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

BMI (kg/m²)	-0.01	-0.03 - 0.01	-0.01	-0.02 - 0.01	-0.01	-0.03 - 0.01	-0.01	-0.02 - 0.01
Duration at current address (yrs)	0.00	-0.00 - 0.01	0.01	-0.00 - 0.01	0.00	-0.00 - 0.01	0.01*	0.00 - 0.02
# of people living in household	-0.05	-0.19 - 0.09	-0.02	-0.16 - 0.11				
					-0.05	-0.19 - 0.09	-0.00	-0.13 - 0.13

* = p<0.05; ** = p<0.01

For Peer Review

Table 3. Latent profiles and quality of life

VARIABLES	GIS-based latent profiles				Perceived latent profiles			
	Seattle/King County region		Baltimore/DC region		Seattle/King County region		Baltimore/DC region	
	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI
Latent profile membership								
L-L-L / LWTR								
LWRS	N/A		N/A		N/A		-0.10	-0.33 - 0.14
M-M-M / MWMR	0.01	-0.18 - 0.20	0.22*	0.01 - 0.42	0.24*	0.00 - 0.47	0.13	-0.10 - 0.36
H-H-H / HWRD	0.52	-0.05 - 1.09	0.24	-0.06 - 0.54	0.04	-0.18 - 0.25	0.45*	0.14 - 0.77
Gender								
Male								
Female	0.08	-0.09 - 0.24	-0.06	-0.25 - 0.13	0.05	-0.11 - 0.22	-0.03	-0.22 - 0.15
Race/ethnicity								
Non-Hispanic white								
Racial/ethnic minority	0.03	-0.20 - 0.25	0.07	-0.10 - 0.24	-0.04	-0.26 - 0.17	0.13	-0.04 - 0.30
Education Level								
High school or less								
Some college/vocational training	0.03	-0.18 - 0.25	0.04	-0.20 - 0.27	0.09	-0.13 - 0.30	0.05	-0.17 - 0.28
Completed college or university	0.04	-0.19 - 0.27	0.08	-0.18 - 0.34	0.10	-0.13 - 0.33	0.03	-0.23 - 0.28
Completed graduate degrees	-0.09	-0.35 - 0.17	0.08	-0.18 - 0.34	-0.10	-0.36 - 0.17	0.08	-0.17 - 0.33
Type of residence								
Single family house								
Apartment/condominium/ townhouse or other	0.04	-0.21 - 0.29	-0.11	-0.33 - 0.10	-0.01	-0.24 - 0.23	-0.22*	-0.44 - 0.00
Valid driver's license holder								
Yes								
No	0.32	-0.07 - 0.71	-0.18	-0.54 - 0.18	0.28	-0.09 - 0.66	-0.22	-0.58 - 0.13
Comfortable driving distance from home								
10 miles or less								
more than 10 miles	0.09	-0.16 - 0.35	0.38**	0.13 - 0.63	0.10	-0.15 - 0.36	0.35*	0.11 - 0.60
Marital status								
Married or living with a partner								
Widowed	-0.04	-0.28 - 0.21	0.12	-0.14 - 0.37	-0.07	-0.32 - 0.17	0.08	-0.16 - 0.33
Divorced/separated or single	-0.08	-0.34 - 0.19	-0.08	-0.34 - 0.19	-0.11	-0.37 - 0.16	-0.10	-0.36 - 0.16
Employment Status								
Employed								
Unemployed/retired/not working	-0.28**	-0.47 - -0.10	-0.13	-0.31 - 0.06	-0.33	-0.51 - -0.14	-0.14	-0.32 - 0.04
Annual household income								
<\$30,000								
\$30,000-\$49,000	0.06	-0.14 - 0.26	-0.25*	-0.48 - -0.02	0.05	-0.15 - 0.26	-0.26*	-0.49 - -0.03
\$50,000-\$79,000	0.26*	0.02 - 0.50	-0.01	-0.26 - 0.24	0.24	-0.00 - 0.48	-0.07	-0.31 - 0.17
>\$80,000	0.27	-0.01 - 0.55	-0.03	-0.33 - 0.27	0.19	-0.09 - 0.47	-0.09	-0.39 - 0.21
Age (years)	-0.01	-0.02 - 0.01	-0.01	-0.02 - 0.01	-0.00	-0.02 - 0.01	-0.01	-0.02 - 0.01

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

BMI (kg/m²)	-0.04**	-0.06 - -0.02	-0.02*	-0.04 - -0.00	-0.04	-0.05 - -0.02	-0.02*	-0.04 - 0.00
Duration at current address (yrs)	0.00	-0.00 - 0.01	-0.00	-0.01 - 0.01	0.00	-0.00 - 0.01	-0.00	-0.01 - 0.01
# of people living in household	0.05	-0.08 - 0.17	0.01	-0.12 - 0.15				
					0.05	-0.08 - 0.17	0.01	-0.12 - 0.14

* = p<0.05; ** = p<0.01

For Peer Review

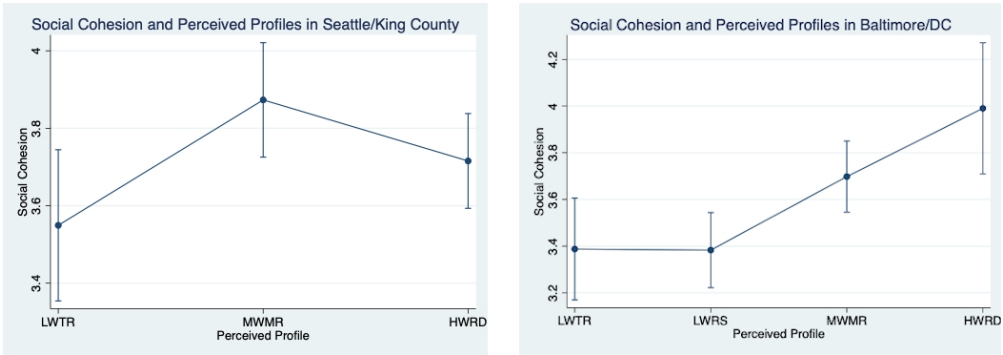


Fig. 1. Social cohesion and perceived BE profiles, Seattle/King County and Baltimore/DC

