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Assessing health-related resources in senior living residences

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Abstract

This study evaluated a new tool, “The Audit of Physical Activity Resources for Seniors” (APARS), which assesses the physical activity environment in Senior Living Residences (SLRs). Audits were conducted in 29 SLRs and inter-rater reliability was assessed. Pearson correlations were examined between APARS items and objectively measured physical activity and sedentary time, and self-rated health, collected from residents at a subset of 12 SLRs (N=147). Eighty-nine of the 90 items (98.9%) demonstrated Kappa or ICC values above .70 and/or percent agreement above 80%. The 90 items were summarized into nine scales. Two scales (outside supportive physical activity features/functionality and outside exercise facilities) were related to greater physical activity and less sedentary time. Four scales (inside social facilities, onsite services, exercise programs, and social activities) were related to greater sedentary time and better self-rated health. APARS items demonstrated adequate inter-rater reliability and some evidence for construct validity to assess health-related environments in retirement facilities. Social activities in SLRs could benefit residents by incorporating more physical activity. Use of APARS could inform more health-promoting designs of senior living facilities.

Keywords

Built environment; Exercise; Health promotion; Quality of life; Obesity

As older adults age and lose function they become more vulnerable to environmental challenges (Clarke & Nieuwenhuijsen, 2009; Tomey & Sowers, 2009). This is relevant for

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housing environments (Iwarsson, 2005; Oswald et al., 2007) as older adults sometimes choose to move to congregate living facilities that provide safe environments for continued independence and quality of life (Horowitz & Vanner, 2010; Wert, Talkowski, Brach, & Van Swearingen, 2010). Wert et al. (2010) found that older adults in Senior Living Residences (SLRs) had lower functioning (reflective of their need for more support) but higher levels of physical activity, less fear of falling, and fewer falls (reflective of a safe supportive environment for activity) than community dwelling older adults. Environments designed to support mobility and safety can maintain or even increase activity and quality of life in older adults (Connell, 1996). Such congregate living facilities also provide opportunities for social engagement which is also related to better quality of life (Horowitz & Vanner, 2010).

Physical activity is critical to older adults' health (Nelson et al., 2007) through improved functioning and independence, delayed cognitive impairment, and reduced depression (Sjösten & Kivelä, 2006; Spirduso & Cronin, 2001). Recent recommendations from the U.S. Department of Health & Human Services and other organizations suggest older adults engage in at least 30 min of moderate intensity activity on most days of the week, strength training two or three times a week, and balance exercises for those at risk for falls (U.S. Department of Health & Human Services, 2008). The guidelines also emphasize that doing any amount of physical activity is better than none. In addition, extended periods of sitting, which are common among some older adults (Depp, Schkade, Thompson, & Jeste, 2010; Matthews et al., 2008), can negatively impact health and appear related to premature mortality independent of physical activity (Owen, Healy, Matthews, & Dunstan, 2010).

The neighborhood built environment is related to physical activity in older adults (Frank, Kerr, Rosenberg, & King, 2010a; Kerr, Rosenberg, & Frank, in Submission; Yen, Michael, & Perdue, 2009). Destinations to walk to, safe crossings, well-maintained sidewalks, trees, benches, lighting, and even gentle hills in some populations, are associated with walking in older adults (Clarke & Nieuwenhuijsen, 2009; Kerr et al., in Submission). Although these studies have focused on neighborhood settings, the same built environment considerations are relevant to large campus-style housing facilities. One study of SLRs found that well connected paths with destinations were associated with walking for errands, and longer, well connected paths without steps were associated with recreational walking (Joseph & Zimring, 2007). A built environment more conducive to walking can enable physical activity even when functioning is impaired (King et al., 2010). Studies of building environments indicate that architectural design can also impact physical activity. For example, visible centrally located stairs (Nicoll, 2007; Zimring, Joseph, Nicoll, & Tsepas, 2005), the design of communal areas, and staff organization of activities in residential settings can affect the activities and social interaction of elderly residents (Heller, Byerts, & Drehmer, 1984; Milke, Beck, Danes, & Leask, 2009; Van Hoof, Kort, van Waarde, & Blom, 2010). Based on good evidence that physical activity programs tailored to older adults can increase physical activity and maintain adherence (Taylor et al., 2004), physical activity facilities and programs at SLRs could improve residents' health.

For the present study, we refer to serviced retirement communities as SLRs. Services can range from nursing care to occasional social worker visits. Other services may include transportation, laundry, facilities management and food services. Most SLRs provide some

recreation facilities and programs including physical activity resources and programs. Measures are needed to quantify attributes within SLRs that could be related to physical activity and other health outcomes in order to identify opportunities for improved design. Previous studies on physical activity environments in retirement communities compared staff perceptions of environmental characteristics to residents' physical activity (Joseph & Zimring, 2007). No known audit (direct observation) tools exist that specifically aim to quantify built environment features of SLRs. The aim of the present study was to develop an audit tool to objectively assess the physical activity environment in SLRs, evaluate its reliability, and assess validity in relation to objectively measured physical activity, sedentary time and quality of life. Although previous research has found that individuals may self select to live in facilities with more supportive recreational environments (Grant-Savelle, 2010), we did not account for self selection in these analyses.

Methods

Tool details and development

The Audit of Physical Activity Resources for Seniors (APARS) tool was primarily designed to objectively assess features of the buildings at SLRs, as well as the surrounding campus area that could support physical activity. Physical activity programming and promotion by the SLR were also assessed. A secondary aim was to measure educational and social activities in the SLRs. Educational and social activities may be related to quality of life in residents but may simultaneously encourage sedentary time because these activities often involve prolonged sitting. The items assessed in the tool are outlined in Table 2. The 90 items were grouped into nine scales. This study focused on SLRs that provided services and minimum care from part-time nursing or social work staff. Study participants resided in independent or assisted living facilities, although some facilities also provided a continuum of care including full time nursing care.

Literature review and expert input—The audit items were developed following a literature review of tools that assessed living environments for seniors and design guidelines. The existing literature focused on universal design and equal access for all users (e.g., ENABLE-AGE; Iwarsson et al., 2007), design for dementia and Alzheimer's care (e.g., TESS-NH; Lawton et al., 2000; Sloane et al., 2002), falls prevention screening (e.g., HOMEFAST; Mackenzie, Byles, & Higginbotham, 2002) or green design (Schweitzer, Gilpin, & Frampton, 2004). The review confirmed the absence of a tool that assessed physical activity environments, but it did provide guidance on important features for safety and examples of audit tool structure. Other materials related to physical activity were also reviewed, including a study of staff perceptions of physical activity environments (Harris-Kojetin, Kiefer, Joseph, & Zimring, 2005; Joseph, Zimring, & Kiefer, 2005), a walking path choice objective analysis (Joseph & Zimring, 2007), an audit tool for worksite physical activity environment assessment (CHEW; Dannenberg, Cramer, & Gibson, 2005), a tool for park quality assessment (EAPRS; Saelens et al., 2006), and tools for neighborhood audits (e.g., SPACES; Pikora et al., 2006), including one specifically focused on older adults (SWEAT; Michael et al., 2009).

Formative Interviews with staff and residents of SLRs—Following the literature review and expert input, 20 interviews were conducted with a convenience sample of staff and residents of five SLRs in San Diego County. Participants provided informed consent and received a \$20 incentive. Resident participants, two to three per site, were identified by the staff as individuals who were regularly physically active. Staff members were those responsible for activity planning at the site. Participants were asked to lead the researchers on a tour of the facility (including indoor and outdoor environments) and to highlight places that supported and deterred physical activity. Interviewers prompted participants to share their perceptions of the features that made physical activity convenient or pleasant, and those that made it difficult or less enjoyable. Additional features or services that would encourage residents to be more active were also sought. The audit tool was refined to include staff and resident perspectives. A 4-page APARS manual was created to assist in training and standardizing APARS completion. Both the tool and the manual are available online (www.drjamessallis.sdsu.edu/measures.html); online versions were finalized following the reliability and validity analyses described herein.

Audits of SLRs: reliability and validity of tool

Site selection

Validity sites (N=12): The Senior Neighborhood Quality of Life Study (SNQLS) was conducted from 2005 to 2008 in the Seattle, WA and Baltimore, MD regions. The cities and surrounding counties were identified in 2000 for the first NQLS study in adults aged 18–64. Previous papers describe the study design and methods for SNQLS (Buman et al., 2010; King et al., 2010) and a younger-adult study with similar methods (Frank et al., 2010b; Sallis et al., 2009). In addition to independent living older adults, twelve SLRs (six per region) were contacted to participate in SNQLS. SLR staff permitted researchers to recruit a sample of up to 30 SLR residents from each site and to have researchers audit the site using the APARS tool.

Additional reliability sites (N=17): To increase the sample of SLRs assessed and allow inter-rater reliability testing, an additional convenience sample of 17 SLRs was assessed in San Diego, CA, Palo Alto, CA, and the Baltimore region. These additional SLRs were within reasonable distance of study offices, included a range of sizes and facility types with a known contact to facilitate access, and included independent living care facilities.

Audit procedures—Trained research assistants conducted the audits. The raters received standardized training including detailed instructions on use of the tool and manual, a practice site audit with study researchers, and a feedback session to clarify questions. Raters familiarized themselves with the layout of each site and gathered additional information (e.g. such as site layout and number of buildings) before the site visit using the Internet and Google Earth images. Most site visits commenced with a brief tour of the facilities by the site contact, and then researchers proceeded with their systematic audit of the facility. Researchers used an aluminum measuring wheel to measure the distance of the longest walking path. Raters started the observation on the outside of the facility and proceeded indoors. Buildings that were used only for nursing care were not assessed because the tool was focusing on features of the environment for mobile residents. If mixed levels of care

were provided in one building, sections dedicated to nursing care were excluded. The time to complete the tool was generally 60–90 min depending on the size and complexity of the site. Raters contacted site staff to complete any sections where the information was not readily available. Two raters completed the tool independently at each site. During the visit, raters also collected a copy of the site recreational activity schedule. If sites had a monthly schedule, an average was taken to create a weekly number of physical activity and educational/social events. Site characteristics (i.e., number of residents and levels of care) were provided by the site staff.

Individual participant data for 12 sites—Individual participant data were collected in the 12 SLRs that were part of the SNQLS. Recruitment was conducted remotely as the study extended across several counties. Potential participants were mailed recruitment materials and contacted by study staff by phone. The number of participants per site ranged from 4 to 23 (Mean=12.25; SD=6.25) due to differences in eligible populations at sites. Participants signed an informed consent document, wore an accelerometer for 7 days, and then completed a survey. A total of 147 participants had accelerometer and survey data available for the current analyses. Participant descriptive characteristics by SLR are presented in Table 1.

Measures

Objective physical activity and sedentary time—ActiGraph accelerometers (Pensacola, FL) were used to objectively measure physical activity. Actigraphs have been validated as physical activity measures in numerous studies (Welk, Schaben, Morrow, & J. R., 2004). The accelerometer was set to record intensity of movement at 60-second intervals, and participants were asked to wear the meter all waking hours over 7 days, except when in water (Buman et al., 2010). Participants who did not wear the accelerometer for at least 10 hours per day on 5 days were asked to re-wear the meter, although for scoring purposes a valid day was defined as 8 hours of wearing time. Seventy-six percent of participants had 12 h per day on 7 days. Each interval was scored as meeting or not meeting an activity criterion for sedentary, moderate, or vigorous physical activity based on established cutpoints (Freedson, Melanson, & Sirard, 1998). Non wear time was established as 45 or more minutes of continuous zeros. The cutpoint for scoring sedentary time was <100 counts, whereas moderate to vigorous physical activity (MVPA) was defined as 3 metabolic equivalents (>1952 counts). MeterPlus version 4.0 software from Santech, Inc. was used to clean and score the data (www.meterplussoftware.com). Total minutes in sedentary time and MVPA were divided by total valid hours across all valid days that the participant wore the accelerometer. Total valid hours of accelerometer wearing time ranged from 49 to 155 (Mean=96.4; SD=16.1). Minutes per valid hour were multiplied by 12 to approximate the average minutes participants spent in sedentary time and MVPA per 12-hour wearing day.

Quality of life/Self-Rated Health (SRH)—One SF-36 item asked the following: “In general, would you say your health is poor, fair, good, very good, or excellent?” scored on a one to five scale. Higher values corresponded with better health status (Ware & Sherbourne, 1992).

Demographic characteristics—Additional survey items included age, gender, education, ethnicity, and household income. Participants also reported their height and weight which was converted into a BMI score (kg/m^2), and those with a BMI ≥ 25 were considered overweight.

Data reduction and statistical analyses

Items on the audit tool were grouped a priori into the scales indicated in Table 2. The number of items described here was the final 90 items that remained in the scales (from an original list of 204). Items with low reliability, no variation, or high collinearity were removed. Initially, item response options were yes/no or three or five Likert-type categories. The descriptive statistics for each of the Likert scale items revealed limited variability so a decision was made to dichotomize all items. All results presented here are on the final items using dichotomous scoring. Items were scored consistent with the valence of their scales (e.g., the presence of outdoor stairs was coded as '0' because this item was in the supportive outdoor features scale and previous research has shown that no stairs is related to increased walking; Joseph & Zimring, 2007).

Reliability analyses—SPSS version 17.0 was used for all analyses. In the 29 sites, distributions (% yes vs. % no) and means and standard deviations of APARS items and scales were first examined. Kappa statistics were used to assess inter-rater reliability for dichotomous individual items. One-way random effects single rater intra-class correlation coefficients (ICC) were used to assess inter-rater reliability for scales. ICC and Kappa values were considered as: .60 good to excellent, .40–.59 moderate, and <.40 poor (Landis & Koch, 1977). Percent agreement between raters was also examined for dichotomous items.

Validity analyses—Bivariate Spearman correlations were examined for each APARS item and scale with each outcome variable: sedentary time, MVPA, and Self-Rated Health (SRH). It was hypothesized that most APARS items and scales would be negatively correlated with sedentary activity and positively correlated with MVPA and SRH, with the exception of the Outside Hazards items and scale. It was expected that some social activity indicators would be positively related to SRH but also positively related to sedentary time because social activities often involve prolonged sitting, for example during lectures or games like bingo. Because of the clustering of residents within sites, we explored the effect of adjusting for this using mixed effects regression models (Nezlek, 2001).

Results

Descriptive statistics for the 29 sites

Nine sites were in San Diego, 8 in Palo Alto, 6 in Seattle, and 6 in Baltimore. Site size data from GIS were available for 12 sites only and ranged from .15 to 38 acres (Median = 3.04) and building square footage from 11,000 to 521,000 (Median = 107,000). The number of onsite buildings ranged from 1 to 17 (Median = 1). The number of floors in buildings from 2 to 13 (Median = 4). The number of residents ranged from 27 to 555 (Median = 150). The percent of residents with independent living status ranged from 0 to 100% (Median = 56%). Only 4 sites had nursing care facilities. All sites had some indoor and outdoor physical

activity facilities and programming, and all sites had some access to a walking path, although the length varied from 43 to 5280 ft (Median = 734).

Inter-rater reliability

The majority of APARS items (69 of 90; 76.7%) demonstrated Kappa or ICC values above .70. Twenty of the 21 items with Kappa or ICC values below .70 exhibited percent agreement above 80%, indicating moderate to high reliability for all but 1 item (social activity programming). The 10 APARS scales demonstrated ICCs ranging from .43 to .98 (see Table 2). Site characteristics were not entered into the reliability analyses as this information was mostly provided by staff members or external sources (e.g., GIS database). Individual item test–retest reliability coefficients can be found at www.drjamessallis.sdsu.edu/measures.html.

Validity results

Validity data were collected on 147 individuals across 12 sites in Seattle and Baltimore. Demographic characteristics are presented in Table 1 for each site and validity results are presented in Tables 3 and 4. More supportive outdoor physical activity features were associated with more MVPA, greater SRH, and less sedentary time. The outside aesthetics scale and outside hazards scale were not significantly related to any of the outcome variables. Having outside exercise facilities was significantly related to less sedentary time and more MVPA. The inside exercise facilities scale was related to SRH but not sedentary time or MVPA. The number of inside social facilities was significantly related to sedentary time and SRH in the expected direction. The inside building features scale was not related to any of the outcomes. Number of onsite services was positively related to sedentary time and SRH. Number of exercise programs and number of social activities on calendar were associated with greater sedentary time and greater SRH, but not MVPA. Individual items within the aforementioned scales are presented in Table 4 if they had a significant relationship with at least one outcome ($p < .01$) or if significance was at the 95% level but the items were related to more than one outcome.

Discussion

The APARS tool was successfully deployed in 29 SLR sites that varied in building design and location. The results demonstrate that the tool can be completed reliably by raters with minimal training, but clear instructions. The tool measured features of the sites that are related to physical activity, sedentary time and self-rated health. The analyses provided direction to simplify the tool response format and to reduce the number of items. The revised tool is available online for researchers to employ in studies of SLRs.

Inter-rater reliabilities were high (i.e., $\text{Kappa} > .70$), indicating that items can be consistently coded by independent raters. Items that demonstrated lower reliability were often about features that required some rating on quality. Such items have proven difficult to rate in other contexts (Saelens et al., 2006). Several scales and numerous items were related to residents' moderate–vigorous physical activity and SRH. Previous research has shown that a higher number of path intersections and no outdoor steps were related to increased amounts

of self-reported walking (Joseph & Zimring, 2007). In our study, however, over 80% of sites had outside stairways, and less than a third had connected pathways. We found that outside stairways were highly correlated with sedentary time and that connected paths were related to physical activity. Other outdoor features with a significant correlation to MVPA included more than 1 building, directional signs, tree shade, and paths with moderate slope. These features were present in a third of sites and were also correlated with SRH. Previous studies have shown that gentle hills and trees can encourage physical activity (Sallis & Kerr, 2006).

Most sites had outdoor aesthetic features that would make the grounds pleasing to walk. Unfortunately, none of these features were related to outcomes. Previous studies found that pleasant things to see were related to physical activity, but findings were not consistent (Joseph & Zimring, 2007; Sallis & Kerr, 2006). Outdoor hazards, although frequent, were not inversely related to physical activity as hypothesized. Obstructions on nearby path were unexpectedly positively related to MVPA. Obstructions included trees, shrubs, and other things that intruded upon the path. It is possible that some obstructions, such as planters, added interest to the walking path.

Outdoor exercise facilities were scarce in the sites studied, yet outdoor exercise stations along a path (e.g., parcourses) demonstrated positive associations with MVPA and SRH, and a negative association with sedentary time. If sites want to improve their outdoor facilities, exercise stations may be a first step. Several outdoor exercise features were related to SRH, indicating that residents may enjoy these activities, even if they did not involve much movement. Staff could consider ways of expanding activities like lawn bowling and golf putting to involve more brisk walking. The presence of a swimming pool was strongly related to SRH. Unfortunately, accelerometers are not able to measure water based activities so no correlation with MVPA was seen.

Moving indoors, only aerobic equipment in a fitness room was positively related to MVPA and SRH, and negatively related to sedentary time. Over 70% of sites had aerobic equipment in a fitness room. Resistance equipment was also highly prevalent, but was not related to MVPA. This may reflect the inability of the accelerometer to detect stationary upper body movements. It seems a worthwhile investment for sites to have a fitness room with multiple types of equipment. The overall inside exercise facilities score had a stronger relationship with SRH than MVPA. Like the outdoor locations, this may indicate that facilities are positive site features that generate a sense of availability, options, and service, but they are not being best used to maximize MVPA. They may be encouraging resistance type exercise but not aerobic activity detected by the accelerometer. The study by Joseph et al. (2005) that assessed indoor and outdoor physical activity resources found that the presence of such features was related to staff estimates of residents' physical activity.

Social/educational facilities were much more apparent in sites. Although these features were often related to SRH, they also were positively related to sedentary time, particularly having a music or multipurpose room. To improve their health impact, sites could consider encouraging dancing rather than sitting and listening to music, and more active uses for multipurpose rooms. One study found common areas were not well used unless activities

were organized by staff (Milke et al., 2009), suggesting the importance of having structured and organized physical activities available at SLRs.

The number of staircases was negatively related to MVPA and positively related to sedentary time. If older adults avoid using stairs or stairs are not visible, more staircases would not be expected to increase physical activity. Stairs that were visible from a main entrance, in contrast, were negatively related to sedentary time and positively related to MVPA, as were fewer elevators. The design and placement of stairwells in buildings is known to affect physical activity (Grimstvedt et al., 2010; Nicoll, 2007). Specific stair and building design guidelines are outlined in the Active Design Guidelines for New York City (http://www.nyc.gov/html/ddc/html/design/active_design.shtml). Perhaps stair use could be improved by promoting stairwells that are open and attractive. Stairs may be a hazard for some residents with limited functioning. Continued ability to use stairs, however, is important for residents to be able to continue normal mobility outside of residential facilities.

In neighborhood research, walking destinations are consistently related to physical activity (Heath et al., 2006). A previous study of walking paths in SLRs also found this relationship (Joseph & Zimring, 2007). In our study, most sites had multiple destinations, but few were related to MVPA. Most destinations were positively related to SRH but also positively related to sedentary time. This suggests that onsite destinations may reduce the need to take off-site trips where incidental activity may be more likely to occur.

A previous survey of SLR staff suggested that physical activity programming was related to physical activity (Harris-Kojetin et al., 2005). In contrast, in our study with objective measures, the number of posted activity programs, both exercise related (mean of 10) and social/educational activities (mean of 32), were positively related to sedentary time, positively related to SRH and not related to MVPA. This suggests that exercise activities are either ill attended or do not involve much aerobic physical activity. Casual observations indicate that many “exercise” sessions involve only light activities while seated. Training of program staff may be needed to offer more active classes safely. Social/educational activities also tend to have a focus on sitting. More activities may give residents a sense of well being, but considering the literature on the relationship between sitting and mortality (Owen et al., 2010), sites would be well advised to try to involve some movement in social/education activities. In the same way schools are introducing activity breaks such as Take 10 (Yancey, Ory, & Davis, 2006), SLRs could broadcast breaks from being sedentary every hour by encouraging standing among those who are able and any type of upper body movement by those in wheelchairs or otherwise unable to stand. Card tables or game tables could also be set up to allow for standing or movement, such as placing puzzle pieces in one part of the room and the puzzle table in another.

Limitations

The present analyses did not adjust for self selection; active older adults may choose to live in facilities with more supportive recreational environments (Grant-Savelle, 2010). Validity analyses remained exploratory as data were only available in 12 sites. When clustering of participants and scales by site were adjusted for, many associations were no longer

significant. Future studies should assess a larger number of sites and adjust for other covariates such as demographics and physical functioning.

Conclusions

Medium length walking paths (i.e., around 500 m) with functional and interesting features (shade, slopes, connectivity and no stairs) support MVPA among residents of SLRs. Outdoor exercise stations and indoor fitness facilities also were associated with MVPA and quality of life.

We observed a consistent pattern that recreational opportunities were positively related to quality of life but not physical activity, and in some cases related to increased sedentary time. Other studies have shown the importance of active engagement in life activities in care settings and its relationship to quality of life (Horowitz & Vanner, 2010). The challenge remains as to how to increase movement during such social and educational opportunities and to maximize MVPA in organized physical activity programs.

Future studies could use technology, such as GPS or radio frequency tags, or objective techniques like behavioral mapping, to monitor use of indoor and outdoor space and further inform specific design guidelines for physical activity (Milke et al., 2009; Oswald et al., 2010). Objective assessments of activity are also key; one study using behavioral mapping techniques found nursing home residents to be less sedentary than previously estimated (Milke et al., 2009). The behavioral mapping study also found that both placement of communal areas and staff organization of activities could affect resident participation. It is important to train staff to lead physical activity classes effectively, especially if the site design is less supportive.

Given the importance of physical activity to health, especially in older adults, and considering the role the physical environment can play in facilitating or deterring physical activity behavior, this type of reliable and valid audit tool can play a role in improving physical activity opportunities within SLRs. Design guidelines, operating regulations and policy recommendations currently do not include best practices for physical activity promotion in SLRs. The APARS tool can be employed to determine which features most strongly predict physical activity and health, and identify areas where improvements can be made. Users could use the entire APARS tool or specific items and scales that are related to their outcome of interest (i.e., physical activity, sedentary time, or quality of life). The tool can also be used to compare the built environment of different sites, to adjust for site differences in prospective or intervention studies, and to generate evidence for policy recommendations. Intervention trials can test whether changes to these features increase physical activity levels after accounting for demographic factors and physical functioning. After such studies have been conducted, evidence based guidelines for physical activity promotion in SLRs can be developed.

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References

- Buman MP, Hekler EB, Haskell WL, Pruitt L, Conway TL, Cain KL, et al. Objective light-intensity physical activity associations with rated health in older adults. *American Journal of Epidemiology*. 2010; 172(10):1155–1165. [PubMed: 20843864]
- Clarke P, Nieuwenhuijsen ER. Environment for the healthy ageing: A critical review. *Maturitas*. 2009; 64(1):14–19. [PubMed: 19695800]
- Connell BR. Role of the environment in falls prevention. *Clinics in Geriatric Medicine*. 1996; 12(4): 859–880. [PubMed: 8890120]
- Dannenberg AL, Cramer TW, Gibson CJ. Assessing the walkability of the workplace: A new audit tool. *American Journal of Health Promotion*. 2005; 20(1):39–44. [PubMed: 16171160]
- Depp CA, Schkade DA, Thompson WK, Jeste DV. Age, affective experience, and television use. *American Journal of Preventive Medicine*. 2010; 39(2):173–178. [PubMed: 20621265]
- Frank LD, Kerr J, Rosenberg DE, King AC. Healthy aging and where you live: Community design relationships with physical activity and body weight in older Americans. *Journal of Physical Activity & Health*. 2010a; 7:S82–S90. [PubMed: 20440017]
- Frank LD, Sallis JF, Saelens BE, Leary L, Cain K, Conway TL, et al. The development of a walkability index: Application to the neighborhood quality of life study. *British Journal of Sports Medicine*. 2010b; 44:924–933. [PubMed: 19406732]
- Freedson PS, Melanson E, Sirard J. Calibration of the computer science and applications, inc. accelerometer. *Medicine and Science in Sports and Exercise*. 1998; 30(5):777–781. [PubMed: 9588623]
- Grant-Savelle SD. The influence of self-selection on older adults' active living in a naturally occurring retirement community. *Journal of Housing for the Elderly*. 2010; 24(1):74–92.
- Grimstvedt M, Kerr J, Oswalt S, Fogt DL, Vargas-Tonsing TM, Yin Z. Using signage to promote stair use on a college campus in hidden and visible stairwells. *Journal of Physical Activity & Health*. 2010; 7(2):232–238. [PubMed: 20484762]
- Harris-Kojetin L, Kiefer K, Joseph A, Zimring C. Encouraging physical activity among retirement community residents. *Seniors Housing & Care Journal*. 2005; 13(1):3–20.
- 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:S55–S76.
- Heller T, Byerts TO, Drehmer DE. Impact of environment on social and activity behavior in public housing for the elderly. *Journal of Housing for the Elderly*. 1984; 2(2):17–26.
- Horowitz BP, Vanner E. Relationships among active engagement in life activities and quality of life for assisted-living residents. *Journal of Housing for the Elderly*. 2010; 24(2):130–150.
- Iwarsson S. A long-term perspective on person-environment fit and ADL dependence among older Swedish adults. *The Gerontologist*. 2005; 45(3):327–336. [PubMed: 15933273]
- Iwarsson S, Wahl HW, Nygren C, Oswald F, Sixsmith A, Sixsmith J, et al. Importance of the home environment for healthy aging: Conceptual and methodological background of the European ENABLE-AGE project. *The Gerontologist*. 2007; 47(1):78–84. [PubMed: 17327543]
- Joseph A, & Zimring C. Where active older adults walk: Understanding the factors related to path choice for walking among active retirement community residents. *Environment and Behavior*. 2007; 39(1):75–105.
- Joseph A, Zimring C, Kiefer K. Presences and visibility of outdoor and indoor physical activity features and participation in physical activity among older adults in retirement communities. *Journal of Housing for the Elderly*. 2005; 19(3/4):2–32.
- Kerr J, Rosenberg D, Frank L. The role of the built environment in healthy aging community design, physical activity, and health among older adults. *Journal of Planning Literature*. in submission.
- King AC, Sallis J, Frank L, Saelens B, Ahn D, Conway T, et al. Neighborhood design, physical function, and healthful lifestyles in older adults: Results from the Seniors Neighborhood Quality of Life Study. *International Journal of Behavioral Medicine*. 2010; 17(suppl 1):S252.

- Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977; 33(1):159–174. [PubMed: 843571]
- Lawton MP, Weisman GD, Sloane P, Norris-Baker C, Calkins M, Zimmerman SI. Professional environmental assessment procedure for special care units for elders with dementing illness and its relationship to the therapeutic environment screening schedule. *Alzheimer Disease and Associated Disorders*. 2000; 14(1):28–38. [PubMed: 10718202]
- Mackenzie L, Byles J, Higginbotham N. Reliability of the home falls and accidents screening tool (HOME FAST) for identifying older people at increased risk of falls. *Disability and Rehabilitation*. 2002; 24(5):266–274. [PubMed: 12004972]
- Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. *American Journal of Epidemiology*. 2008; 167(7):875–881. [PubMed: 18303006]
- Michael YL, Keast EM, Chaudhury H, Day K, Mahmood A, Sarte AFI. Revising the senior walking environmental assessment tool. *Preventive Medicine*. 2009; 48(3):247–249. [PubMed: 19136025]
- Milke DL, Beck CHM, Danes S, Leask J. Behavioral mapping of residents' activity in five residential style care centers for elderly persons diagnosed with dementia: Small differences in sites can affect behaviors. *Journal of Housing for the Elderly*. 2009; 23(4):335–367.
- Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, et al. Physical activity and public health in older adults. recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007 116 online.
- Nezlek JB. Multilevel random coefficient analyses of event-and interval-contingent data in social and personality psychology research. *Personality and Social Psychology Bulletin*. 2001; 27(7):771–785.
- Nicoll G. Spatial measures associated with stair use. *American Journal of Health Promotion*. 2007; 21(4s):346–352. [PubMed: 17465180]
- Oswald F, Wahl HW, Schilling O, Nygren C, Fänge A, Sixsmith A, et al. Relationships between housing and healthy aging in very old age. *The Gerontologist*. 2007; 47(1):96–107. [PubMed: 17327545]
- Oswald F, Wahl HW, Voss E, Schilling O, Freytag TIM, Auslander G, et al. The use of tracking technologies for the analysis of outdoor mobility in the face of dementia: First steps into a project and some illustrative findings from Germany. *Journal of Housing for the Elderly*. 2010; 24(1):55–73.
- Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: The population health science of sedentary behavior. *Exercise and Sport Sciences Reviews*. 2010; 38(3):105–113. [PubMed: 20577058]
- Pikora TJ, Giles-Corti B, Knuiman MW, Bull FC, Jamrozik K, Donovan ROBJ. Neighborhood environmental factors correlated with walking near home: Using SPACES. *Medicine and Science in Sports and Exercise*. 2006; 38(4):708–714. [PubMed: 16679987]
- Saelens BE, Frank LD, Auffrey C, Whitaker RC, Burdette HL, Colabianchi N. Measuring physical environments of parks and playgrounds: EAPRS instrument development and inter-rater reliability. *Journal of Physical Activity & Health*. 2006; 3:S190–S207.
- Sallis J, Kerr J. Physical activity and the built environment. *President's Council on Physical Fitness and Sports Research Digest*. 2006; 7(4):1–8.
- Sallis JF, Saelens BE, Frank LD, Conway TL, Slymen DJ, Cain KL, et al. Neighborhood built environment and income: Examining multiple health outcomes. *Social Science & Medicine*. 2009; 68(7):1285–1293. [PubMed: 19232809]
- Schweitzer M, Gilpin L, Frampton S. Healing spaces: Elements of environmental design that make an impact on health. *Journal of Alternative and Complementary Medicine*. 2004; 10(Supplement 1): 71–83.
- Sjösten N, Kivelä SL. The effects of physical exercise on depressive symptoms among the aged: A systematic review. *International Journal of Geriatric Psychiatry*. 2006; 21(5):410–418. [PubMed: 16676285]

- Sloane PD, Mitchell CM, Weisman G, Zimmerman S, Foley KM, Lynn M, et al. The Therapeutic Environment Screening Survey for Nursing Homes (TESS-NH). *The Journals of Gerontology. Series B: Psychological Sciences and Social Sciences*. 2002; 57(2):S69–S78.
- Spirduso WW, Cronin DL. Exercise dose-response effects on quality of life and independent living in older adults. *Medicine and Science in Sports and Exercise*. 2001; 33(6):S598–S608. [PubMed: 11427784]
- Taylor AH, Cable NT, Faulkner G, Hillsdon M, Narici M, Van Der Bij AK. Physical activity and older adults: A review of health benefits and the effectiveness of interventions. *Journal of Sports Sciences*. 2004; 22(8):703–725. [PubMed: 15370483]
- Tomey KM, Sowers MFR. Assessment of physical functioning: A conceptual model encompassing environmental factors and individual compensation strategies. *Physical Therapy*. 2009; 89(7):705–714. [PubMed: 19443558]
- U.S. Department of Health and Human Services. 2008 physical activity guidelines for Americans. 2008. Available from: <http://www.health.gov/paguidelines/guidelines/default.aspx>
- Van Hoof J, Kort HSM, van Waarde H, Blom MM. Environmental interventions and the design of homes for older adults with dementia: An overview. *American Journal of Alzheimer's Disease and Other Dementias*. 2010; 25(3):202–232.
- Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Medical Care*. 1992; 30(6):473–483. [PubMed: 1593914]
- Welk GJ, Schaben JA, Morrow JRJR. Reliability of accelerometry-based activity monitors: A generalizability study. *Medicine and Science in Sports and Exercise*. 2004; 36(9):1637–1645. [PubMed: 15354049]
- Wert DM, Talkowski JB, Brach J, Van Swearingen J. Characteristics of walking, activity, fear of falling, and falls in community-dwelling older adults by residence. *Journal of Geriatric Physical Therapy*. 2010; 33(1):41–45. [PubMed: 20503733]
- Yancey AK, Ory MG, Davis SM. Dissemination of physical activity promotion interventions in underserved populations. *American Journal of Preventive Medicine*. 2006; 31(4):82–91.
- Yen IH, Michael YL, Perdue L. Neighborhood environment in studies of health of older adults: A systematic review. *American Journal of Preventive Medicine*. 2009; 37(5):455–463. [PubMed: 19840702]
- Zimring C, Joseph A, Nicoll GL, Tsepas S. Influences of building design and site design on physical activity: Research and intervention opportunities. *American Journal of Preventive Medicine*. 2005; 28(2):186–193. [PubMed: 15694527]

Table 1

Demographics and outcome descriptive characteristics by site (N=12 sites, 147 individuals).

Site	City	N	Mean age	% Female	% with college degree	% Overweight	% White	Mean sedentary minutes/day (SD)	Mean MVPA minutes/day (SD)	Mean SRH score 1–5 (SD)
1	Seattle	23	83 (5.6)	52.2	69.6	34.8	100	486 (52)	12.1 (15.2)	3.9 (.9)
2	Seattle	15	85 (4.6)	54.5	73.3	40	100	515 (50)	11.0 (12.6)	3.2 (1.2)
3	Baltimore	12	74 (6.6)	0	0	81.8	9.1	444 (32)	8.3 (9.7)	3.6 (1.0)
4	Baltimore	9	77 (8.1)	90.9	25	50	37.5	399 (79)	6.8 (6.0)	3.0 (1.0)
5	Seattle	22	83 (4.6)	81.8	54.5	50	100	498 (41)	6.3 (8.9)	3.2 (.8)
6	Seattle	11	86 (4.0)	60	36.4	63.6	100	489 (55)	5.6 (6.6)	2.7 (.6)
7	Baltimore	15	74 (6.1)	80	6.7	80	26.7	471 (32)	4.0 (3.1)	3.0 (.8)
8	Seattle	14	84 (5.2)	71.4	42.9	57.1	100	527 (38)	3.6 (6.6)	3.2 (1.0)
9	Seattle	4	71 (4.2)	50	25	50	75	478 (47)	2.0 (1.1)	2.7 (.8)
10	Baltimore	13	74 (5.9)	54.5	9.7	81.8	0	490 (63)	1.9 (1.5)	3.4 (.8)
11	Baltimore	5	70 (4.3)	60	0	60	100	459 (123)	1.8 (1.0)	3.9 (.6)
12	Seattle	4	88 (6.2)	75	25	75	100	556 (36)	.5 (.2)	3.0 (1.0)
Total		147	80 (7.5)	70.8	38.5	57.3	70.1	486 (60)	6.5 (9.6)	3.4 (1.0)

Table 2

Descriptive statistics and inter-rater reliability for Audits of Physical Activity Resources for Seniors (APARS) scales (N=29 sites).

APARS scale	# Items	Mean (SD)	One-way inter-rater ICCs
Outside supportive PA features/functionality Items: > 1 building, grassy area, exit route and exit routes connected by sidewalk, marked crossing, directional signs, bike racks, no outside stairway, greater than 30% of path with tree shading, benches along path, path intersections, curved paths and path with moderate slope	12	6.25 (3.8)	.975
Outside aesthetics Items: water features, art/sculptures, pleasant views	3	1.6 (.9)	.743
Outside hazards Items: hazardous path sections, roads to cross, obstructions on path and lighting	4	1.1 (1.1)	.813
Outside exercise facilities Items: putting green, horse shoes, bocce ball, lawn bowling, basket ball hoop, exercise stations, tennis court, swimming pool, bike path, shuffle board	10	1.0 (1.8)	.946
Inside exercise facilities Items: dedicated aerobics classroom, combined fitness aerobic classroom, aerobic equipment, resistance equipment, indoor pool, physical therapy room, exercise equipment not in designated room	7	3.4 (1.8)	.763
Inside social facilities Items: exergames, mind fitness games, open lounges, lecture hall, multipurpose room, dining room, TV room, public TVs, computer room, music room, billiard table, games room, craft room, library, kitchen, fireplace, newspapers	19	10.3 (3.7)	.805
Inside buildings Items: number of floors, staircase, elevators, corridors with view to outside, artwork, changing surfaces, staircases visible from main entrance, automatic doors to outside.	8	4.6 (1.5)	.796
Onsite services Items: open areas/courtyards/patios, seating/eating areas, shaded or covered seating or eating areas, bank, pharmacy, hairdresser/beautician, chapel/religious services, mediation/quiet room, mail room, café/cafeteria, spa/wellness center, gift shop, snack shop, vending machines, laundry, physiotherapist, medical/dental clinic	17	7.8 (3.2)	.859
Activity programming (exercise) Item: number of weekly organized exercise activities from calendar or postings	count	9.5 (8.3)	.887
Activity programming (social) Item: number of weekly organized social activities from calendar or postings	count	32.0 (32.2)	.432

Table 3

Correlations for APARS scales with sedentary activity, Moderate to Vigorous Physical Activity (MVPA) and Self-Rated Health (SRH) (N=12 sites, 147 individuals).

Scale	# Items	Spearman r		
		Minutes/hour		SRH
		Sedentary	MVPA	(1–5)
Outside supportive PA features/functionality	12	–.177 *	.262 ** ^a	.353 ** ^a
Outside aesthetics	3	.101	.024	.145
Outside hazards	4	–.094	.102	.098
Outside exercise facilities	10	–.222 **	.191 *	.164
Inside exercise facilities	7	.065	.104	.328 ** ^a
Inside social facilities	19	.254 ** ^a	–.059	.226 *
Inside buildings	8	.115	–.110	–.096
Onsite services/destinations	17	.209 * ^a	.092	.320 ** ^a
Activity programming (exercise)	Count	.192 *	.005	.179 *
Activity programming (social)	Count	.189 *	–.026	.272 **

Note:

* p<.05;

** p<.01,

^a association remained significant after adjusting for clustering.

Table 4

Significant correlations for APARS individual items with sedentary activity, MVPA and SRH (N=12 sites, 147 individuals).

Item or scale	Spearman r		
	Minutes/hours		SRH
	Sedentary	MVPA	(1–5)
Outside supportive PA features/functionality			
>1 Building	-.003	.165 *	.311 **
>1 Exits connected by sidewalks	.135	.094	.397 **
Marked crossings	-.283 **	.112	-.077
Bike racks	.034	.060	.272 **
No outside stairways (not from building)	-.282 **	.070	.012
Directional signs	-.187 *	.206 *	.180 *
30% of path shaded by trees	-.272 **	.293 **	.241 **
>1 Path intersections within site	-.003	.165 *	.311 **
Paths with moderate slope	-.185 *	.193 *	.218 *
Outside hazards			
Obstructions on path	-.003	.165 *	.311 **
1 exterior light	-.011	-.141	-.271 **
Outside exercise facilities			
Putting green	-.030	.138	.264 **
Lawn bowling	-.030	.138	.264 **
Basketball hoop	-.030	.138	.264 **
Exercise stations	-.187 *	.206 *	.180 *
Swimming pool	-.030	.138	.264 **
Inside exercise facilities			
Dedicated aerobics classroom	-.171 *	.154	.182 *
CV/aerobic equipment in fitness room	-.286 **	.234 **	.217 *
Dedicated physical therapy room/facility	.151	.025	.269 **
Inside social facilities			
Exergames/interactive video games e.g. Wii	.360 **	-.064	.293 **
Mind fitness games	.346 **	-.066	.282 **
Warm-water therapy pool	.311 **	-.090	.110
Lecture hall or theater	-.018	.123	.245 **
Multipurpose room	.296 **	-.056	.244 **
Dining room	.241 **	-.103	.134

Item or scale	Spearman r		
	Minutes/hours		SRH
	Sedentary	MVPA	(1–5)
Public computer	-.204 *	.228 **	.082
Music room	.360 **	-.064	.293 **
Arts/craft room	.207 *	-.178 *	-.036
Kitchen	-.204 *	.228 **	.082
Daily newspaper	.273 **	-.123	.048
Inside buildings			
N2 staircase	.265 **	-.158	-.091
1 elevator	-.273 **	.123	-.048
1 staircases visible from main entrance	-.252 **	.137	-.078
>1 corridors with view to outdoors	-.045	-.081	-.285 **
Onsite services/destinations			
>1 Shaded or covered seating or eating areas	.236 **	.055	.259 **
Hairdresser/beautician	.253 **	-.086	.117
Gift shop	.279 **	.008	.308 **
Laundry	.030	-.138	-.264 **
Physiotherapist	.225 **	-.126	-.037
Site info (individual items)			
Number of residents (continuous)	.140	.050	.275 **
Length of longest walking path in feet	-.195 *	.176 *	.153
# corridors (continuous)	-.163 *	-.044	-.257 **
Percent independent residents (continuous)	-.383 **	.173 *	-.145

Note: Individual items are presented if they had a significant relationship with at least one outcome ($p < .01$) or if significance was at the 95% level but the items were related to more than one outcome;

* $p < .05$.

** $p < .01$.