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The Seniors' Outdoor Survey (SOS Tool): A Proposed Weighting and Scoring Framework to Assess Outdoor Environments in Residential Care Settings

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ABSTRACT

Spending time outdoors offers substantial health benefits for older adults. However, in long-term care settings, outdoor areas may fail to adequately support elderly residents' needs and preferences. The Seniors' Outdoor Survey (SOS Tool) was recently developed to help users evaluate outdoor areas and indoor–outdoor connections in residential facilities for seniors, by rating 60 environmental features on a 1–7 scale. This article proposes a weighting strategy to approximate the relative importance of different items on the tool, according to their potential level of support for resident usage and preferences. A standardized scoring system will allow multiple stakeholders to apply the results to research, design, construction, and renovation projects.

KEYWORDS

Aging; environmental assessment; landscape design; older adults; residential long-term care

Introduction

Concern about the rapid aging of our society has placed increasing emphasis on nonpharmacological approaches to promote and maintain health in later years. Low-cost, noninvasive interventions such as healing gardens and green space are seen as therapeutic strategies that could potentially be beneficial in senior housing. For example, major Centers for Disease Control and Prevention (CDC) reports on aging in 2003 and 2013 addressed the therapeutic potential of access to nature (CDC, 2003, 2013). It was an important focus in a recent research-based book by landscape designers Cooper Marcus and Sachs (2013). Studies such as those by Lee (2007), Mowen, Orsega-Smith, Payne, Ainsworth, and Godbey (2007), and Takano, Nakamura, and Watanabe (2002) have explored multiple facets of nature-related outcomes in different settings, such as community parks. A systematic review by Wang and MacMillan (2013) found a wide range of gardening-related benefits in senior populations. A number of studies in long-term care settings such

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as assisted living, skilled nursing, and dementia care facilities have focused on the importance of nature elements for aging residents; for example, Barnicle and Midden (2003) found improved psychological well-being in long-term care residents; Calkins, Szmerekovsky, and Biddle (2007), and Connell, Sanford, and Lewis (2007) found improved sleep in individuals with dementia; and a number of relevant studies on the topic were summarized in a modified scoping review by Gonzales and Kirkevold (2014). Evaluation approaches have been developed by researchers such as Bengtsson and Grahn (2014), Chaudhury and Cooke (2013), and Heath and Gifford (2001); in addition, a comprehensive tool for evaluating outdoor spaces for persons with dementia (the Alzheimer's Garden Audit Tool [AGAT]) has been developed and published by Cooper Marcus (2007). A number of books and practitioner guidelines have emphasized the importance of outdoor space for older adults (e.g., Anderzhon, Fraley, & Green, 2007; Berentsen, Grefsrød, & Eek, 2009; Brawley, 2007; Cassidy, 2011; Moore, Geboy, & Weisman, 2006; Regnier, 2002; Rodiek & Schwarz, 2005, 2007;Stoneham & Jones, 1997). However, in spite of widespread agreement on the therapeutic benefits of spending time outdoors, the outdoor areas in existing residential facilities are commonly reported to be underutilized (Grant & Wineman, 2007; Kearney & Winterbottom, 2006; Rappe & Kivelä, 2005). While residents' use of outdoor space can be negatively impacted by inclement weather, poor resident health, or restrictive staff policies, problems are also reported with nonsupportive design of a facility's outdoor areas, and how those areas connect to the inside of the building (e.g., Cutler & Kane et al., 2004; Heath & Gifford, 2001; Rodiek, Lee, & Nejati, 2014; Sugiyama & Thompson, 2007). The purpose of this article is to improve an existing evaluation tool that was developed to assess the characteristics of usable outdoor space in a wide range of settings for older adults.

Outdoor evaluation and the SOS Tool

Although there appears to be widespread agreement among care providers, researchers, design practitioners, and policymakers that senior facilities should provide access to safe and supportively designed outdoor areas (Cohen-Mansfield, 2007; Regnier, 2002; Zeisel et al., 2003), most existing tools for assessing senior environments have few, if any, items related to outdoor space (Agency for Healthcare Research and Quality, 2007; Cutler, 2000). Recently, the Seniors' Outdoor Survey (SOS Tool) was developed to address this gap as a validated instrument intended for a broad range of stakeholders, including researchers, planners, designers, and care providers (Rodiek, Nejati, Bardenhagen, Lee, & Senes, 2016). Items in the tool are worded to allow experts and nonexperts to evaluate environmental features based on their own observations. Using an approach derived from Gibson's affordance theory (Gibson, 1979), the tool asks users to rate 60 discrete items, in terms of how well each feature would support outdoor usage by frail older adults, using a 1–7 scale. To aid raters, these 60 items are arranged within five organizing

domains that include (a) access to nature—aspects of the natural world, such as plants and water; (b) outdoor comfort and safety—features that support physical comfort and relaxation; (c) walking and outdoor activities—features that support walking and physical movement; (d) indoor–outdoor connection—the interface between the building and the outdoor space; and (e) connection to the world—aspects that give residents contact with the nearby surrounding environment, including visitors to the facility. Because the individual items in these domains are expected to have very different configurations in different real-world settings, there is no attempt to provide illustrations of an "ideal" place, but instead the feature is rated by how well the intended activity or behavior is "afforded" by the feature (Bardenhagen & Rodiek, 2016).

Development and scope of the SOS Tool

Content validation for the items in the tool derived from a variety of sources, including a series of preliminary studies that used focus groups, photographic comparison methods, and written surveys (both closed- and open-ended), to determine resident preferences and levels of outdoor usage (Rodiek, 2005, 2006, 2008; Rodiek & Fried, 2005; Rodiek et al., 2014). A preliminary version of the SOS Tool was tested for interrater reliability while being used to evaluate characteristics of 152 outdoor spaces at 68 assisted living facilities; the tool's results were compared with residents' levels of walking and outdoor usage at those facilities ($N = 1128$), statistically controlling for other variables, to see which features were associated with behavioral outcomes (Rodiek & Lee, 2009). All these studies were conducted in skilled nursing (SN), assisted living (AL), and independent living (IL) facilities, with the majority of studies at the assisted living level; the mean age of residents ranged from 77.8 to 83.9 years (for more detail, see Rodiek et al., 2016, p. 224, Table 1, and pp. 226–228, Table 2). Additional content validation for items in the tool was derived from 53 experts selected because of their relevant publications or national conference presentations on outdoor space for older adults. Primarily academics, researchers, and practitioners, these subject matter experts were asked to provide input on the items in the near-final version of the SOS Tool. After further refinement, the SOS Tool was again tested for reliability at a mix of facility levels (four SN, five AL, three IL). The tool exhibited high interrater and test–retest reliability, with an intraclass correlation coefficient (ICC) of .91 for the overall instrument (Rodiek et al., 2016), where .75 is generally considered good reliability (Lee, Kim, Dowdy, Hoelscher, & Ory, 2013; Portney & Watkins, 1993). This tool was intended to be widely applicable in long-term care settings ranging from independent living to skilled nursing facilities. However, the tool was not intended to assess outdoor spaces for people with advanced levels of dementia, whose environments should be tailored to accommodate dementia-related changes in cognition and spatial perception (Rodiek et al., 2016). A stated goal by developers was that the SOS Tool should be "*widely applicable*—

appropriate for a range of residential care settings, to reflect the increased blurring between different levels of care" (Rodiek et al., 2016, p. 223).The authors noted that broad applicability was important "because of the increasing diversity in functional capacity among residents at each level of care, and a trend toward multilevel facilities with shared outdoor spaces … as these models respond to evolving regulatory requirements and residents' preference for aging in place" (Rodiek et al., 2016, p. 224; also see Golant & Hyde, 2008; Oliva, 2013). Although the terms "senior housing," "residential care," and "long-term care" tend to have different interpretations in different parts of the United States, they all connote the broader meaning of "congregate residential facilities for older adults" and are used interchangeably in this article. Although some of the validity support for the SOS Tool was derived from studies in skilled nursing and independent living, the main studies were conducted in assisted living, which is an intermediate level of care (Rodiek et al., 2016, p. 224, Table 1). The items in the tool itself appear to be intended to assess the outdoor spaces provided for resident use and interaction. While these are often found in courtyard, patio, and front porch areas, theoretically the tool could be used to assess any outdoor space that could be used by residents. Specific items in the tool suggest that the emphasis is on providing outdoor spaces that facilitate and encourage independent use by residents, rather than relying on staff assistance to take residents outdoors; for example, several items address the visibility and accessibility of the indoor–outdoor interface, to facilitate unassisted outdoor usage by frail residents. (Seniors' Outdoor Survey: Access to Nature, 2014). This emphasis was likely due to the tool being developed by architectural and landscape designers, who focused on how the physical environment would likely impact resident preferences and behavior (Rodiek et al., 2016). Originally written in English, the tool has also been translated into Chinese, Japanese, Spanish, and Italian (available at http://www.accesstonature.org/resources.html); it has already been used in a large-scale evaluation of nursing homes in Milan, Italy (Fumagalli et al., 2006; Senes et al., 2013). However, although the tool can be used to compare specific environmental features across settings, all items currently have the same weight, even though they are likely to have very different levels of impact on resident outdoor usage and satisfaction. This tool is also lacking a scoring system that provides a meaningful and intuitive way to interpret the results—the field ratings are simply numbers that indicate how supportive each environmental feature is, on a 1–7 scale. Because the SOS Tool is intended to be easily understood and applied by people from diverse fields without special training or expertise, this article proposes a weighting and scoring method to increase the tool's usefulness in the senior housing industry.

Terminology

For consistency, the descriptive terms used in diverse fields are standardized in this article: *rating* = evaluating an item by assigning a numerical or categorical value;

weighting = assigning different values to denote the relative impact or importance of different items; and *scoring* = using metrics to compute final scores for individual items, subsets or domains of an instrument, or an entire instrument.

Background

Weighting of assessment tools in diverse fields

In fields such as health care, education, and risk assessment, a number of assessment tools provide differential weighting for discrete items. However, the basis for weighting is not always clearly identified, and several published instruments relied mainly on expert consensus or the authors' experience to establish the weighting coefficients (e.g., Cole, 1998; Dannenberg, Cramer, & Gibson, 2005; Ding, 2008; Todd, Crawley, Geissler, & Lindsey, 2001; Zwakhalen, Hamers, Abu-Saad, & Berger, 2006). Weighting is also found in tools for assessing the sustainability of buildings and their components. Widely used instruments such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) are used to evaluate adherence to established sustainability guidelines in the design and construction industry. The potential impact of weighting can be seen in these instruments. Weighting differences between assessment systems can make a crucial difference in how a building or neighborhood is evaluated, with potentially major economic consequences, depending on which items are weighted more heavily (Sharifi & Murayama, 2013). In a study assessing the environmental correlates of walking and bicycling, Moudon and Lee (2003) examined a large number of audit tools that originated in the fields of transportation, planning, and health. Weighting was not reported for any of the tools; of the 31 tools that met their inclusion criteria, only two were considered suitable for use by lay people; the rest were designed primarily for researchers or specialized professionals. In the field of environmental assessment for senior facilities, few published instruments have been standardized or subjected to psychometric testing; none were found that assigned weights to denote the relative importance of different items (see overviews in Agency for Healthcare Research and Quality, 2007; Cutler, 2000). Cutler (2000) notes, "The lack of standardized instruments is partially due to the lack of consistency and uniformity in defining industry-wide standards for senior housing" (p. 375). In the field of evaluating senior housing environments, no relevant examples were found that could serve as accepted standards for weighting the SOS Tool.

The purpose of weighting the SOS Tool

In a broad survey of evaluation tools for senior environments, Cutler (2000) noted the value of weighting, remarking, "Different aspects of the residential setting should not necessarily be assigned equal weight or salience in a consideration of their impact" (p. 368). When developing the SOS Tool, user preference, behavioral

outcomes, literature-based data, and expert opinion gave empirical support for content validity of all 60 items in the tool (Rodiek et al., 2016). Some items, however, seem likely to have a larger impact than others. For example, the rating for the item "Can residents easily open the door with minimal effort?" is likely to have a stronger impact (positive or negative) on resident outdoor usage, compared with an item such as "Do at least some seats have cushions?" While empirical support for content validity was found for both items, they are likely to have very different levels of impact on resident behavior. By reflecting these different levels of empirical support and implied impact in differential weighting for these items, the tool will more accurately reflect the level of influence each might be expected to have on the experience of residents. Even though the weighted final scores might not reflect the actual "resident preferences and levels of outdoor usage" with complete accuracy, they will likely be closer to this ideal than what is reflected in the raw, unweighted field ratings.

Issues in developing weighting strategies

Although weighting may increase the value of an evaluation tool and help it more accurately fulfill its intended purpose, it is a challenging process to develop an appropriate weighting strategy. Some of the main reported problems stem from the difficulty of developing a weighting strategy that is objectively based, and that accurately reflects stakeholder priorities. Previous studies of assessment tools in the fields of green building, neighborhood sustainability, and active living/walkability/physical activity provide guidance for developing weighting strategies. According to Retzlaff (2009), "any assignment of weights is essentially a subjective exercise, although some points can be objectively verified…" (p. 10). Sharifi and Murayama (2013) note that "different stakeholders and actors involved in the development have different interests and priorities and accordingly value the criteria differently" (p. 81). Similarly, Moudon and Lee (2003) point out that "instruments from the health field tend to undervalue the transportation components … whereas those from the transportation field disregard the physical activity aspects" (p. 35). This is less problematic in assessment fields that have existing "impact categories and standards set by different institutes and organizations," and where the level of subjectivity can be minimized by using weighting that reflects these accepted standards (Sharifi & Murayama, 2013, p. 80). Unfortunately, reference measures have not yet been standardized for the design of outdoor space for older adults; the SOS Tool is thought to be the only instrument on this topic with psychometric data available.

The purpose of scoring the SOS Tool

In field-testing the SOS Tool with provider industry representatives, it became apparent that a scoring system was needed to assign meaning to the field ratings resulting from the tool. Target users reported that although they were able to

compare different items and domains with each other, they did not know how to interpret the individual or aggregated results. For example, it was unclear whether 4.7 should be considered a high or low value on the 7-point scale used for rating the items. Also, because the domains contain different numbers of items, it is unclear how to combine the results of items within domains, or how to compute an overall summary score for the entire outdoor space. As a tool to support research and decision-making, the scoring system for the SOS Tool would ideally be easily calculated and applied to all items uniformly, and would produce resulting scores that permit intuitive valuation and comparison.

Methods

Weighting the SOS Tool based on triangulating validity support

The weighting system proposed in this article is based on the relative level of support for each item in the main sources that had been used to support content validity during the instrument's initial validation process (Rodiek et al., 2014). These sources (resident preferences, behavioral outcomes, and expert opinion), were triangulated to increase the objectivity of the weighting, by reflecting diverse perspectives and methodologies. This is similar to the approach used by Millstein et al. (2013), who developed their Microscale Audit of Pedestrian Streetscapes (MAPS) items and subscales by triangulating theory, expert consensus, and policy relevance. Triangulation makes it possible to examine the convergence or internal consistency of multiple sources (Jick, 1979; Weiss, 1968), as well as the level of support for each specific item from each validity source. This process was used by Bengtsson and Grahn (2014) in developing an assessment tool for health care gardens, although it was based on triangulating theories rather than data sources. In the present study, this approach made it possible to come to reasonable conclusions about the relative importance of different items in the SOS Tool, in terms of providing support for seniors' outdoor usage and preferences. Although the existing literature on this topic helped inform the initial instrument development, and showed support for the majority of the items (e.g., Carstens, 1998; McBride, 1999; Regnier, 2002; Rodiek et al., 2016; Tyson, 1998), the overall literature base could not be feasibly quantified for use in the weighting process. The validity sources that could feasibly be quantified for weighting purposes were:

Resident preferences. These were based on a multiregional survey asking which outdoor features/qualities were most important (1100+ residents at 68 assisted living facilities in three diverse U.S. climate regions).

Behavioral outcomes. These were based on correlating levels of walking and outdoor usage with evaluations of the outdoor environment features, while controlling other variables (1100+ residents at 68 facilities).

Expert opinions. These were based on subject matter experts rating the importance of outdoor environment features in terms of their potential to "support resident outdoor usage and preferences" ($n = 53$).

Developing a weighting strategy

Based on these three sources, the level of support for each item was quantified and combined to create a numerical weighting value for each item in the tool. For the resident preferences source, the findings for all items were compiled, sorted, and ranked in descending order, with numerical break points determined by clusters occurring in the data rankings. The behavioral outcomes values were determined by using the *p* value and coefficient of each item included in the statistical models. In both these validity sources, each item was assigned a category of high, medium, low, or insufficient [support]. The decision to assign four levels of support emerged from the natural data clusters, and appeared to meet the study's goal of providing differential values, without a level of fine-grained discrimination that was inappropriate for the type of data used. To complement this information collected on resident outdoor preferences and behavior, 53 subject-matter experts on this topic were asked to rank the importance of each item in supporting residents' outdoor usage and satisfaction; they used the same scale, in a Likert-type format (*high, medium, low*, or *unimportant* [in terms of support]). Experts showed fairly high levels of agreement on most items, and no items were found to be split evenly among high, medium, and low importance; experts' responses were compiled and averaged. Using the same 4-point scale for all three validity sources made it possible to combine and numerically quantify different levels of validity support, in developing the weighting strategy.

Numerical valuation of levels of support

To develop the numerical values used in calculating the item weights from the validity sources, several value ranges were tested, including some with subsequent numbering (e.g., 0, 1, 2, 3) and some that increased more steeply as validity support increased (e.g., 0, 1, 4, 7 and 0, 2, 5, 9). Analysis of these schemes found that while the increased values showed clearer divisions between high- and low-validity support, ultimately these would result in overly inflated weightings that would then appear to diminish the value or environmental support that some of the lower-rated items provide. Although several different numerical weighting schemes appear in the literature (Dannenberg et al., 2005; Faragher, Cooper, & Cartwright, 2004; Sharifi & Murayama, 2013; Zwakhalen et al., 2006), no clear evidence was found to support the value of using one approach over another. After testing a wide range of numerical schemes with actual field ratings from the facilities used in reliability-testing the instrument, the levels of validity support were assigned numerical values of high (H) = 4, medium (M) = 3, low (L) = 2, and insufficient (I) = 1 (to facilitate calculation, 1 was used instead of 0 for items with insufficient support from any particular source). Items that had not been specifically tested in the outcome-based study were assigned a 1, to avoid having a positive or negative influence on the resulting weighting calculation. In the subsequent weighting calculation, which averaged the numerical values from the three

sources, these items used a slightly different divisor (2.5 instead of 3), to reduce the penalty to items missing this potential validity source.

Determining weight of different validity sources

After computing numerical values for each item from each validity source, several different approaches were tested for combining them into a single numerical weighting value for that item. The possibility of giving different weights to the three different validity sources was considered, based on (a) the estimated level of certainty of the data, (b) the nature of the data (e.g., preference-based vs. outcome-based), and (c) the perspective/overview provided by the data (e.g., experts vs. residents). Although the literature discusses the question of whether "all components of a multimethod approach" should be weighted equally, it is also clear that "there are no formal tests to discriminate between methods to judge their applicability" (Jick, 1979, p. 607). In fact, a recurrent theme in the literature is the risk of introducing bias in weighting schemes through valuing one perspective more than another (Moudon & Lee, 2003; Retzlaff, 2009; Sharifi & Murayama, 2013). Because the three validity sources for this instrument were selected to represent highly diverse perspectives, and no clear reason for differential valuation was found, they were accorded equal numerical value in the weighting scheme. The final weight for each item, on a scale of 1–4, was calculated as the mean of the numerical values for these three validity sources. As an example, an item with validity support of H, L, L, would be quantified as 4, 2, 2; adding these values and dividing by 3 gives a mean of 2.7 that represents the item's weighting (see Table 1).

Developing a scoring system

Several methods were tested in developing a system to produce scores that (a) could be interpreted intuitively by a wide range of stakeholders; (b) used the same range for items, domains, and the overall instrument, to facilitate comparison; and (c) could feasibly be calculated by hand if necessary. Field-testing suggested a 100-base score would be simple to understand, intuitive, and widely accepted, perhaps because of similarity to many educational scoring systems (Allen, 2005). In addition to producing a 100-base score for each item, comparable 100-base scores could also be obtained for each domain and for the overall instrument, by adding individual scores and dividing the total by the number of subscores included. This approach allows comparison of scores between items, domains, and the overall summary score of the outdoor space, making it possible to see which individual items and domains are above or below average. The extra sensitivity of 100 points makes even small differences apparent. Although this approach is simple conceptually, and can be calculated by hand, several different iterations of scoring calculations were

Table 1. Validity support, weighting, and example scoring of the SOS Tool.

Levels of validity support[a]			Agreement across validity sources[b]		Domain and item weights[c]	Domains/items[d]	Example: Mean Results from Reliability Test Facilities[e]		
User preferences[f]	Outcome-based	Expert opinion	Percent absolute agreement	Percent near agreement			Unweighted rating[g]	Weighted raw score[h]	Weighted final score: overall, domain and item[i]
Overall means			36%	68%	2.6		3.5	9.3	77.1
Domain means			45%	81%	2.5	ACCESS TO NATURE (14 items)	3.3	8.1	76
H	H	M	67%	100%	3.7	Amenities for birds and wildlife	1.4	5.2	70
H	M	M	67%	100%	3.3	Diverse mix of plants and trees	4.0	13.3	87
M	H	M	67%	100%	3.3	Water features available	1.7	5.5	71
H	–	H	67%	67%	3.0	Abundance of greenery	4.1	12.2	84
H	–	H	67%	67%	3.0	Abundant flowers and color	4.0	12.1	84
–	H	H	67%	67%	3.0	Easily reachable or raised plants	3.6	10.7	81
M	L	H	0%	67%	3.0	Seating has pleasant views	3.8	11.3	83
L	L	M	67%	100%	2.3	Amenities for pets	2.9	6.7	73
L	X	M	0%	67%	2.0	Private places to sit	3.3j	6.6	73
L	–	M	0%	67%	2.0	Outdoor area is not noisy	3.7	7.4	75
L	–	M	0%	67%	2.0	Privacy from resident rooms	4.0	8.0	76
–	X	M	0%	67%	1.6	Can see domesticated animals k	3.3j	5.3	71
L	X	L	100%	100%	1.6	Hard boundaries screened by plants	3.3j	5.3	71
–	X	L	67%	100%	1.2	Features with movement	3.3j	4.0	68
Domain means			9%	44%	2.4	OUTDOOR COMFORT AND SAFETY {15 items)	3.2	7.8	68
H	L	H	67%	67%	3.3	Plenty of seating available	3.4	11.4	83
M	L	H	0%	67%	3.0	Seats available in sun or shade	3.6	10.8	82
M	–	H	0%	33%	2.7	Seats comfortably shaped	3.6	9.6	79
M	–	H	0%	33%	2.7	Microclimate control	1.3	3.4	67
M	–	H	0%	33%	2.7	Outdoor area well-maintained	4.6	12.3	85
L	X	H	0%	0%	2.4	Smoking areas well-separated	3.2	7.6	75
L	–	H	0%	33%	2.3	Some seats have cushions	1.3	3.1	66
L	–	H	0%	33%	2.3	Tables for coffee, food, etc.	2.8	6.4	73
–	L	H	0%	33%	2.3	Seating has arms and backs	5.3	12.4	85
–	L	H	0%	33%	2.3	Seats will not tip over	4.1	9.5	79

L	–	H	0%	33%	2.3	Choice of different seating types	2.9	6.7	73
L	–	H	0%	33%	2.0	Seats do not get hot or cold	3.6	7.3	75
L	–	M	0%	67%	2.0	Swing, glider, rocking chairs	3.2	6.3	73
–	–	H	67%	67%	2.0	Some seating easily movable	3.4	6.8	74
–	X	L	0%	100%	1.2	Restroom, drinking fountain	3.2	3.8	68
Domain means			34%	62%	2.7	WALKING AND OUTDOOR ACTIVITIES (14 items)	3.0	8.3	76.7
H	L	H	67%	67%	3.3	Abundant walkways of different lengths	2.2	7.2	74
L	H	H	67%	67%	3.3	Round trip walkways available	2.7	9.0	78
H	L	H	67%	67%	3.3	Paving level, easy for wheelchairs	4.2	14.0	88
M	M	H	67%	100%	3.3	Destinations to move toward	3.6	12.0	84
H	X	H	67%	67%	3.2	Places for social activities	3.0 i	9.5	79
	H	H	67%	67%	3.0	Paving nonskid and nonglare	4.9	14.7	89
H	L	M	0%	67%	3.0	Places for recreation and exercise	1.8	5.4	71
L	M	H	0%	67%	3.0	Interesting views from walkways	3.4	10.2	80
L	L	H	67%	67%	2.7	Walkways partly shaded	3.4	9.1	78
L		H	0%	33%	2.3	Frequent seating along walkways	2.6	6.0	72
L		H	0%	33%	2.3	Some walkway seating in shade	2.7	6.4	73
L		M	0%	67%	2.0	Play areas for children	1.3	2.7	65
L	X	M	0%	100%	2.0	Place for gardening horticultural therapy	3.0 i	6.0	72
–	X	M	0%	0%	1.6	Handrails along some walkways	3.0 i	4.8	70
Domain means			46%	67%	2.9	INDOOR–OUTDOOR CONNECTION (11items)	4.3	13.4	87
H	H	H	100%	100%	4.0	Doors open with minimal effort	4.7	18.7	97
M	H	H	67%	100%	3.7	Automatic door available, easy to use	5.9	21.7	103
M	H	H	67%	100%	3.7	can easily cross door threshold	3.5	12.9	86
L	H	H	67%	67%	3.3	Doors unlocked during daytime	6.6	22.1	104
–	H	H	67%	67%	3.0	Doors do not close too quickly	4.6	13.7	87
L	M	H	0%	67%	3.0	Outdoors visible from main indoor areas	4.1	12.3	85
–	M	H	0%	33%	2.7	Indoor transition space near doorway	3.7	9.8	80
–	M	H	0%	33%	2.7	Wide paved landing outside doorway	5.0	13.4	87
L	–	H	0%	33%	2.3	Easily reached from indoor commons	5.0	11.6	83
–	–	H	67%	67%	2.0	Outdoor transition space near doorway	3.2	6.4	73
–	–	M	67%	67%	1.7	Multiple ways to reach outdoor area	2.7	4.5	69

(*Continued on next page*)

Table 1. (*Continued*)

Levels of validity support[a]			Agreement across validity sources[b]		Domain and item weights[c]	Domains/items[d]	Example: Mean Results from Reliability Test Facilities[e]		
User preferences[f]	Outcome-based	Expert opinion	Percent absolute agreement	Percent near agreement			Unweighted rating[g]	Weighted raw score[h]	Weighted final score: overall, domain and item[i]
Domain means			45%	84%	2.5	CONNECTION TO THE WORLD (6 items)	3.6	9.0	78
L	H	M	0%	67%	3.0	Area is located near main entry	4.0	11.9	84
M	L	M	67%	100%	2.7	Views of off-site scenery	3.3	8.7	77
L	M	M	67%	100%	2.7	Views of nearby streets or traffic	3.3	8.8	78
L	M	L	67%	100%	2.3	View of vehicles arriving at facility	4.1	9.5	79
M	–	M	67%	67%	2.3	Views of front-door activities	4.1	9.7	79
–	L	M	0%	67%	2.0	Views of off-site buildings, activities	2.8	5.6	71

[a]Letters indicate level of support on a 4-point scale: high = 4 (H), medium = 3 (M), low = 2 (L), and insufficient to quantify = 1 (–). An "x" denotes items not tested for correlation with behavioral outcomes, assigned a value of 1.
[b]Shows the percent absolute agreement (same level of support) and near agreement (within 1 point on a 4-point scale) among validity sources.
[c]Calculated by averaging the level of support in validity sources, using 4-point scale. Item weights were averaged to obtain mean domain weights; domain weights were averaged to obtain mean weight for the overall instrument.
[d]Under each domain, items are sorted in descending order, by weighting. Items are described briefly; the item wording on the instrument itself is slightly more detailed.
[e]Example data set is from field ratings for 22 outdoor spaces used in reliability testing of instrument.
[f]Reanalysis of resident preference data for weighting accuracy modified some previously published values.
[g]Means of unweighted field ratings assigned to each item, by two independent raters in 22 outdoor spaces.
[h]Raw scores are the unweighted mean ratings multiplied by the item's weighting.
[i]Final scores are weighted raw scores multiplied by 2, added to 60.
[j]The mean ratings for these items were not reported; for purposes of testing the weighting scheme, each was assigned the mean rating for its domain.
[k]This item was initially reported incorrectly as having outcome-based data.

necessary to see which approach made sense in terms of producing a range of scores that roughly replicated user expectations, when tested with target users. Because of the widely used grading system of A = 90–100, B = 80–89, C = 70–79, and D = 60–69, it was desirable for the final scores to roughly replicate this range of expectations. After testing a series of trial-and-error calculations using different multipliers and addends with actual data from facility ratings, a straightforward formula emerged that produced satisfactory results:

$$\text{ItemRating} \times \text{ItemWeighting} \times 2(\text{Multiplier}) + 60\ (\text{Addend}) = \text{ItemScore}$$

Using this system, it is expected that a mid-level rating for an item of medium importance would yield a score of 80, or about the equivalent grade of a low B. Although this system produces item scores that could potentially range from a low of 62.4 (for the lowest rating on the least important item), to a high of 116 (for the highest rating on the most important item), when tested with a set of 1,320 actual item ratings, approximately 95% of scores fell between 65 and 95. This met the target goal of producing a range of typical scores that were low enough to provide incentive for improvement, yet high enough to avoid discouraging users altogether (Deutsch, 1979; Stan, 2012).

Results

Overview

Table 1 shows the 60 items on the SOS Tool, organized into five domains. Within each domain, items are listed in order of descending importance, based on the weighting calculations. The "validity source" columns show the level of support found for each item in each source, along with how much absolute or near agreement was found across the sources. The weighting for each item was calculated from the combined validity sources, and is shown as a number ranging from 1 to 4. The weighting for each domain is simply the average weighting of items in that domain; similarly, the average weighting of the overall instrument was calculated, and shown for comparison with individual item weights. As an example based on real-world facilities, Table 1 also shows the means of the original unweighted field ratings reported for 22 outdoor spaces, using two trained raters, published in the test of the tool's reliability (Rodiek et al., 2016). The "weighted raw scores" shown for each item were calculated by multiplying the item's mean field rating times the item's weighting. Finally, the scoring formula (multiply by 2, add 60) was used to convert these weighted raw scores to a 100-base final score for each item, domain, and the overall instrument, at these 22 spaces. These example facilities may or may not be typical of other facility ratings, but they give an idea of the range of possible scores that may be obtained by applying the proposed weighting and scoring scheme to the SOS Tool in a real-world setting.

Agreement across validity sources

The percent of absolute agreement shown on Table 1 indicates how many of the three validity sources agreed perfectly on the level of importance of the item (H, M, L, –). The percent of near agreement shows how many of the three sources agreed within 1 point on the importance of the item. Items that were missing outcome-based data were treated as null and not entered in the calculation. Only two items showed absolute agreement of 100% in terms of their importance. First was "Are hard boundaries partly screened by plants?" in the Access to Nature domain, which received low support from the two validity sources tested. The second, "Can residents easily open the door with minimal effort?," in the Indoor–Outdoor Connection domain received high support from all three validity sources. About half the items (27 of 60) showed absolute agreement of 67% (same level of support from two of the three sources). Looking at the near agreement among validity sources (within 1 point), a total of 15 items showed 100% near agreement among sources, representing one-fourth of the items on the tool. Another 29 items showed 67% near agreement among sources. Collectively, 44 of the 60 items showed 67% or higher near agreement among validity sources.

Domain and item weights

Table 1 shows that all five domains have fairly similar domain weightings, calculated by averaging the weightings of individual items within each domain. The domain weightings range from 2.4 to 2.9, on a possible 4-point scale. Across the domains, individual item weightings are fairly evenly distributed in the middle ranges, with 88% of all items being weighted between 2.0 and 3.9, and a standard deviation among all item weightings of 0.64. Only one item had a rating of 4.0 ("doors open with minimal effort"), suggesting the paramount importance of this item. All five domains contain items weighted from 3.0 to 3.9 and items weighted from 2.0 to 2.9. Four of the five domains contain items weighted 1.9 or below.

Mean final scores for example facilities

Table 1 shows that, in the example of data from 22 outdoor spaces used in reliability testing, the mean final item scores ranged from 65 to 104. This broadly conforms to the 100-base scale, by having the scores for most items fall within the intuitive range of 60–100, where below 60 is a failing score (Allen, 2005). Two mean item scores were above 100, indicating high ratings on features with high impact on resident usage and preference. Both 100+ scores (103 and 104) were related to doors, which are predicted to have a high impact on outdoor usage, based on the validity sources referenced in this study. Only six items had mean scores below 70 in the spaces rated in the data set; these items either had received low field ratings, or had low weighting values, or both. There was less variation in the mean domain scores, which ranged from 68 to 87. The mean summary score

for the overall instrument across these 22 outdoor spaces was 77.1, showing that the weighted instrument was operating in the intended target range of final scores.

Discussion

The main purpose of the proposed weighting and scoring system is to provide an evidence-based approach to refine the evaluation of outdoor spaces for older adults. Because no quantifiable precedents were available to confirm the relative value of specific features, the weighting scheme was developed from the instrument's original validity sources, rather than being based on other assessment instruments; the scoring scheme was focused on maximizing feasibility and ease of interpretation for target users.

Weighting

The main value of the proposed weighting strategy is to acknowledge which environmental features are likely to have higher impacts on seniors' outdoor usage and preferences. Although there were minimal differences in the mean weightings among the five domains, they are worth discussing. The domain with the highest overall mean weighting (2.9) was "indoor–outdoor connection"; the domain with the lowest mean weighting (2.4) was "outdoor comfort and safety." This may reflect the fact that the all outdoor paving-related items are located in a specific "walkway/activity" domain (the second highest weighted domain, at 2.7), whereas the "comfort/safety" domain is oriented toward more passive activities such as sitting, for which environmental support may be seen as slightly less crucial. This agrees with the higher level of outcome-based findings for the "indoor–outdoor" domain items, and also with the indispensable role of the doorway in providing physical access to any outdoor space (Hiatt, 1991; Kaup 2011; Rodiek et al., 2014). In previously published outcome-based findings using a preliminary prototype of the SOS Tool, the "indoor–outdoor connection" items with highest impact on outdoor usage were associated with an average of about three times more minutes spent outdoors per week, compared with the highest impact "comfort/safety" items (Rodiek & Lee, 2009). This suggests that several of the "comfort/safety" items, while important and desirable, might not have a "make-or-break" impact on outdoor usage, and may instead represent amenities that serve to increase usage and satisfaction, rather than barriers that actually prevent usage (such as doors that residents cannot open without assistance). Table 1 shows that 55% of the "indoor–outdoor connection" items received a weight of 3.0 or above, while only 13% of the "comfort and safety" items were weighted 3.0 or above. Overall, the fairly close range of mean weightings across domains found in this study supports the broad concept that seniors have multifaceted needs in terms of environmental support needed for their activities, which should all be taken into account in providing housing for the elderly (Golant, 2015; Regnier, 2002; Rodiek, 2009). The need for support from a wide range of environmental features of different levels of

importance is also seen in the mean weightings for individual items, which ranged from 1.2 to 4.0. While a range of levels of importance was expected (and is the main purpose of this exercise), all items had support from at least one validated source (for further discussion of content validity of specific items and domains see Rodiek et al., 2016).

Scoring

The main value of the proposed scoring system is to make it easier to understand and apply the results of the SOS Tool. Using a 100-base score for items as well as domains, the overall instrument allows users to compare the scores of various items and domains, against each other and against the summary score of the overall outdoor space. For users without access to computer programs, individual item ratings can be done on paper, and the calculations can be done by hand or with a calculator. To maximize usability, ratings can be entered onto an Excel, .pdf, or Web-based spreadsheet with an embedded formula, which automatically calculates the item, domain, and summary scores for a given outdoor area (www.accesstonature.org). While the relative "success" or "quality" of individual items can be examined and compared in the field ratings for each item (and by referring to the Likert-type description associated with each rating number), the chief value of the weighted 100-base scores is to assign additional meaning, value, and comparability to the ratings. The scoring system makes it possible for (a) facility administrators to prioritize budgets for environmental improvement; (b) planners and designers to target high-impact amenities for new construction; and (c) future researchers to have an evidence-based metric for examining the outdoor environments, behaviors, and preferences of older adults.

Limitations and further research

The system proposed here has several limitations. The main limitation is the inevitability that the proposed weighting does not represent the actual supportiveness of items with complete accuracy. In spite of using three diverse sources to capture and quantify the relative impact of each item on resident outdoor usage and preferences, weightings are necessarily approximations based on the available information. Future studies could employ additional research methods to test and further fine-tune these weightings, or propose an alternative weighting scheme. Research possibilities include doing prospective quasi-experimental studies to observe and quantify the effects of different environmental features, to capture predictive validity. An additional large-scale study could ask facility residents to rank the relative importance of specific SOS items, and compare their outdoor usage with their own ratings (or those of staff or researchers) on the final version of the SOS Tool. A second main limitation is that because each climate and facility site is unique, the weightings may be more accurate for some settings than for others. For example, in assessment systems for

neighborhood walkability or building sustainability, some weighting systems use regional values intended to improve the accuracy of weighting (Sharifi & Murayama, 2013). Future multiregional studies could explore whether this approach is feasible for long-term care environments, and what sources would be valid for determining the regional or climate-based weightings. Also, because the tool has already been translated into four non-English languages, future studies could explore how the instrument might be adapted or modified for use in different cultural settings. A third main limitation is that the proposed weighting system did not include quantifiable input from care providers who understand the local environment, residents, and facility policies. Although such input was collected from 432 assisted living staff members in the large preliminary study, it was not available in analyzed, quantifiable format. Future improvements to the SOS Tool could quantify and incorporate these data, comparing them with other sources of validity. It would also be possible to replicate the previous "subject-matter experts survey," with caregivers, targeting those in roles likely to observe residents' outdoor usage patterns firsthand, and obtaining their input on the items in the tool. A fourth main limitation is that this tool, by focusing mainly on residents' unassisted use of outdoor space, does not directly address the inevitable policy and programming issues that impact residents at care facilities, except in specific issues such as locked doors to outdoor areas. As an example of this, outdoor space might be provided for resident gardening or horticultural therapy, but unless staff members and policies encourage these activities, they might be very limited in some situations. To capture policy hurdles or staff activities that might affect facilities that otherwise appear to afford usage, a short series of objective response items addressing this could be tested for possible inclusion in the tool. Because the SOS Tool is not intended to evaluate outdoor environments for advanced dementia, a different tool is recommended for this purpose: the Alzheimer's Garden Audit Tool (AGAT, by Cooper Marcus, 2007). Although the AGAT has been used extensively in the field, it has not yet been subjected to psychometric testing, which could be done in future studies. To summarize, although the weighting system proposed here for the SOS Tool is imperfect, the weighted final scores are likely to provide a more accurate reflection of actual environmental support for outdoor usage than what is found in the raw, unweighted field ratings. Future research could extend the value of the weighting and scoring system presented here, by testing it in a wide range of studies and recommending possibilities for further refinement of the tool. Gathering data via a Web-based SOS Tool that provides automatic scoring would also open opportunities to establish benchmark data sets for types of outdoor space, levels of resident care, geographic locations, and other variables. These benchmarks, as have been successfully used in instruments such as the Artifacts of Culture Change (Bowman, 2006), could then be used in further refinements of the tool itself or in how practitioners and facility managers can interpret results.

Conclusion

The proposed weighting and scoring system has strong implications for practice, and is expected to greatly increase the usefulness of the SOS Tool. By giving greater importance to environmental features with stronger potential impact on resident outdoor usage and satisfaction, the weighted tool will more accurately indicate which features should be prioritized in designing new facilities, or renovating existing ones. Facility administrators will be able to allocate budgetary resources and target capital improvements to better support the outdoor usage and preferences of their residents. The scoring system will make it possible for non-research-oriented staff to easily produce meaningful scores that can be compared within and across facilities. Finally, administrators could utilize the tool as a way to showcase their supportive outdoor space to potential residents (and family members) as they consider their possible choices in housing options. Having a single tool shared by multiple stakeholders, ranging from ordinary caregiving staff and administrators, to designers, researchers, and policy planners, can help promote consensus among diverse viewpoints. Overall, finding better ways to evaluate residential environments can make it easier and more feasible to improve living conditions for older adults, resulting in potential benefits to their health and quality of life.

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