Published in final edited form as:
Ann Epidemiol. 2014 March ; 24(3): 214–221. doi:10.1016/j.annepidem.2013.12.007.

PREDICTORS OF DISCORDANCE BETWEEN PERCEIVED AND OBJECTIVE NEIGHBORHOOD DATA

Erin J. Bailey, MS,
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Kristen C. Malecki, Ph.D.,
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Corinne D. Engelman, Ph.D.,
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Matthew C. Walsh, Ph.D.,
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Andrew J. Bersch, MS,
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Ana P. Martinez-Donate, Ph.D.,
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Paul E. Peppard, Ph.D., and
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

F. Javier Nieto, MD, Ph.D.
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726

Abstract

Purpose—Pathways by which the social and built environments affect health can be influenced by differences between perception and reality. This discordance is an important for understanding health impacts of the built environment. This study examines associations between perceived and objective measures of 12 non-residential destinations, as well as previously unexplored sociodemographic, lifestyle, neighborhood and urbanicity predictors of discordance.

Corresponding author: Kristen C. Malecki, Ph.D., Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, WI 53726 Phone :(608) 821-1253 Fax: (608) 821-1244 kmalecki@wisc.edu.

Methods—Perceived neighborhood data were collected from participants of the Survey of the Health of Wisconsin (SHOW), using a self-administered questionnaire. Objective data were collected using the Wisconsin Assessment of the Social and Built Environment, an audit-based instrument assessing built environment features around each participant's residence.

Results—Overall, there was relatively high agreement, ranging from 50% for proximity to parks to >90% for golf courses. Education, positive neighborhood perceptions, and rurality were negatively associated with discordance. Associations between discordance and depression, disease status, and lifestyle factors appeared to be modified by urbanicity level.

Conclusions—These data show perceived and objective neighborhood environment data are not interchangeable and the level of discordance is associated with or modified by individual and neighborhood factors, including level of urbanicity. These results suggest that consideration should be given to including both types of measures in future studies.

Keywords

Epidemiological methods; Environment Design; Obesity; Perception; Validity (Epidemiology); Rural Population; Urban Population

Introduction

There is growing evidence that the built environment has far-reaching impacts on many health-related behaviors and outcomes, including physical activity, obesity, mental health, and quality of life.[1–8] Despite this progress, methodological challenges regarding measurement and characterization of the built and social environment remain. Although many types of measures (surveys, geographic information systems (GIS)-based, and objective audits) have demonstrated associations between various aspects of the built environment and health outcomes,[1,3,9–12] the relative strengths and weaknesses of each type of measurement approach in terms of providing reliable and valid measurements, as well as relative importance in predictability of health impacts, remains unclear. How one perceives their environment compared to what is observable by others can have different impacts on health related behaviors and outcomes. Furthermore, the impact of the mismatch between the two is important in understanding the myriad of pathways by which neighborhoods can affect health.[13] Improved measurement is needed to disentangle the complex relationships between how one perceives and responds to their environment and other social influences relative to actual features, as well as how these relationships operate in varying geographic and social contexts.[13–16]

Several previous studies have found moderate to poor agreement between perceived and objectively collected data[17–22] with varying associations of health outcomes with objectively vs. subjectively measured predictors.[23] Gebel, et. al. provide evidence that discordance between measurement types is associated with weight gain,[18] suggesting that characterizing discordance is important for understanding the effect the built environment has on health. Furthermore, identifying perceived vs. objective determinants of concordance is important for designing effective interventions aimed at improving health. In some circumstances, increasing awareness, rather than (or in addition to) modifying the physical environment may prove more effective.[24] Conversely, it is possible that by modifying surroundings, behavior changes may follow, regardless of how people perceive their environment.

Previous studies of predictors of discordance between individual perceptions and objectively measured built environment features have been mixed. Older individuals, those with low income and education, less physically active, shorter duration of time in residence, and

cohabitation have been shown to be associated increased discordance.[8,17,21] However, these studies collected only basic demographic and other individual characteristics, and other more detailed information on psychosocial or geographic determinants have not been explored. This limits the ability to comprehensively assess potential behavioral, psychosocial and neighborhood level predictors of discordance. In addition, most previous studies have focused on high density urban areas (characterized by dense housing, grid-like street networks, and mixed-use zoning;[25]), and few have explored the role of the built environment in suburban or rural communities.[8,9,24] The built environment varies dramatically between urban, suburban, and rural settings, and this is a crucial but largely neglected aspect of built environment research.[3]

This paper presents analysis of associations between perceived and objective measures of the built environment within a representative sample of the statewide population of Wisconsin. Levels of agreement between perceived and objective built environment data, using presence/absence of non-residential destinations, reassessed. Additionally, we explore whether lifestyle, health status, neighborhood perception and neighborhood-level characteristics predict or modify the level of discordance between perceived and objective built environment assessments. The comprehensive datasets used in this study allow for greater exploration of the effects of individual and neighborhood level predictors on discordance, including specific behavioral and health predictors, as well as neighborhood satisfaction variables which have not been examined in previous studies. Furthermore, use of a statewide survey allows exploration of the effects of urbanicity on discordance between perceived and objective data.

Methods

Data

This study uses data from the Survey of the Health of Wisconsin (SHOW), an ongoing, annually representative, cross-sectional, statewide household-based interview and examination survey in Wisconsin that collects data on a wide array of health related topics. [26] During the summer of 2011 past SHOW participants' households were revisited, and the Wisconsin Assessment of the Social and Built Environment (WASABE) audit was conducted.

Study Sample

A total of 652 households were assessed using the WASABE audit tool during the summer of 2011, corresponding to 943 individual SHOW participants who are part of the 2010 annual sample. Participants who completed the entire SHOW study in 2010, and for whom WASABE data were collected, were included in present analysis (n=836).

Perceived Measures of Non-Residential Destination

In addition to a broad range of socio-demographic, psychosocial, and lifestyle factors, SHOW participants are asked approximately how far twenty non-residential destinations are from their residence (0–10 minutes, 11–20 minutes, etc.) in walking distance. Participants are also asked to rate their community as a place which is conducive to physical activity, safe from crime and traffic, well maintained, and interesting. Measures of perceived destinations are calculated as binary variables, in which a destination is considered present if a participant indicated the destination is within a ten minute walk and absent if distance was reported as missing or greater than a ten minute walk. Safety and aesthetics were measured by participant's level of agreement with the statement that the neighborhood is safe from crime or traffic or well maintained.

Objective Measures of Non-Residential Destinations

The WASABE instrument gathers objective neighborhood-level data around the household of each SHOW participant. The instrument includes validated measures of the social and built environment covering five domains (destinations/land use, connectivity, social environment, transportation environment, and neighborhood characteristics). A 400-meter buffer (or about a quarter mile, approximately equivalent to a 5–10 minute walk)[2,7,24]was drawn using Street Network Analyst in Arc Map 9.3 (ESRI, Redlands, CA). Trained raters systematically gathered data on the number and type of destinations for each segment within the specific buffer.

Predictors

Three broad categories of self-reported or exam based predictors of discordance of SHOW participants' perceptions with objective assessments were analyzed: sociodemographic/ lifestyle, health and mental health status, neighborhood perception, and urbanicity levels. Sociodemographic/lifestyle variables analyzed were age, race/ethnicity, gender, marital status, years of residence in household, number of people in household, and education. Health status variables included depression,[27] body mass index [BMI, weight (kg) divided by height (m) squared], chronic disease status, physical activity level,[28] and dog ownership (as a proxy for neighborhood walking).[29,30] Neighborhood variables included perceptions of the neighborhood for physical activity based on safety from crime or traffic, neighborhood well-maintained; and feelings regarding neighborhood as a place to be physically active.

A narrow definition of "urban," as a densely populated, urban center with a grid-like street network[25] adapted for use specifically with Wisconsin US census block groups[31] was used for this study. This definition, based on a population density approach, focuses on differentiating between urban, suburban, and rural by accounting not only for the population density of a specific block group, but also incorporating density measures from surrounding block groups. This measure was selected, in order to gain insight into generalizability of results vis-à-vis previously conducted studies in densely populated centers.[3] Finally, number of destinations was included as an indicator variable to adjust for density and normalize comparisons of discordance across different geographies.

Discordance

Discordance between perceived and objective data is the primary outcome for analysis in this study. For example, a participant who perceives that a grocery store is within a 10-minute walk, but no grocery store is recorded in the objective audit would be coded as discordant. Discordance is defined as presence of such a discrepancy for two or more destinations vs. no discrepancy or discrepancy on only one measure.

Statistical Analysis

All analyses were run using SAS 9.3 (SAS Institute, Cary, NC). The SURVEYFREQ and the SURVEYLOGISTIC procedures in SAS (including strata, units, and weights statements) were used in order to account for the cluster random selection sampling design of SHOW.

Percent Agreement

The twelve destination types for this analysis were selected based on comparability between the objective and perceived datasets, as well as relevance to potential impacts on physical activity and quality of life.[7,11,19,23,32,33] Presence/absence of each type of non-residential destination within the 400-meter buffer (WASABE) or 10-minute walk of the household (participant's perception) was compared. In most cases, wording between the

WASABE instrument and the SHOW neighborhood perceptions questionnaire was similar. However, in a few cases variables were aggregated to make wording more similar (Table 1).

Due to limited variability and relative rarity of the destination variables, percent agreement and positive percent agreement were used to evaluate concordance instead of Cohen's kappa.[34–36] Additionally, sensitivity and specificity of the perceived information, using the objective audit as the gold standard, were also estimated.

Regression Analyses

Univariate and multiple-logistic regression analyses were conducted to examine predictors of discordance. Potential individual, neighborhood, and geographic predictors were selected for inclusion in the analyses either because they have been previously found to be associated with health outcomes and/or with perceptions of the built environment. They were also identified based on theory as potentially important predictors not yet explored but having the potential to modify one's perception of the environment such as depression, anxiety or stress or behavior. Statistically significant predictors were included in subsequent regression models. Interaction terms were included in the fully adjusted model, and regression models stratified by urbanicity were also estimated to determine if effect modification was present. This was to assess whether associations between predictors and discordance also vary by urbanicity.

Results

Percent Agreement between Perceived and Objective Measures

Overall presence of destinations (based on objective audit) ranged from 1.3% of households reported as having a golf course to 24.4% for schools (Table 2).All but two of the 12 items analyzed had agreement >70%; four had agreement >80%. Discordance between objective and perceived presence of destinations was always the result of presence of a destination in the perception questionnaire which was not identified during the objective audit (Table 2).

Percent agreement was higher when including destinations that were not identified by either the audit or questionnaire. As was expected, the destinations with lowest prevalence (parks, golf courses, and pools) also had the lowest positive percent agreement (11%– 15%), and the most common destinations (religious centers, trails, and schools) had the highest positive percent agreement (ranging from 46% – 55%). Only pharmacies and pools had both sensitivity and specificity over 80% (Table 2).

Urban, Suburban and Rural Differences in % Agreement

Percent agreement, rather than positive percent agreement, was used for the stratified analysis to facilitate comparisons with previous studies.[17,37] Percent agreement was consistently higher for households located in rural areas for all destination types (Table 2). The discrepancy between rural compared to suburban and urban was particularly clear for parks (66% vs. 30% and 34%, respectively).

Prevalence and Predictors of Discordance

Discordance varied significantly by levels of several lifestyle, health, and neighborhood predictors (Table 3), including marital status, household size, education, and length of residence, depression, dog ownership, chronic disease status, and belief that one's neighborhood is conducive for physical activity, safe from traffic, and is well maintained.

Table 4 shows the results for the three logistic regression models examining odds of discordance according to significant predictors. Marital status, household size, and length of

residence were significantly associated with discordance in the unadjusted and partially adjusted models. However, significant attenuation of these three predictors occurred in the fully adjusted model. Low education was associated with lower odds of discordance in all three models, although the OR was not statistically significant in the fully adjusted model.

People who perceive their neighborhood to be unfriendly for physical activity, unsafe from traffic, and poorly maintained had lower odds of discordance compared to those who perceive their neighborhood positively in each of these categories (OR = 0.54 [0.17 – 1.16], 0.44 [0.21 – 0.93], and 0.54 [0.21 – 1.36], respectively). In the fully adjusted model suburban and urban compared to rural had 3 and 5 times higher odds, respectively, of being discordant. Similarly, the odds of discordance increased as number of destinations increased.

Effect Modification of Predictors of Discordance

Interactions terms in the fully adjusted model between urbanicity and marital status, length of residence, household size, depression, and chronic disease status were all significant at $p<0.0001$. Table 5 presents stratified ORs, rather than interaction terms, for ease of interpretation. The urban and suburban subgroups were collapsed into one category, because of lack of power resulting from small sample sizes in both the urban and suburban strata.

The significant attenuation of association between depression and discordance in the fully adjusted model was partially due to effect modification by urbanicity. People who live in rural areas and are depressed were more likely to have discordant perceptions (OR = 2.7 [1.2 – 5.9]) than non-depressed people in rural areas, whereas people who are depressed and live in suburban areas were less likely to discordant, although the latter association was not statistically significant (OR = 0.8 [0.3 – 2.8]). As shown in Table 5, urbanicity also appears to modify the “effect” of chronic disease status, length of residence, and household size.

Discussion

The characteristics of the built environment and how one perceives them as assets may facilitate or inhibit healthy living. Modifying the built environment is a utilitarian intervention with broad population reach; however, the effectiveness and behavior change associated with modifications to the built environment to some extent hinges on the residents’ perceptions, i.e., their awareness of opportunities and barriers for certain behaviors. Objective and perception data have been shown to have different associations in several studies.[23] Furthermore, discrepancies between perceived and measured built environment characteristics have been associated with health outcomes.[18] Thus, better understanding of the relationship between perceived and objective built environment data is important not only in future studies of the associations with health outcomes but also in developing successful evidence-based interventions that take into consideration both the objective and the subjective perceptions. Our study tries to address this gap by examining predictors of discrepancy in more depth and in more varied types of geographical environments than previous research.

Our results suggest that agreement between objective and perceived data is not uniform across urbanicity level, and can vary by features. Percent agreement was higher in this analysis for most measures than has previously been reported, potentially due to the fact that previously conducted studies were conducted primarily in urban areas, which had lower agreement in this analysis than other geographic regions.[8,9,38] Parks had a much lower percent agreement than any other destination in this study, particularly in urban and suburban areas, which is consistent with previously conducted studies,[19,37] and with the notion that the “risk” for discordance inherently increases with density of destinations within the buffer. However, in our analyses, several individual and contextual predictors remained

significantly associated with discordance after adjusting for number of destinations, suggesting discordance is associated with more than just the number of destinations. Previous studies also found that lower levels of physical activity and obesity were associated with a higher likelihood of discordance.[8,17] However, this analysis found no such association.

Length of residence and education were both significant predictors of discordance in the partially adjusted model; however, the associations of both were no longer significant in fully-adjusted models. As education is related to geographic mobility,[39] it may be less educated individuals live in their neighborhoods for longer, and that our study population is less geographically mobile than previously studied populations, and the fully-adjusted model may therefore be over-adjusted.

Stratified analyses show that associations between some individual predictors and discordance are different for participants living in urban/suburban vs. rural areas, suggesting that the relationship between objective vs. perceived measurement is different for urban compared to rural residents. Given that differences exist between objective and perceived data in urban compared to rural populations, associations between the measured built and social environment and health related outcomes may also be different for those living in rural communities. Furthermore, urbanicity remained significantly positively associated with discordance when included in the model with destinations, suggesting that urbanicity and number of destinations are independently associated with discordance, and that people living in rural areas have lower odds of being discordant than their urban counterparts, after adjusting for number of destinations. Our results suggest that much of the previous built environment literature that included either or both perceived and objective outcomes and has focused on urban areas,[3] might not be generalizable to rural populations and that future research should be aimed at specific characterizations of influence and perceptions of the built environment in rural settings.

Limitations

One limitation of this study is the slight discrepancy between the phrasing of questions/items in the objective audit and the perceptions instruments. These instruments were designed to be used together and the differences are minimal, and unlikely to be differential according to the predictors examined. Additionally, the 400-meter distance that defined the objective buffer and self-report perceptions of differences may vary than perceptions of distance of destination. Given individual variability in walking speed, it is unlikely that even those participants who were accurately assessing a 10-minute walk radius were assessing exactly 400 meters.

Furthermore, although the WASABE audit tool was tested for validity and reliability (and improved based on results of these tests) and data collectors were trained extensively, the objective data is prone to error because it only encompasses destinations seen from the street. Therefore, it is not be a perfect gold standard. Future research should incorporate GIS and other administrative level data, in order to better assess the validity of the objective audit tool for evaluating non-residential destinations in the built environment. Additionally, although WASABE was used as the gold standard, there may be studies in which perception data is a more health-relevant measurement tool.

Strengths

Despite these limitations, this study has several strengths. SHOW is a population based study that recruits from a representative sample of residents in an entire state across all socioeconomic and urbanicity strata, allowing for greater range of types of environment than

previous study samples, including areas of low-income underserved rural populations (including eleven American Indian tribes)[40] and some of the most segregated urban communities in the country with a high proportion of African American and Hispanics in Milwaukee and surrounding areas.[41,42] The external validity of our findings should thus compare favorably to that of most previous studies have that have targeted study populations selected from within specific, narrowly defined, neighborhoods in urban cities[2,12,43–46] or specific sub-populations, such as the elderly.[47,48] The individual level data collected through SHOW allows for analysis of predictors of discordance which have not been previously examined.

Conclusions

Similar to previous studies, analysis of the data presented demonstrates only moderate agreement between objective and perceived built environment measures. The results also demonstrate that urbanicity level is highly associated with discordance. That discordance is so much greater in urban compared to rural areas suggests that the built environment of rural areas may need to be studied in a different manner than urban communities. Furthermore, this study presents evidence that individual and neighborhood factors may predict discordance between measurement types. Given that discordance has been shown to be associated with health outcomes, furthering understanding of the source of this discordance is critical to accurately ascertaining the relationship between the built environment and health and to design more effective and comprehensive interventions.

Acknowledgments

The authors thank all the individuals who helped to manage and organize the WASABE data collection, including Dr. Maggie Grabow, Milena Bernardinello, Madeline Duffy, Jessica Warrens, Sarah Moen, Kelly Blackmore, and Navnit Sekhon, as well as all the members of the data collection team. We would also like to acknowledge and thank current and former SHOW office and field staff, including Kathy Roberg, Susan Wright, Lulu Zhang, Phoebe Frenette, Mary Farrell-Stieve, Jennifer Tratnyek, and Lynne Morgan who make this project possible. The SHOW survey and WASABE project were funded by Wisconsin Partnership Program PERC Award(PRJ56RV), National Institutes of Health's Clinical and Translational Science Award (5UL 1RR025011), and National Heart Lung and Blood Institute (1 RC2 HL101468)

List of Abbreviations used in the Text

BMI	Body Mass Index
CI	Confidence Interval
GIS	Geographic Information Systems
OR	Odds Ratio
SHOW	Survey of the Health of Wisconsin
WASABE	Wisconsin Assessment of the Social and Built Environment

References

1. Mõttus, R.; Gale, CR.; Starr, JM.; Deary, IJ. Social science & medicine (1982). Vol. 74. Elsevier Ltd; May. 2012 "On the street where you live": Neighbourhood deprivation and quality of life among community-dwelling older people in Edinburgh, Scotland; p. 1368-1374.
2. Boehmer TK, Hoehner CM, Despande AD, Brennan Ramirez LK, Brownson RC. Perceived and observed neighborhood indicators of obesity among urban adults. Int J Obes. Jan 16.2007 31:968–977.

3. Brownson RC, Hoehner CM, Day K, Forsyth A, Sallis JF. Measuring the built environment for physical activity: state of the science. American journal of preventive medicine. Apr; 2009 36(4 Suppl):S99–S123. e12. [PubMed: 19285216]
4. Kahn E, Ramsey L, Brownson R, Heath G, Howze E, Powell K, et al. The Effectiveness of Interventions to Increase Physical Activity A Systematic Review. American journal of preventive medicine. 2002; 22(4S)
5. Heath GW, Brownson RC, Kruger J, Miles R, Powell KE, Ramsey LT. The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity□: A Systematic Review. Journal of physical activity & health. 2006; 3(S1):S55–S76.
6. Duncan MJ, Spence JC, Mummery WK. Perceived environment and physical activity: a meta-analysis of selected environmental characteristics. The international journal of behavioral nutrition and physical activity. Sep 5.2005 2:11. [PubMed: 16138933]
7. Pikora TJ, Bull FCL, Jamrozik K, Knuiman M, Giles-Corti B, Donovan RJ. Developing a reliable audit instrument to measure the physical environment for physical activity. American journal of preventive medicine. Oct; 2002 23(3):187–194. [PubMed: 12350451]
8. Gebel K, Bauman A, Owen N. Correlates of non-concordance between perceived and objective measures of walkability. Annals of behavioral medicine: a publication of the Society of Behavioral Medicine. Apr; 2009 37(2):228–238. [PubMed: 19396503]
9. McGinn AP, Evenson KR, Herring AH, Huston SL, Rodriguez Da. Exploring associations between physical activity and perceived and objective measures of the built environment. Journal of urban health □: bulletin of the New York Academy of Medicine. Mar; 2007 84(2):162–184. [PubMed: 17273926]
10. Van Cauwenberg J, Van Holle V, Simons D, Deridder R, Clarys P, Goubert L, et al. Environmental factors influencing older adults' walking for transportation: a study using walk-along interviews. The international journal of behavioral nutrition and physical activity. International Journal of Behavioral Nutrition and Physical Activity. Jan.2012 9(1):85. [PubMed: 22780948]
11. Lee C, Moudon AV. Correlates of Walking for Transportation or Recreation Purposes. Journal of physical activity & health. 2006; 3(1):77–98.
12. Cohen DA, Inagami S, Finch B. The built environment and collective efficacy. Health Place. Jun; 2008 14(2):198–208. [PubMed: 17644395]
13. Giles-Corti B. People or places: what should be the target? Journal of science and medicine in sport / Sports Medicine Australia. Oct; 2006 9(5):357–366. [PubMed: 16931155]
14. Ball K. People, places…and other people? Integrating understanding of intrapersonal, social and environmental determinants of physical activity. Journal of science and medicine in sport / Sports Medicine Australia. Oct; 2006 9(5):367–370. [PubMed: 16857424]
15. Blacksher E, Lovasi GS. Place-focused physical activity research, human agency, and social justice in public health: taking agency seriously in studies of the built environment. Health & place. Elsevier. Mar; 2012 18(2):172–179.
16. Pacione M. Urban environmental quality and human wellbeing—a social geographical perspective. Landscape and Urban Planning. Sep; 2003 65(1–2):19–30.
17. Ball K, Jeffery RW, Crawford Da, Roberts RJ, Salmon J, Timperio AF. Mismatch between perceived and objective measures of physical activity environments. Preventive medicine. Sep; 2008 47(3):294–298. [PubMed: 18544463]
18. Gebel K, Bauman AE, Sugiyama T, Owen N. Mismatch between perceived and objectively assessed neighborhood walkability attributes: prospective relationships with walking and weight gain. Health & place. Mar; 2011 17(2):519–524. [PubMed: 21233002]
19. Lackey KJ, Kaczynski AT. Correspondence of perceived vs. objective proximity to parks and their relationship to park-based physical activity. The international journal of behavioral nutrition and physical activity. Jan.2009 6:53. [PubMed: 19671173]
20. Lin L, Moudon AV. Objective versus subjective measures of the built environment, which are most effective in capturing associations with walking? Health & place. Mar; 2010 16(2):339–348. [PubMed: 20004130]

21. Arvidsson D, Kawakami N, Ohlsson H, Sundquist K. Physical activity and concordance between objective and perceived walkability. Medicine and science in sports and exercise. Feb; 2012 44(2): 280–287. [PubMed: 21716148]
22. Leslie E, Sugiyama T, Ierodiaconou D, Kremer P. Perceived and objectively measured greenness of neighbourhoods: Are they measuring the same thing? Landscape and Urban Planning. Mar; 2010 95(1–2):28–33.
23. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking; Review and research agenda. American journal of preventive medicine. Jul; 2004 27(1): 67–76. [PubMed: 15212778]
24. Hoehner CM, Brennan Ramirez LK, Elliott MB, Handy SL, Brownson RC. Perceived and objective environmental measures and physical activity among urban adults. American journal of preventive medicine. Mar; 2005 28(2 Suppl 2):105–116. [PubMed: 15694518]
25. Miller, DR.; Hodges, K. Hodges-Miller-Population-Density_Urban-Rural-Dimension.pdf. A population density approach to incorporating an urban-rural dimension into small area lifestyle clusters. Miami: Florida; 1994.
26. Nieto, FJ.; Peppard, PE.; Engelman, CD.; McElroy, Ja; Galvao, LW.; Friedman, EM., et al. The Survey of the Health of Wisconsin (SHOW), a novel infrastructure for population health research: rationale and methods. Vol. 10. BMC public health: BioMed Central Ltd; Jan. 2010 p. 785
27. Kroenke K, Strine TW, Spitzer RL, Williams JBW, Berry JT, Mokdad AH. The PHQ-8 as a measure of current depression in the general population. Journal of affective disorders. Apr; 2009 114(1–3):163–173. [PubMed: 18752852]
28. Questionnaire IPA. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) – Short and Long Forms. 2005:1–15.
29. Coleman KJ, Rosenberg DE, Conway TL, Sallis JF, Saelens BE, Frank LD, et al. Physical activity, weight status, and neighborhood characteristics of dog walkers. Preventive medicine. Sep; 2008 47(3):309–312. [PubMed: 18572234]
30. Ham, Sa; Epping, J. Dog walking and physical activity in the United States. Preventing chronic disease. 2006 Apr.3(2):A47. [PubMed: 16539788]
31. Vargo, J.; Habeeb, D.; Stone, B. Journal of environmental management. Vol. 114. Elsevier Ltd; Jan 15. 2013 The importance of land cover change across urban-rural typologies for climate modeling; p. 243-252.
32. Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. Social science & medicine (1982). Jun; 2002 54(12):1793–1812. [PubMed: 12113436]
33. Wood L, Shannon T, Bulsara M, Pikora T, McCormack G, Giles-Corti B. The anatomy of the safe and social suburb: an exploratory study of the built environment, social capital and residents' perceptions of safety. Health & place. Mar; 2008 14(1):15–31. [PubMed: 17576088]
34. Cicchetti DV, Feinstein AR. High agreement but low kappa: II. Resolving the paradoxes. Journal of Clinical Epidemiology. 1990; 43(6):551–558. [PubMed: 2189948]
35. Thompson WD, Walter SD. A rEAPPRAISAL OF THE KAPPA COEFFICIENT. Journal of Clinical Epidemiology. 1988; 41(10):949–958. [PubMed: 3057117]
36. Szklo, M.; Nieto. Jones & Bartlett Publishers. Third. 2012. Epidemiology Beyond the Basics; p. 336-338.
37. Macintyre S, Macdonald L, Ellaway A. Lack of agreement between measured and self-reported distance from public green parks in Glasgow. Scotland. 2008; 8:1–8.
38. McCormack GR, Cerin E, Leslie E, Du Toit L, Owen N. Objective Versus Perceived Walking - Distances to Destinations Correspondence and Predictive Validity. Environment and Behavior. 2007; 40(3):401–425.
39. Börsch-Supan A. Education and its double-edged impact on mobility. Economics of Education Review. 1990; 9(1):39–53.
40. Ricketts TC. The changing nature of rural health care. Ann Rev Public Health. 2000; (21):639–657. [PubMed: 10884968]
41. Vila P, Swain G, Baumgardner D, Halsmer S, Remington P, Cisler R. Health disparities in Milwaukee by socioeconomic status. WMJ. 2007; 106(7):366–372. [PubMed: 18030822]

42. Chen, H.; Baumgardner, D.; Galvao, L.; Rice, J.; Swain, G.; Cisler, R. Milwaukee Health Report 2011: Health Disparities in Milwaukee by Socioeconomic Status. Milwaukee, WI: 2011.

43. Bourdeaudhuij, IDe; Teixeira, PJ.; Cardon, G.; Deforche, B. Environmental and psychosocial correlates of physical activity in Portuguese and Belgian adults. Public Health Nutrition. Jan 2; 2007 8(07):886–895. [PubMed: 16277805]

44. Cervero R, Duncan M. Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay Area. American journal of public health. Sep; 2003 93(9):1478–1483. [PubMed: 12948966]

45. Day K, Boarnet M, Alfonzo M, Forsyth A. The Irvine-Minnesota inventory to measure built environments: development. American journal of preventive medicine. Feb; 2006 30(2):144–152. [PubMed: 16459213]

46. Galea S, Ahern J, Rudenstine S, Wallace Z, Vlahov D. Urban built environment and depression: a multilevel analysis. Journal of epidemiology and community health. Oct; 2005 59(10):822–827. [PubMed: 16166352]

47. Berke EM, Gottlieb LM, Moudon AV, Larson EB. Protective association between neighborhood walkability and depression in older men. Journal of the American Geriatrics Society. 2007; 55:526–533. [PubMed: 17397430]

48. Cunningham GO, Michael YL, Farquhar Sa, Lapidus J. Developing a reliable Senior Walking Environmental Assessment Tool. American journal of preventive medicine. Oct; 2005 29(3):215–217. [PubMed: 16168871]

Table 1

Relationship between perceived and objective destination variables

Study Variable	Perception (SHOW)	Objective (WASABE)
Question Phrasing:	About how many minutes would it take to walk from your home to the nearest of these facilities?	How many of each type of non-residential building are present in the segment?
Parks	Parks, playgrounds, or playing field	Playground or splash pad; Sports/playing field, courts, or track; Park listed in comments
Trails	Trail for walking or biking	Off-road walking/biking trail or path
Recreation Center	Public recreation center	Non-religious community center
Fitness Center	Private fitness center; Indoor fitness center	Indoor fitness facilities
Fast Food	Fast food restaurant	Fast food restaurants
Restaurant	Other restaurants	Other restaurants
Grocery Store	Convenience or small grocery store; Supermarket	Specialty/Ethnic food store; Food supermarkets or grocery stores; Convenience stores or gas station stores
Place of Worship	Place of worship	Church, synagogue, mosque, other religious center
School	Elementary school; Other school	Educational facilities
Golf Course	Golf course	Golf course
Pharmacy	Pharmacy or drug store	Pharmacies, drug stores
Pool	Public indoor pool; Public outdoor pool	Pool (indoor or outdoor)

Table 2

Percent agreement and Sensitivity and Specificity of Perceived vs. Objective Presence of Neighborhood Destinations

Destination Type	Prevalence	% Agreement (95% CI)				Positive % Agreement (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
		Overall	Rural	Suburban	Urban			
Park	3.7%	50 (47–53)	66 (62–71)	30 (25–37)	34 (24–44)	11 (7–16)	87 (75–99)	49 (45–52)
Trail	19.5%	64 (61–67)	66 (52–61)	63 (58–69)	60 (49–70)	46 (42–51)	79 (73–85)	60 (55–66)
Recreation Center	9.2%	77 (74–80)	88 (85–91)	66 (61–71)	57 (47–67)	22 (17–28)	59 (48–70)	81 (79–84)
Fitness Center	8.4%	79 (76–82)	88 (85–91)	70 (64–75)	63 (53–73)	33 (27–40)	63 (52–74)	80 (77–83)
Fast Food	8.5%	83 (80–86)	91 (90.8–91.4)	74 (69–79)	66 (56–76)	37 (30–44)	59 (48–70)	85 (83–88)
Other Restaurant	14.8%	76 (73–79)	84 (80 – 87)	68 (63–73)	64 (54–74)	46 (40–52)	70 (62–78)	77 (74–80)
Grocery Store	12.2%	73 (70–76)	80 (76–84)	65 (60–70)	62 (52–72)	36 (31–42)	64 (54–73)	74 (71–77)
Religious Center	20.5%	74 (71–77)	82 (85–92)	63 (58–69)	68 (58–78)	50 (44–55)	60 (52–67)	76 (73–79)
School	24.4%	74 (70–77)	85 (82–89)	62 (56–67)	55 (44–65)	55 (50–60)	65 (59–72)	76 (73–80)
Golf Course	1.3%	91 (89–92)	95 (95.1–95.5)	87 (83–91)	82 (74–88)	14 (6–2)	55 (25–84)	91 (91.2–91.6)
Pharmacy	5.0%	85 (82–87)	91 (88–93)	81 (76–85)	66 (57–76)	38 (31–46)	95 (89–100)	84 (82–87)
Pool	1.8%	84 (81–86)	89 (86–92)	80 (76–85)	70 (60–79)	15 (9–21)	80 (60–100)	84 (81–86)

CI, confidence interval

Table 3

Descriptive Statistics of Potential Predictors of Discordance

	Predictor	Description	Categories	No.	2+ discordance (%)	Chi-square p-value
Socioeconomic/Lifestyle	**Age**	Self report at time of consent	21–30 years	142	80.3	<0.0001
			31–40 years	136	67.7	
			41–50 years	178	54.0	
			51–60 years	211	48.3	
			>61 years	171	55.6	
	Gender	Self-report	Male	375	59.4	0.92
			Female	463	59.7	
	Race/Ethnicity	Categorized self-reported race/ethnicity to 4 categories	Non-Hispanic White	752	57.9	0.016
			African American	36	80.6	
			Hispanic	24	66.7	
			Other	24	75.0	
	Married	Categorized as married or living with partner; never married; divorced/separated/ widowed	Married			<0.0001
			Never Married	569	52.6	
			Formerly Married			
	Household Size		1 Person	168	76.2	<0.0001
			2 people	301	51.5	
			3 people	123	60.2	
			4 people	135	63.7	
			5+ people	104	49.0	
	Education	Categorized highest level of school completed	High School or less	205	45.9	<0.0001
			Some College	352	62.2	
			College or Post	278	66.2	

	Predictor	Description	Categories	No.	2+ discordance (%)	Chi-square p-value
	Poverty	Midpoint of annual combined family income range above or below 200% of federal poverty guidelines	Below 200%			
			Above 200%	215	64.2	0.082
				584	57.4	
	Residence		Less than 1 year	151	76.2	
			1–2 years	75	66.7	
			2–5 years	131	60.3	<0.0001
			5–10 years	151	60.3	
			10+ years	328	49.7	
Health	**Self-Reported Health**	Response to “In general would you say your health is…” from on SF-12 questionnaire	Excellent/Very			
			Good	314	60.2	0.11
			Good	89	49.4	
			Fair/Poor			
	Depression	PHQ-8 diagnosis of anhedonia or depressed mood and at least 2 or 8 symptoms present “more than half the days”	Not Depressed			0.049
			Depressed	629	56.3	
	BMI	BMI <18.5, underweight; 18.5–24.9, normal weight; 25.0–29.9, overweight; >30.0, obese	Underweight	28	60.7	
			Normal	217	62.2	0.28
			Overweight	285	62.2	
			Obese	306	55.2	
	Physical Activity	Completion of 600 MET-minutes of physical activity per week from self-reported vigorous, moderate, and transportation activities	>600 MET-minutes	527	61.3	0.081
			<600 MET-minutes	282	55.0	
	Dog Ownership	Proxy for walking	Yes	337	54.6	0.017
			No	496	62.9	
	Chronic Disease	Defined as having any of the following: myocardial infarction, stroke, diabetes, asthma, or high blood pressure/hypertension	None	379	62.3	
			1	248	62.5	0.017
			2+	209	51.2	
Neighborhood/Geography	**Neighborhood Active**	“How would you rate your community as a place to be physically active?”	Not Safe	52	42.3	0.0004

Predictor	Description	Categories	No.	2+ discordance (%)	Chi-square p-value
		Somewhat	329	55.0	
		Very Pleasant	450	65.3	
Safe from Crime	"How safe from crime is your community for walking or riding a bike?"	Not Safe	15	53.3	
		Somewhat	221	63.4	0.39
		Very Safe	599	58.4	
Safe from Traffic	"How safe from traffic is your community for walking or riding a bike?"	Not Safe	77	53.3	
		Somewhat	398	55.8	0.014
		Very Safe	360	65.3	
Well Maintained	"My community is well maintained"	Disagree	84	59.5	
		Agree	525	54.5	<.0001
		Strongly Agree	221	72.4	
Urbanicity	Based on HH CBG – rural (rural, town, second city), suburban, urban	Rural	451	40.1	
		Suburban	296	79.1	<.0001
		Urban	89	93.3	
Destinations[1]	Defined using objective audit	0	328	31.4	
		1	125	51.2	<.0001
		2	91	69.2	
		3	292	91.8	

[1]Fisher test used to test significance due to fewer than 5 observations in one cell SF, short form; PHQ, patient health questionnaire; BMI, body mass index; MET, metabolic equivalent; HH, household; CBG, Census block group

Table 4

Predictors of Two or More Discordant Pairs

Predictor	Categories	Unadjusted		Adjusted[a]		Fully Adjusted[b]	
		OR	95% CI	OR	95% CI	OR	95% CI
Married	Married	1		1		1	
	Never Married	4.3	2.2 – 8.1	2.9	1.5 – 5.7	1.1	0.3 – 3.6
	Formerly Married	2.2	1.4 – 3.6	2.6	1.5 – 4.2	1.4	0.7 – 2.7
Household	5+ people	1		1		1	
Size	4 people	1.7	0.9 – 3.2	1.8	1.0 – 3.3	1.8	0.6 – 5.4
	3 people	1.5	0.7 – 3.2	1.9	0.8 – 4.9	1.6	0.6 – 4.6
	2 people	1.1	0.6 – 1.9	1.6	0.9 – 2.9	1.5	0.7 – 3.4
	1 Person	3.4	1.7– 6.7	4.0	2.9 – 7.6	1.4	0.5 – 3.9
Education	College or Post	1		1		1	
	Some College	0.9	0.6 – 1.4	0.8	0.5 – 1.2	0.8	0.4 – 1.5
	High School or less	0.5	0.3 – 0.8	0.4	0.2 – 0.7	0.5	0.2 – 1.1
Depression	Not Depressed	1		1		1	
	Depressed	2.2	1.09 – 4.21	1.9	1.0 – 3.4	1.6	0.4 – 5.6
Residence	10+ years	1		1		1	
	5–10 years	1.5	0.8 – 2.9	1.3	0.7 – 2.4	1.4	0.5 – 3.6
	2–5 years	1.6	0.9 – 2.7	1.2	0.7 – 2.1	0.9	0.5 – 1.6
	1–2 years	2.0	1.0 – 4.3	1.2	0.6 – 2.4	0.6	0.2 – 1.7
	Less than 1 year	3.6	1.9 – 7.1	2.2	1.0 – 4.5	1.0	0.4 – 2.2
Dog	Yes	1		1		1	
Ownership	No	1.2	1.0 – 2.4	1.5	1.0 – 2.3	0.9	0.5 – 1.5
Chronic	None	1		1		1	
Disease	1	1.0	0.7 – 1.4	1.2	0.8 – 1.7	1.0	0.6 – 1.6
	2+	0.6	0.4 – 0.8	0.9	0.6 – 1.3	0.7	0.4 – 1.2
Neighborhood active	Very Pleasant	1		1		1	

Predictor	Categories	Unadjusted		Adjusted[a]		Fully Adjusted[b]	
		OR	95% CI	OR	95% CI	OR	95% CI
	Somewhat	0.7	0.5 – 0.9	0.6	0.4 – 0.9	0.8	0.5 – 1.3
	Not at All/Not very	0.3	0.2 – 0.6	0.2	0.1 – 0.5	0.5	0.2 – 1.2
Neighborhood	Strongly Agree	1		1		1	
Safe from	Agree	0.6	0.5 – 0.9	0.6	0.4 – 0.8	0.5	0.3 – 0.8
Traffic	Disagree	0.6	0.4 – 0.9	0.5	0.3 – 0.8	0.4	0.2 – 0.9
Well	Strongly Agree	1		1		1	
Maintained	Agree	0.5	0.3 – 0.7	0.4	0.3 – 0.6	0.7	0.5 – 1.1
	Disagree	0.6	0.3 – 1.0	0.5	0.3 – 0.8	0.5	0.2 – 1.4
Urbanicity	Rural	1		1		1	
	Suburban	5.7	2.3 – 11.0	4.9	2.2 – 11.0	4.1	1.9 – 8.9
	Urban	17.0	3.7 – 82.0	16	4.6 – 56.0	3.3	1.1 – 10.0
Destinations	0	1		1		1	
	1	2.1	1.4 −3.2	2.1	1.3 – 3.2	1.9	1.1 – 3.2
	2	4.8	2.3 – 9.9	4.9	2.4 – 10.0	3.1	1.3 – 7.0
	3+	19.0	11.0 – 35.0	18.0	9.9 – 31.7	20.0	9.1 – 43.0

[a] Adjusted for age, gender, and race/ethnicity

[b] Adjusted for age, gender, race/ethnicity, and all other predictors included in table CI, confidence interval

Table 5

Predictors of Two or More Discordant Pairs

Predictor	Categories	Overall, Adjusted		Stratified, Adjusted			
				Rural		Urban/suburban	
		OR	95% CI	OR	95% CI	OR	95% CI
Married*	Married	1		1		1	
	Never Married	1.1	0.3 – 3.6	2.6	0.7 – 9.0	1.4	0.4 – 5.1
	Formerly Married	1.4	0.7 – 2.7	1.6	0.5 – 4.4	1.4	0.5 – 4.1
Household Size*	5+ people	1		1		1	
	4 people	1.8	0.6 – 5.4	2.7	0.5 – 6.4	0.7	0.2 – 2.7
	3 people	1.6	0.6 – 4.6	3.7	1.0 – 4.8	0.6	0.1 – 2.7
	2 people	1.5	0.7 – 3.4	2.2	1.4 – 9.9	0.8	0.2 – 2.9
	1 Person	1.4	0.5 – 3.9	1.8	1.0 – 7.3	0.9	0.2 – 3.7
Depression*	Not Depressed	1		1		1	
	Depressed	1.6	0.4 – 5.6	2.7	1.2 – 5.9	0.8	0.3 – 2.8
Residence*	10+ years	1		1		1	
	5–10 years	1.4	0.5 – 3.6	2.2	1.2 – 9.6	1.0	0.2 – 4.8
	2–5 years	0.9	0.5 – 1.6	1.4	0.5 – 5.3	0.8	0.4 – 1.9
	1–2 years	0.6	0.2 – 1.7	1.6	0.6 – 3.0	0.7	0.1 – 3.1
	Less than 1 year	1.0	0.4 – 2.2	3.4	0.9 – 5.4	0.8	0.2 – 2.9
Chronic Disease*	None	1		1		1	
	1	1.0	0.6 – 1.6	1.2	0.6 −2.1	0.6	0.2 – 1.6
	2+	0.7	0.4 – 1.2	1.1	0.6 – 2.2	0.4	0.2 – 0.9

* interaction term significant at p>0.05 in model adjusted for age, gender, race/ethnicity, and all other predictors included in table 4; CI, confidence interval