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Perceptions of greenspace and social determinants of health across the life course: The Life Course Sociodemographics and Neighborhood Questionnaire (LSNEQ)

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Abstract

We developed the Life Course Sociodemographics and Neighborhood Questionnaire (LSNEQ) to query older adults about perceived neighborhood greenspaces across the life course (i.e., distance to park, number of neighborhood parks/playgrounds, and neighborhood greenness) and about characteristics hypothesized to confound or moderate/mediate greenspace-health associations. Six perceived life course indices are derived from the LSNEQ: neighborhood socioeconomic status, neighborhood walking/biking, urbanicity, neighborhood amenities, neighborhood park access, and neighborhood greenness. Older adults from St. Louis, Missouri, and Sacramento, California, completed the LSNEQ in 2020–2021. The indices demonstrated borderline acceptable to good

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Conflicts of Interest

Dr. Besser, Dr. Meyer, Ms. Streitz, Dr. Farias, Dr. Olichney, Dr. Mitsova, and Dr. Galvin have no conflicts of interest to declare.

internal consistency (alpha=0.60–0.79) and good to excellent test-retest reliability (ICC=0.71–0.96) and detected different patterns of park access and neighborhood greenness by racialized group and location. Individuals with index scores indicating more neighborhood walking/biking and greater presence of neighborhood amenities over their life course were more likely to report neighborhood-based walking in older age. Overall, the LSNEQ is a reliable instrument to assess perceptions of life course social determinants of health including neighborhood greenspaces.

Keywords

neighborhood; green space; park; social determinants of health; questionnaire; built environment

Introduction

Neighborhood greenspaces including parks, gardens, and other areas with natural vegetation such as tree-lined streets are integral elements of the socio-exposome, which is the accumulation of environmental exposures and their social determinants from the peri-conceptual period and throughout an individual's life course.[1] Greenspaces have been associated with multiple health outcomes among children through older adults[2–5], including lower odds of low birth weight and small for gestational age[6], better mental health[7], longer and higher quality sleep[8], lower cardiovascular and cerebrovascular disease risk, greater physical activity[9,10], higher cognitive functioning[11,12], and lower risk for Alzheimer's disease and related dementias.[11] They provide opportunities for physical activity, social engagement, stress relief and relaxation, exposure to natural environments with less air pollutants, and exposure to natural chemicals from trees that are postulated to benefit the immune system (e.g., phytoncides). It is through these mechanisms that greenspaces are hypothesized to relate to human health.[11]

Researchers from health, social science, and environmental disciplines typically use objective measures of neighborhood greenspaces derived from satellite-based imagery or maps/street views. For instance, in a review of the literature on greenspaces and Alzheimer's disease-related outcomes, 21 of the 22 studies used objective (versus perceived) greenspace measures such as the validated normalized difference vegetation index (NDVI).[11,13] The NDVI, which is calculated from satellite imagery, describes the greenness or amount of healthy vegetation in an area based on light reflectance from plants, with more positive, higher scores indicating greener environments (range: −1 to +1).[14] Tree canopy cover measures (i.e., amount of ground coverage from leaves, stems, needles, and branches of trees) are similarly derived from satellite imagery.[15] Public park space data ascertained from maps or public/licensed data sources can be used to calculate measures such as the number of neighborhood parks or the percentage of the neighborhood composed of park space.[12,16] Walking audit tools such as the Senior Walking Environment Audit Tool or Wisconsin Assessment of the Social and Built Environment have also been used to capture neighborhood environmental features including presence of parks/playgrounds and shade trees, and often employ two raters to increase reliability of the measures.[17–19] Increasingly, studies are developing detailed measures of greenspace from virtual street views (e.g., Google), such as amounts of grass, trees, and low-lying vegetation at the

perspective of people on the ground. Virtual street view techniques have been found to have low to high validity depending on the study (compared to manual review).[20,21] Other studies have derived various greenspace indices based on more than one factor (e.g., single measure combining data on Normalized Difference Vegetative Index, percent park space, and distance to nearest park).[22]

While objective measures may provide a more accurate quantitative representation of a greenspace compared to self-reported measures, they have some limitations. NDVI and tree canopy cover measures do not capture types of greenspaces (e.g., tree lined streets with sidewalks versus parks) that may be more likely to influence health, and values for these measures will vary over the year and differ across regions, which is often not accounted for in analyses. Geospatial/map data on parks are often not readily available longitudinally, which limits research particularly for regions that experience frequent development resulting in new parks or removal of greenspace. Walking audits are time and resource intensive, are not typically conducted longitudinally, and while they are based on visual assessment are still subject to observer bias. Virtual street view greenspace measures have the benefit of providing rich data on types of greenspaces at the individual's perspective, but like other measures have the limitations of not being systematically assessed longitudinally or by season due to lack of data. Lastly, while composite greenspace indices provide a single measure to describe neighborhoods, which can simplify analyses and help account for high correlation among multiple greenspace measures, they reduce the specificity and translatability of findings to future interventions. In addition to the limitations noted above, objective data on greenspace such as satellite imagery are not readily available prior to the 1980s, and other greenspace data on parks and from street views are available for even fewer years. Thus, while tracing residential history can assist in developing longitudinal greenspace measures for decades prior, it currently cannot be used to assess greenspace exposure in childhood and early adulthood for existing cohorts of older adults.

Perceived measures of greenspace availability, quality, and use provide new perspectives compared to objective measures and also have been associated with health outcomes including but not limited to physical activity, hypertension, and diabetes.[23–25] Unlike objective measures, self-reported measures can detail the varied uses of neighborhood greenspaces (e.g., time of day used, time spent in, greenspace types used, activities in greenspaces), quality and preferences for those spaces (e.g., preferred greenspace types and activities/programming, safety and aesthetics), and perceived access to nearby greenspaces. In some studies, perceived but not objective measures of greenspace have been associated with physical activity, suggesting that greenspace perceptions are just as important to positive health behaviors and outcomes.[24,25] Altogether, while perceptions of greenspace may vary between individuals depending on factors such as culture, preference, and neighborhood context, it has been suggested that they may ultimately capture greenspace in ways more closely aligned with greenspace quality than objective measures.[23,26,27]

The type and number of perceived greenspace items measured have varied depending on the research study, and no standardized measures or questionnaires are broadly in use.[28] While many studies are based on a few select questions such as the perceived presence of street trees or the amount of greenspace in the neighborhood[29–31], more extensive surveys

have been conducted. For instance, the 2017 Greenspace Use and Attitudes Survey asked 13 questions including distance to the nearest greenspace, frequency of visiting greenspaces, and expectations and perceptions of the greenspaces for residents in Scotland.[32] Four greenspace questions from the widely disseminated Neighborhood Environment Walkability Scale (NEWS) have been shown to have moderate to strong test-retest reliability (correlation coefficients: walking proximity to park=0.67; trees along the streets=0.63; tree cover or canopy along sidewalks=0.52; and attractive natural sights in neighborhood=0.59.[33] However, comparisons between perceptions of the presence of neighborhood parks and tree lined streets measured in NEWS and objective measures calculated using GIS have suggested weak correlations ($r=-0.23$ and $r=0.06$, respectively).[34] Overall, the evidence for the reliability and validity of self-reported greenspace measures and instruments remains limited and there is a lack of assessments of perceived greenspace beyond the present neighborhood environment.

Research has primarily assessed greenspaces for an individual's current residential neighborhood. Given the paucity of standardized greenspace questionnaires more generally[28], it is unsurprising that studies have yet to focus on perceived greenspace measures from a life course perspective.[35] A systematic review of 59 studies that examined longitudinal exposure to greenspace and healthy aging outcomes found that all long-term exposure measures were objective and not self-reported/perceived.[36] As noted above, objective measures are limited in that historic maps and satellite imagery have limited availability (e.g., USGS satellite imagery was captured annually starting in the 1980s) and thus cannot be linked to the early to midlife residential addresses for many older adults. The exposure to greenspaces over the life course including those earlier periods may have a cumulative and more potent association with health outcomes compared to a single point in time or in later life. In addition, greenspace exposures during particular life stages may be more strongly associated with human health. Thus, experts on the research intersections between health and place have called for a life course approach to studying greenspace and health associations.[37] To date, there are no known standalone instruments designed for older adults to self-report perceptions on their neighborhood greenspaces from various time points extending back to childhood.

This study fills this gap by providing such a questionnaire that can be used and adapted to survey older adults regarding their perceptions of greenspaces and other key individual and neighborhood-level characteristics across the life course. The Life Course Sociodemographics and Neighborhood Questionnaire (LSNEQ) was designed as part of a National Institute of Aging K01-funded study (AG063895) to allow examination of associations between perceived neighborhood greenness and park access in early-, mid-, and late-life and brain health measures (i.e., cognition and magnetic resonance imaging). Lack of objective data with which to assess neighborhood greenspaces during earlier periods when studying older adults provided the impetus to design the LSNEQ. In addition, the questionnaire provides a resource for researchers that do not possess time/personnel and expertise in mapping software/geographic information systems (GIS) with which to derive objective measures of the neighborhood environment including greenspace. In this paper, we aimed to: 1) describe the LSNEQ development, items, and index measures, 2) assess the internal consistency and test-retest reliability of the LSNEQ indices, 3) examine differences

in LSNEQ index scores depending on participant characteristics (i.e., age, sex, racialized group, education, and location), and 4) investigate whether LSNEQ indices are associated with self-reported neighborhood walking among older adults.

Methods

Life Course Sociodemographics and Neighborhood Questionnaire (LSNEQ).

Greenspace content was determined based on a PubMed literature review of studies on greenspace and cognitive and physical health in older adults (e.g.,[38–42]) to determine the commonly used measures of greenspace/greenness which could be readily self-reported in the LSNEQ for various life stages. The final set of self-reported greenspace measures (reported further below) were chosen because they could be easily compared to objective, GIS-derived measures for a future validation study. We chose not to use/adapt existing questions from instruments such as NEWS because the specificity of questions in existing instruments may be more likely to be misreported for the childhood and midlife period (e.g., level of agreement that “trees give shade to the sidewalks in the neighborhood” (NEWS[34]), “There [are] a variety of plants, planted in different ways” (OpenX[43])). Previous studies have shown that adolescents reporting on their local parks are more accurate regarding the presence/absence of major features (playground equipment or basketball court) versus the detailed amenities provided in the parks (e.g., paths or trails).[44] This implies that questions to older adults on childhood and midlife neighborhood environments should be simplified and tailored to capture broad categories of features that were more likely to leave lasting impressions and are easier to qualify (e.g., parks and overall level of greenness/urbanicity).

Other questions capture individual- and neighborhood-level characteristics across the life course hypothesized to confound or modify/mediate associations between neighborhood greenspace and brain health based on prior literature and that are often unavailable from aging-focused cohort studies (e.g., parents’ education levels, neighborhood socioeconomic status, libraries and grocery stores within walking distance).[41,45–49] For instance, any observed associations between greenspace and brain health outcomes may vary level of neighborhood crime (e.g., positive associations in low crime and inverse associations in high crime areas) or may be mediated by feeling lonely in one’s neighborhood (variables collected in the LSNEQ).

Coauthors reviewed, ensured the clarity of, and verified the content and face validity of the penultimate draft of the LSNEQ. The questionnaire was field tested by 5 volunteers (40% female; 40% Asian, 60% White) to determine time to complete (range of 6–10 minutes) and questions needing improvement for clarity, which resulted in minor wording changes. The LSNEQ consists of 52 items total.

Life course periods assessed.

Age 11 was chosen to represent the childhood period in which individuals gain increased independence in exploring their neighborhood environments.[50] Age 40 represents the early midlife period, which is important to assess given the increased incidence of comorbidities such as hypertension and diabetes and the initial development of Alzheimer’s disease

pathology during midlife.[51] The “ten years ago” period was designed with the associated NIA-funded study in mind and was chosen to capture the earlier period of older adulthood in which individuals are generally more active in their neighborhood environments.[52] The study participants are enrolled during late middle age to older age and thus all cannot answer a question about when they were a specific age in later life, if they have not reached that age yet. Thus, the intention was to develop a question that could be answered by all participants that could be later revised to reflect a more specific late-life age for other cohorts/studies.

Neighborhood-level greenspace items.

In the questionnaire, neighborhoods are defined as the area within a 20-minute walk or about a mile from the residence.[53] Twenty minutes was chosen to accommodate slower gait speeds of older adults (i.e. less distance covered) who will be answering the questionnaire, as well as to be consistent with the increasingly promoted concept of the 20-minute neighborhood to increase walkability of urban areas. Respondents are asked about the greenness of the neighborhood in the summer (minimal, moderate, or mostly green), how many minutes it took to walk to the nearest public park, and the number of neighborhood parks and playgrounds (respective domains: greenness, park access, and recreational facility density). These questions are asked for the three life course periods of interest (age 11, age 40, and ten years ago).

Neighborhood built and social environment items.

Respondents are asked how long they lived at their address, which provides an estimate of years exposed to their current neighborhood environments. Urbanicity (urban, suburban, or rural), sufficient neighborhood sidewalk coverage (yes/no), presence of a library within a 20-minute walk (yes/no), number of neighborhood supermarkets and grocery stores within a 20-minute walk, and the financial wellbeing of neighbors (comfortable, just enough to make ends meet, or not enough to make ends meet) are asked for age 11, age 40, and ten years ago. In addition, nine questions were adapted from the Health & Retirement Study on current neighborhood environments covering the domains of physical disorder (e.g., vandalism and graffiti) and social cohesion (e.g., feel part of neighborhood) (items ranked from 1=strongly disagree to 10=strongly agree). Two questions on neighborhood crime and traffic for the current neighborhood were adapted from the Neighborhood Environment Walkability Scale (NEWS)[30,54] (ranked from 1=strongly disagree to 10=strongly agree). The HRS and NEWS questions were previously found to be reliable and valid and thus were not included in detailed analyses in this paper, which focuses on the life course LSNEQ items.[33,55,56]

Items capturing respondent’s SES.

The respondent’s childhood SES is assessed from questions on mother’s and father’s education (6 categories from never attended through college) and the financial wellbeing of family during childhood (comfortable, just enough, or not enough to make ends meet). The respondent’s current SES and living situation are assessed from questions on household car ownership (yes/no), residential building type (single family home, 1–3 story multi-unit, 4+ story multi-unit), and main lifetime occupation (write-in answer) (not reported in this study). These questions were added to fill in important dimensions of life course SES that

were not readily available for the associated cohorts for which the LSNEQ was initially designed to assess.

Items capturing respondent's health and behaviors.

Respondents report their perceived physical health (1=poor to 5=excellent), current days/week using public transportation, current minutes/week walking in the neighborhood, current minutes/week bicycling in the neighborhood, days/week visiting places in the neighborhood, and frequency of either walking or bicycling in the neighborhood during the three life course periods (never/rarely, 1–2 times/week, 3+ times/week). Lastly, respondents are asked to rate from 1=strongly disagree to 10=strongly agree whether they feel physical pain from stress.

Life course indices.

Six indices were constructed to capture accumulated exposure to neighborhood environments, neighborhood-based behaviors over the life course, and life course SES. The Life Course SES Index is calculated by summing categorical values for the father's highest level of education, mother's highest level of education, family's financial wellbeing at age 11, and neighbors' financial wellbeing for the three life course periods (possible range=1–24; higher score=higher SES). The Life Course Neighborhood Walking and Biking Index was calculating by summing categorical values for the frequency of walking or bicycling in the neighborhood at the three life course periods (possible range=1–7; higher score=more frequent walking/bicycling). The Life Course Urbanicity Index was derived by summing categorical values on urbanicity at the three life course periods (possible range=1–7; higher score=higher population density). The Life Course Neighborhood Amenities Index was calculated by summing categorical values of presence of a library and sufficient sidewalk coverage in neighborhoods at the three life course periods (possible range=1–12; higher score=more neighborhood amenities). The Life Course Park Access Index was derived by summing the reported minutes to walk to nearest public park during the three life course periods (possible range=0–180; higher score=greater distance/less access to parks). Lastly, the Life Course Greenness Index was calculated by summing the categorical values of neighborhood greenness during the summer for the three life course periods (possible range=1–7; higher score=greener).

The sample

University of Miami's Institutional Review Board deemed the current study exempt. The LSNEQ was completed by participants from Washington University at St. Louis's Knight Alzheimer's Disease Research Center (ADRC) and University of California Davis's ADRC from October 2020 to July 2021. Each ADRC enrolls participants based on their specific research aims and recruitment practices. The Knight ADRC recruits participants 45 years and older for research studies of memory and aging. Data collection for a pilot study that included the LSNEQ was approved by Washington University at St. Louis's Institutional Review Board (IRB) as part of the larger Lifecourses Influencing Aging and Dementia (LIAD) study.[57] As part of the pilot, participants were required to have a global Clinical Dementia Rating (CDR®™) score of 0 or 0.5 indicating normal cognition or very mildly impaired at their most recent visit.[58] Recruitment via the telephone occurred between

September 9, 2020, and November 30, 2020, and individuals who agreed to participate completed the LSNEQ and other LIAD questionnaires online (using Research Electronic Data Capture (REDCap)). Participants were asked to complete two sets of questionnaires approximately two weeks apart to assess test-retest reliability of the LIAD questionnaires. Data were exported from REDCap and provided to the University of Miami study team for analyses. The mean time to complete the questionnaire during the Knight ADRC pilot testing was 7 minutes.

Data collection for UC Davis ADRC participants was approved by the Florida Atlantic University (FAU) IRB under a reliance agreement (FAU was original institution for K01 award). UCD ADRC recruits participants for longitudinal studies of cognitive aging. Approximately two thirds of the cohort was recruited through community methods to represent the range and distribution of cognitive function in the diverse Northern California community. The other third was initially seen for clinical evaluation at the ADRC, or by affiliated UC Davis physicians and then referred to the ADRC for research. UC Davis ADRC research coordinators mailed the LSNEQ directly to their eligible participants and participants mailed the completed questionnaire directly to this study's research team. LSNEQ data were then entered into REDCap for data management and exportation of the data file for analysis.

Analyses.

The age at survey, sex, racialized/ethnic group, education in years, global CDR® score, and the individual LSNEQ items were described for the total sample and stratified by location using descriptive statistics (mean and standard deviation or frequency and percentage). To illustrate possible disparities in mean distance to nearest public park and neighborhood greenness at age 11, age 40, and ten years ago, we constructed figures for these measures by racialized group and location.

The LSNEQ indices were described using means, SDs, and ranges. Cronbach's alpha was calculated to test internal consistency of the indices and the following cutpoints were employed: borderline acceptable: 0.60–0.69 and good: ≥0.70.[59,60] Intraclass Correlation Coefficients (ICC) for absolute agreement (two-way random) were calculated to assess test-retest reliability of the indices, using the following cutpoints: good: 0.60 to 0.74 and excellent: ≥0.75.[61] Since the LSNEQ was collected at a single time point by UCD, test-retest analyses were restricted to Knight ADRC participants. In addition, due to unforeseen formatting issues during the electronic administration of the LSNEQ by the Knight ADRC, the questions on number of parks/playgrounds and on number of grocery stores at the three life course periods were excluded from internal consistency and test-retest analyses. Lastly, we tested whether the LSNEQ index scores differed by participant age (<70 or ≥70 years), sex, racialized group (Black or White), education (<college degree or college degree or higher), and location (Saint Louis or Sacramento).

Results

Sample demographics.

The sample consisted of 169 participants from the Knight ADRC (St. Louis, Missouri) (n=104) and the UCD ADRC (Sacramento, California) (n=65) (Table 1). On average the sample was 70 years old (standard deviation (SD)=8.3 years), 60% were female, and 67% were White, 22% Black, 8% Hispanic, and 4% other racialized/ethnic group. While the majority (68%) of the Black participants were from St. Louis (versus Sacramento), all Hispanic participants were from Sacramento. Participants possessed high levels of education (mean=16 years, SD=2.6) and 88% had a global CDR® score=0 indicating no cognitive impairment, with the remaining 12% having very mild/questionable impairment (CDR®=0.5).

Descriptive statistics for LSNEQ items—Descriptive statistics for the LSNEQ items do not include tests of statistical significance because this paper does not aim to test whether there are differences by location but describe the items and how the LSNEQ captured regional variation. Supplemental Table 1 provides the individual and neighborhood-level SES items. Most participants (96%) lived in households that owned a car and 74% were unemployed or retired, but employment status varied by location (St. Louis=63%, Sacramento=91%). A small proportion (7%) reported that their families did not have enough to make ends meet at age 11. Participants from St. Louis more often had college educated parents (e.g., father's with at least some college education for St. Louis=50.5%, Sacramento=29.5%). Fifty-eight percent reported that the financial wellbeing of neighbors was comfortable at age 11 (versus not enough=5%, or just enough=37%), whereas the percentage reporting neighbors' financial wellbeing as comfortable rose to 86% and 89% at age 40 and from ten years ago, respectively.

Supplemental Table 2 provides the health and behavior items. Saint Louis participants reported taking the bus, train, or other public transportation 1.1 days per week (SD=0.7) compared to 0.1 days (SD=0.6) for Sacramento participants. On average, in the past week, participants visited a place in their neighborhood on 3.6 days. Twenty-eight percent reported no neighborhood walking, 87% reported no neighborhood bicycling, and 7% reported no days in the past week visiting neighborhood places. Eighty-three percent reported walking/bicycling ≥3 times/week in the neighborhood at age 11, compared to 36% at age 40 and 41% from ten years ago.

The neighborhood environment items including greenspace are provided in Supplemental Table 3. Most participants lived in their current residence for a mean of 21.7 years (SD=15.7). Fifty to 60% of all participants reported living in the suburbs at age 11, age 40, and ten years ago. A smaller percentage of participants lived in rural areas (range=6–11% depending on age/time period assessed). Adequate sidewalk coverage in the neighborhood was reported by 65% for age 11, 78% for age 40, and 77% for ten years ago. Having a library within a 20-minute walk of home was reported by 43% for age 11, 53% for age 40, and 47% for ten years ago. Over 80% reported having at least one supermarket/grocery store within a 20-minute walk of home at age 11, age 40, and ten years ago (data only collected in Sacramento). On average, participants reported taking 19.4 minutes (SD=15.1)

to walk to the nearest park at age 11, 19.5 minutes (SD=15.0) at age 40, and 17.3 minutes (SD=13.5) ten years ago. The majority reported living in neighborhoods with a moderate amount of greenness (age 11=62%, age 40=66%, ten years ago=69%). Approximately 30% reported living in mostly green neighborhoods (32% at age 11 and age 40, 30% ten years ago). Lastly, having at least one park/playground within a 20-minute walk of home was reported by the majority (67% at age 11, 86% at age 40, and 89% for ten years ago; data only collected in Sacramento).

Figure 1 shows distance to nearest public park for the three life course periods by racialized group and location. For Black participants in both locations and for White participants in Sacramento, reported distance to the nearest public park declined from age 11 to ten years ago (decline not seen for White participants in Saint Louis). Additionally, the reported distance to nearest park at age 11 was higher for Black than White participants in Saint Louis (mean=25.0 versus 16.8 minutes), with similar distances observed by racialized group in Sacramento (mean=20.9 versus 21.9 minutes). Differences by racialized group were not observed for distance to nearest park at age 40 or ten years ago.

Figure 2 provides neighborhood greenness for the three life course periods by racialized group and location. Similar percentages of Black and White participants reported living in mostly green neighborhoods at age 11, regardless of location (range=29–33%). In contrast a greater percentage of White than Black participants reported living in mostly green neighborhoods at age 40 and ten years ago, regardless of location (e.g., mostly green neighborhoods ten years ago reported by Saint Louis sample, White=30%, Black=4%). Correspondingly, the percentage of Black participants reporting living in moderately green neighborhoods at age 40 and ten years ago (at both locations) was higher than for White participants (e.g., moderately green neighborhoods ten years ago reported by Sacramento sample, White=54%, Black=83%). Few Black or White participants (i.e., <5%) reported living in minimally green neighborhoods at any age. The exception was that 20% of Black participants from Saint Louis reported living in minimally green neighborhoods at age 11 (versus White=3%).

LSNEQ indices—Index score means, SDs, medians, ranges, and internal consistency statistics are provided in Table 2. The Life Course Neighborhood Amenities Index (alpha=0.60), the Life Course Park Index, and Life Course Urbanicity Indices had borderline acceptable internal consistency (alpha=0.69 for both), and the Life Course SES, Life Course Neighborhood Walking and Biking, and Life Course Greenness Indices had good internal consistency (alpha=0.73, 0.73, and 0.79). Table 3 provides the test-retest reliability for the indices, which was good for the Life Course Greenness Index (ICC=0.71) and excellent for the remaining indices (range of ICC=0.83–0.96). Given our focus on greenspace, individual item test-retest reliability was also calculated for park access during childhood (r=0.75), midlife (r=0.82) and older adulthood (r=0.73), and for neighborhood greenness during childhood (κ=0.57), midlife (κ=0.44), and later life (κ=0.65). As a sensitivity analysis, we calculated descriptive statistics (e.g., means and SDs) for the indices after excluding participants with mild cognitive impairment (CDR®=0.05), and differences from the full sample were negligible (Supplemental Table 4).

Supplemental Table 5 provides mean LSNEQ index scores and adjusted linear regression estimates for the difference in scores by participant age, sex, racialized group, education, and location. Life Course SES Index scores were higher for individuals with at least a college degree versus less than a college degree (adjusted estimate=1.56, 95% CI=0.59, 2.53), and were lower for individuals from Sacramento than Saint Louis (adjusted estimate=−1.28, 95% CI=−1.28, 95% CI=−2.32, −0.23). Life Course SES Index scores were lower for Black than White participants (adjusted estimate=−1.07, 95% CI=−1.72, −0.41) but Life Course Urbanicity Index scores were higher for Black than White participants (adjusted estimate=0.38, 95% CI=0.08, 0.68). Lastly, Life Course Greenness Index scores were significantly higher in Sacramento than in Saint Louis (adjusted estimate=0.47; 95% CI=0.03, 0.91). No other differences were observed in mean index scores by participant demographics or location.

Finally, the Life Course Neighborhood Walking and Biking (OR=2.61, 95% CI=1.72–3.96) and Life Course Amenities Indices (OR=1.62, 95% CI=1.03–2.53) were positively associated with current walking in the neighborhood in the past week (any versus none) among older adults. We tested whether specific life course periods (childhood, midlife, or older adulthood) could explain these associations (Supplemental Table 6). We found that neighborhood walking/biking frequency measures for all three life course periods were associated with any neighborhood walking (i.e., individuals reporting often walking/biking in childhood, middle adulthood, and older adulthood were more likely to report current neighborhood walking). In addition, sufficient neighborhood sidewalk coverage reported in middle and older adulthood were associated with current neighborhood walking.

Discussion

The LSNEQ indices were found to have borderline acceptable to good internal consistency (alpha range=0.60–0.79) and good to excellent test-retest reliability (ICC range=0.71–0.96). Participants reported every response option for most of the categorical questions suggesting that the questionnaire would be successful in achieving the full range of categorical distributions in other samples. Differences were found in life course SES by racialized group, participant education, and location; in life course neighborhood urbanicity by racialized group; and in life course neighborhood greenness by location. The Life Course Neighborhood Walking and Biking Index and Life Course Neighborhood Amenities Index were positively associated with the presence of current neighborhood walking (any during the past week), suggesting that neighborhood amenities and neighborhood-based health behaviors across the life course may be associated with obtaining physical activity in the neighborhood in later life. Lastly, the LSNEQ detected different patterns of park access and neighborhood greenness by racialized group and location.

While many of the LSNEQ indices demonstrated strong internal consistency and test-retest reliability, the Life Course Urbanicity, Life Course Neighborhood Amenities, and Life Course Park Access Indices had borderline acceptable internal consistency and the Life Course Greenness Index had good but not excellent test-retest reliability. The LSNEQ items have been grouped into indices aimed at capturing accumulated exposures that may differ across the three life course periods. Thus, while some indices indicated only acceptable

internal consistency, this might be expected given the expressed purpose of the indices. Nevertheless, future modifications to the LSNEQ can work to increase clarity of the questions and response options to determine if this improves internal consistency of the three indices and the test-retest reliability of the greenness index. In addition, the addition of the questions on number of parks/playgrounds and number of grocery stores/supermarkets in the neighborhood for the three life course periods (not included in this study due to data collection issues) may increase the internal consistency of the amenities index.

Other greenspace measures including but not limited to access to private gardens, greenspace qualities, time spent in parks, and barriers to greenspace use[62] may be just as important or more important for certain health outcomes, and thus should be considered for future LSNEQ updates. For instance, a study of perceived quality of greenspaces in Norway found associations between greater quality and more visits to the greenspace.[63] Many of these measures can be validated against objective GIS or GPS measures. In addition, the importance of certain greenspaces or their qualities may be location or culture specific (e.g., pocket parks).[64,65] Any adaptation to this instrument could incorporate questions most pertinent to the greenspaces in the locale of interest.

This study has some limitations. Recall bias is a concern for self-reported measures, particularly those collected retrospectively for many decades prior to data collection as in this study. However, some evidence suggests that self-reported measures of childhood neighborhood exposures such as neighborhood context[66] (e.g., social disorder such as litter and graffiti) are not significantly impacted by recall bias. Possibly, certain types of neighborhood characteristics can be more easily recalled, particularly those that have a greater impression on an individual or that are more easily described because of the way the question is worded (e.g., less complicated or specific). Despite this, some studies have demonstrated differential recall bias for related measures, such as one study that demonstrated differential recall of childhood SES by sex[67], which was found to upwardly bias associations with mental and general health in a cohort of primarily ≥45-year-olds. Additional work will be needed to assess potential recall bias using the LSNEQ such as by collecting residential histories from childhood and midlife to compare the LSNEQ items to objective measures derived from the address data.

The validity of the LSNEQ measures was not ascertained due to the lack of historical address data and “gold standard” measures from maps/satellite imagery for the three life course periods. However, multiple LSNEQ questions including those on neighborhood greenness, distance to nearest park, and number of neighborhood parks have the potential to be compared to similar objective measures derived from GIS. As mentioned further above, studies of perceived neighborhood environments have demonstrated significant associations with multiple health outcomes, and prior evidence also suggests accurate recall of poignant childhood neighborhood environments (e.g., social disorder[66] and presence/absence of parks[44]). This suggests that self-reported life course measures have the potential to be unbiased and can be important irrespective of evidence of convergent/construct validity by capturing different constructs than objective measures[27] (e.g., qualitative versus quantitative greenspace). Irrespective of validity, measures of neighborhood perceptions are useful for studies on how built and social environments influence perceptions and thus health

behaviors. Nevertheless, next steps will be to assess LSNEQ validity in a future study by comparing the perceived measures to objective measures for the “ten years ago”/older adulthood time period.

The questionnaire was designed as a short assessment (completed in <10 minutes) of neighborhood environments over multiple life course periods. Thus, it restricted to three key periods and elements thought to be more likely to be remembered and accurately describe back to childhood including parks and playgrounds and the relatively greenness of the neighborhood. However, the LSNEQ could be expanded in future iterations to include additional greenspace measures such as presence of forests and gardens as well as assess other important time periods such as younger adulthood (between 18 and 40 years).

Our analyses of associations between the LSNEQ indices and current neighborhood walking investigated whether measures capturing degree of exposure over the three time periods combined was associated with subsequent health behavior in later life. Although we detected associations between two LSNEQ indices and neighborhood walking, the sample size may have limited our power to detect associations with the other indices and did not allow for us to examine differences in associations by cognitive status (i.e., CDR® score). While we also examined whether childhood, midlife, or older adulthood measures were associated with neighborhood walking, which might suggest critical periods of exposure, future work could use a current or adapted version of the LSNEQ to assess other life course concepts such as persistence and important turning points.

Other limitations must be mentioned. Few participants reported that their families or neighbors did not make enough to make ends meet (e.g., 1.0% reported neighbors did not make enough to make ends meet when participant was age 40) and few reported residing in neighborhoods with minimal greenery at any age (e.g., 1.0% reported living in neighborhoods with minimal greenery ten years ago). The use of the LSNEQ in denser urban areas such as New York City or Chicago and inclusion of participants with lower SES may help capture individuals who would self-report these lowest levels of the neighborhood greenness and financial wellbeing. It is also possible that individuals will be less likely to report financial problems of their families or neighbors due to stigma, which is a natural consequence of self-reported measures such as these. To minimize the stigma and hesitance to answer these questions, we placed them in the middle of the questionnaire. However, we cannot eliminate the possibility that participants underreported families or neighbors who struggled to make ends meet. In addition, the distribution of answers to the LSNEQ in this sample may not be generalizable to the rest of the US or in international contexts. Future work using the LSNEQ in diverse populations will help demonstrate its utility and range of responses for other geographic locations, and individuals with lower SES, other racialized/ethnic groups, and younger ages.

Overall, the LSNEQ is a reliable instrument that is unique in assessing life course individual- and neighborhood-level social determinants of health including greenspace. It adds significantly to available questionnaires on neighborhood environments by querying about perceived exposures during childhood, middle age, and older age. The importance of earlier life neighborhood-level SDOH exposures to late-life health outcomes such as

cardiovascular and cerebrovascular disease and dementia has been understudied to date, in part due to the lack of data and questionnaires to study these relationships. Thus, the LSNEQ provides researchers with an instrument that can be used and adapted to initiate these important studies of life course SDOH exposures and healthy aging.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Description of Life Course Sociodemographics and Neighborhood Questionnaire (LSNEQ)
- LSNEQ queries older adults on life course social determinants of health
- Six indices derived on life course neighborhood exposures including greenspace
- Overall, LSNEQ found to have good internal consistency and test-retest reliability
- Questionnaire can be used and adapted to initiate studies of life course SDOH

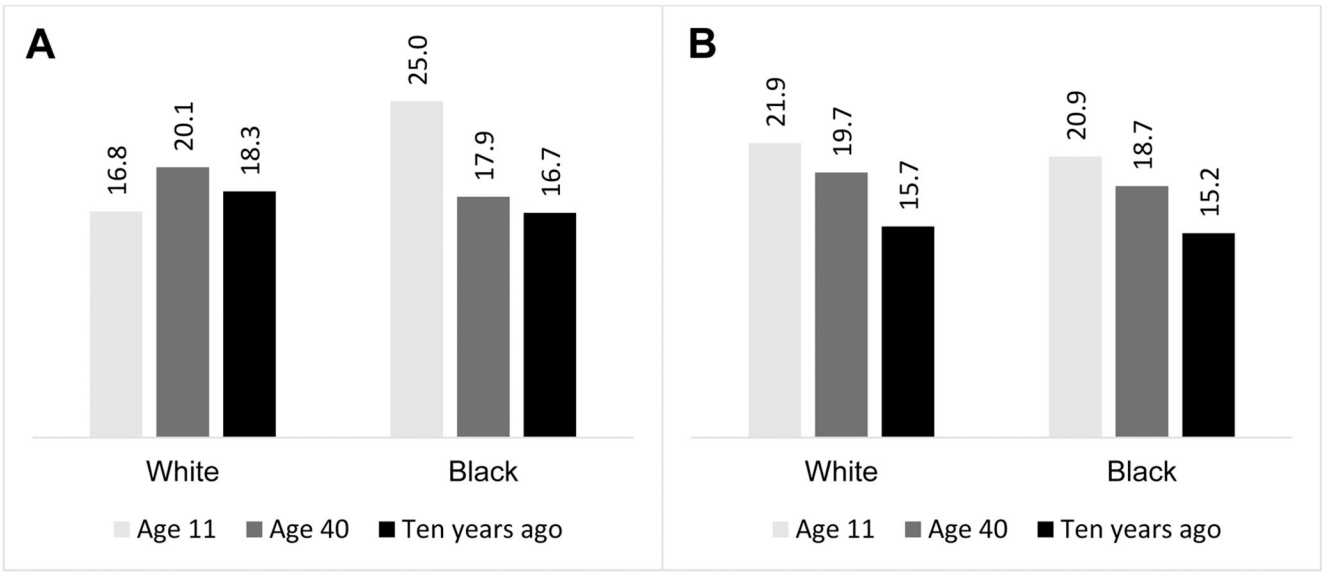

Figure 1.
Mean minutes to walk to nearest public park for three life course periods by racialized group and location (A=Saint Louis, B=Sacramento)

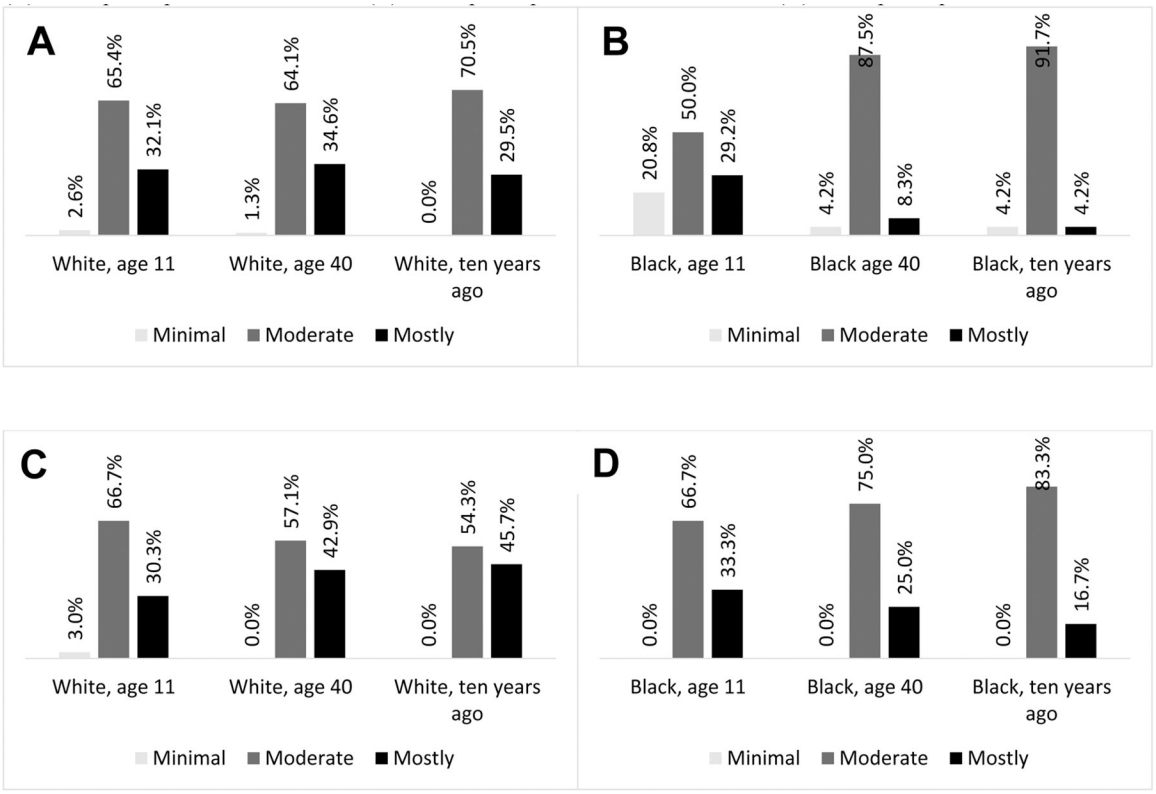

Figure 2.

Neighborhood greenness over the three life course periods for (A) White participants in Saint Louis, (B) Black participants in Saint Louis, (C) White participants in Sacramento, and (D) Black participants in Sacramento

Table 1.

Sample characteristics

Characteristic	St. Louis	Sacramento	Total
Sample size, n	104	65	169
Age (years), mean (SD)	68.4 (9.0)	72.4 (6.2)	69.9 (8.3)
Female, n (%)	57 (54.8%)	45 (69.2%)	102 (60.4%)
Racialized group/ethnicity, n (%)			
White	78 (75.0%)	35 (53.8%)	113 (66.9%)
Black/African American	25 (24.0%)	12 (18.5%)	37 (21.9%)
Hispanic	0 (0.0%)	13 (20.0%)	13 (7.7%)
Other	1 (1.0%)	5 (7.7%)	6 (3.6%)
Education (years), mean (SD)	16.5 (2.3)	15.3 (3.0)	16.1 (2.6)
Global CDR, n (%)	0.07 (0.17)	0.05 (0.15)	0.06 (0.16)
0.0 (no impairment)	90 (86.5%)	59 (90.8%)	149 (88.2%)
0.5 (questionable/very mild impairment)	14 (13.5%)	6 (9.2%)	20 (11.8%)

Abbreviation: SD, standard deviation; CDR, Clinical Dementia Rating

Table 2.

Description of the LSNEQ indices

Index	Component variables	n	Mean (SD)	Median	Possible range	Observed Range	Standardized Cronbach alpha[h]
Life Course SES Index[a]	Father's education, Mother's education, Family's financial wellbeing at age 11, Neighbors' financial wellbeing[g]	161	14.0 (3.4)	14.0	1, 24	5,19	0.73
Life Course Neighborhood Walking and Biking Index[b]	Frequency walking or biking in neighborhood[g]	165	5.0 (1.8)	5.0	1,7	1, 7	0.73
Life Course Urbanicity Index[c]	Neighborhood urbanicity[g]	165	4.8 (1.4)	5.0	1,7	1,7	0.69
Life Course Neighborhood Amenities Index[d]	Library within 20-minute walk from home[g], Neighborhood sidewalk coverage[g]	135	4.6 (1.7)	4.0	1, 7	1, 7	0.60
Life Course Park Access Index[e]	Minutes to walk to nearest public park[g]	121	55.9 (34.0)	50.0	0, 180	6, 180	0.69
Life Course Greenness Index[f]	Neighborhood greenness during summer[g]	164	4.9 (1.3)	4.0	1,7	1,7	0.79

[a] Higher score = greater individual and community-level SES throughout life course

[b] Higher score = more walking and biking throughout life course

[c] Higher score = greater urbanicity (i.e., greater population density) throughout life course

[d] Higher score = more neighborhood amenities throughout life course

[e] Higher score = farther to public parks throughout life course

[f] Higher score = greater neighborhood greenness throughout life course

[g] Each assessed at age 11, 40 and ten years ago

[h] Internal consistency: borderline acceptable: 0.60–0.69 and good: ≥0.70

Table 3.

Test-retest reliability of LSNEQ indices among participants who repeated questionnaire

Index[a]	n	Test-retest reliability[b]
Life Course SES Index	100	0.96
Life Course Neighborhood Walking and Biking Index	99	0.87
Life Course Urbanicity Index	102	0.92
Life Course Neighborhood Amenities Index	78	0.92
Life Course Park Access Index	79	0.83
Life Course Greenness Index	102	0.71

Abbreviation: SES, socioeconomic status

[a] Interpretation of scores provided in Table 2

[b] ICC for absolute agreement: good: 0.60 to 0.74 and excellent: ≥0.75

Table 4.

Association between LSNEQ indices and any neighborhood walking (versus none) in past week

LSNEQ Index (z-standardized)[a]	Adjusted OR (95% CI)	p-value
Life Course SES Index	1.19 (0.77–1.85)	0.43
Life Course Neighborhood Walking and Biking Index	**2.61 (1.72–3.96)**	**<.0001**
Life Course Urbanicity Index	1.45 (0.96–2.21)	0.08
Life Course Neighborhood Amenities Index	**1.62 (1.03–2.53)**	**0.04**
Life Course Park Access Index	1.16 (0.74–1.82)	0.51
Life Course Greenness Index	0.90 (0.62–1.32)	0.60

Each model controlled for age, gender, education, racialized group, and location

[a]Interpretation of scores provided in Table 2