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A Checklist Instrument: Sensory Cues within Assisted Living Facilities

Jeanneane Wood-Nartker[1,*], Emily Beuschel[1], Denise A. Guerin[2]

1. Department of Human Environmental Studies, Central Michigan University
2. Department of Design, Housing, and Apparel, University of Minnesota

ABSTRACT:

As people age, environments supporting changing needs can potentially impact their quality of life. The purpose of this exploratory study was to develop and assess the validity of a checklist instrument used to evaluate senior-supportive environmental risk factors within assisted living facilities (ALFs). Aging often leads to a decrease in the ability of a person to interpret sensory cues within his or her environment. This checklist instrument examined the relationship between sensory cue frequency and the influence on fall incidence within ALFs to maximize safety and quality of life. Observers visited 140 ALFs, utilizing the checklist instrument to document the presence or non-presence of 110 sensory cues. Contrary to the original hypothesis, a positive correlation was found between sensory cues and reported falls in each space. As the number of cues increased, the number of falls also increased. Additionally, the frequency of sensory cues within each room increased as facility size increased. Lastly, data revealed that more sensory cues were present in ALFs designed or renovated by design professionals. Although the results were contrary to expectations, the checklist instrument demonstrated face and predictive validity as a future research tool.

Corresponding author: Department of Human Environmental Studies, Central Michigan University, Education and Human Services Building 442, 195 Ojibway Court, Mount Pleasant, MI 48859 (989) 506-3640, email: wood1bj@cmich.edu

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Introduction

Today's U.S. older adults have increasing longevity, are better off economically as a whole, and are living healthier longer as compared with any previous generation[1]. In 2005, approximately 5% of the Medicare population over age 65 resided in LTC facilities, and increased to 17% for those aged 85+ years[2,3]. It is anticipated that this growing need for external housing options will continue, with one of those being assisted living facilities (ALFs). The average age of a resident entering an ALF is 83, with the duration of stay being a little over two years (28.3 months)[4]. ALFs strive to provide a more residential environment[5] while providing necessary support services and assistance with ADLs[6,7].

More age-related physical, emotional, and mental decline is occurring into later years, largely due to the normative aging process, which is often accompanied by a decreasing ability of the senses to function well[8]. This is an issue for older adults because it can result in an increased difficulty to live independently. Decline in hearing and vision can affect depth perception judgments or make it difficult to acclimate to unfamiliar or dangerous places[8,9]. There is also evidence that balance control is increasingly dependent on visual and touch receptors in the extremities, making older individuals more vulnerable to falls due to their reduced ability to use sensory information to adjust their position within an environment[8,10,11,12]. If physical environments can help compensate for sensory decline, older adults may improve their ability to function competently, safely, and live longer within established settings[13]. As falls are one of the leading causes of death due to unintentional injury among elderly, fall reduction may improve residents' ability to function safely within the built environment.

The environment of an ALF may be able to support the changing lifestyles of older adults if environmental stimuli are designed appropriately, and sensory cues are incorporated redundantly. Sensory cuing is defined as indicators within the built environment that impact the bodily senses, e.g., visual, auditory, olfactory, and touch. If residents receive diverse cues about the environment that increase their ability to discern environmental boundaries such as contrast in walls from the floor or door frames from the wall, then stumbling or trip and fall accidents may be reduced. Identifying such sensory cues can enhance quality of life issues for many older adults.

Carp suggested that the environment can serve not only as a source of press (demand placed on individuals by the environment) but also as a resource to increase people's competency levels[14]. Carp suggests that once environmental sensory cues are identified, they can be used as design components and increase the wellbeing of ALF residents. Therefore, the purpose of this exploratory study was to develop, test, and evaluate the face and predictive validity of a checklist instrument that serves as a design and research tool for the interior design and architectural community to systematically evaluate sensory cues within ALFs.

Method

The purpose of this study was to develop, test, and evaluate the face and predictive validity of a checklist instrument developed as a design and research tool for the interior design and architectural community to systematically evaluate multiple sensory cues within ALFs. The checklist was then piloted in 140 ALFs by observers who analyzed the data to identify any relationships of ALF characteristics and cues and their influence on resident falls. The pilot facilities included one and two story structures, which were ADA compliant. Therefore, public restrooms had comparable support features such as ramps and handrails. Private residences and adjoining bathrooms were not visited.

Instrument Development

All environmental cues in the checklist instrument were developed from characteristics identified in a review of literature and included ~110 diverse sensory cues that could be observed to document their presence/non-presence in ALF public spaces. Public spaces were targeted since observers would have difficulty accessing private individual residential environments. The checklist instrument was then used to document the type and number of sensory cues that were present and to document facility demographic data.

Fig. 1 illustrates the relationship of sensory cues to the literature findings. These cues were analyzed for similarity and exclusiveness and formed the basis of the checklist.

The cues were measured on a scale of 0 to 2 to measure the degree to which each was present within the ALF: not present (0), present in one place (1), or present in more than one place (2)].

Observer Training

The group of observers consisted of students selected from an interior design studio class. The class focused primarily on designing for specialized population groups, including children, individuals who are disabled, and older adults. Additionally, building codes and ADA guidelines were introduced to the students within the class. To facilitate consistent responses, students were given a copy of the ALF checklist to work together in the completion of one ALF public room. Upon completion, the appropriate responses were discussed to increase inter-rater reliability. This was repeated in other rooms until student responses were consistent.

Sample Selection

315 ALFs were selected via www.anyhoo.com from a random selection of 569 Michigan-based locations, omitting any ALFs from the Upper Peninsula, although some of these sites were not visited. For example, some directors did not agree to participate, and a few of the sites were undergoing or had just completed renovation. The final sample included 144 sites. Four facilities were missing complete data, making the final facility sample 140. The directors from each of these facilities were sent a letter indicating that they would be contacted to request permission to visit the site. Upon agreement, the consent form and demographic questions were sent electronically for advance completion. As this study did not obtain identifiable information from individual residents, IRB approval was not required.

Sample Description

In total, there were 1033 public rooms visited at the 140 sites. Sizes of ALFs varied considerably and were grouped into four categories: Facility Size 1: 1-11 residents; Facility Size 2: 12-62 residents; Facility Size 3: 63-225 residents; and Facility Size 4: > 226 residents. In total, approximately one-third of the directors reported being part of a chain. More than 99% of ALFs reported housing residents between the ages of 65-74, with 87.1% housing residents between the ages of 75-84. There were 85.7% facilities housing residents 85-99, and 28.6% housing centenarians. Nearly 89% of directors reported having accessible public spaces, while 86.4% ALF directors reported accessible private residences. Widespread accessibility allowed residents to maneuver freely within each room, regardless of whether they were using a supportive mobility device such as crutches or a wheelchair, or were on foot. Lastly, nearly 70% of the ALFs involved a design professional in the original facility design and 35.7% of facility renovations.

Figure 1: Checklist Relationships to Literature

Literature Citation	**Environmental Sensory Cues (Press)**
	Vision (Finishes)
	To reduce glare
[15]	Matte finishes on furniture
[16]	Matte finishes on walls
	Matte finishes on flooring
	Tinted glass used for windows
	To minimize trip hazard
[16]	Area rugs are not used
	Area rugs are inset so they are flush to the floor
	Area rugs are secure to the floor
	Plastic runners are not used
	Flooring transitions are $\leq$1/4"
	Vision (Lighting/Electrical)
	To minimize vibrating boundaries
	Stripes are not used on walls
	To maintain clear planar definition and balance when walking
[17]	Floor graphics are not used
	Graphic patterns are used on wall surfaces
	To increase light levels
[16]	Portable floor and table lamp placement is used by seating
	To provide transition lighting for eye recovering
	Exterior lighting is placed by entrances
	Lighting is located in parking lots
	Transitional lighting is installed on entrance walkways
	Transitional lighting is used in areas of extreme light contrasts
	Vision (Lighting/Electrical)
	To minimize glare
[15]	Lampshade covers exposed bulbs
	Window treatments adjust to control natural light
	Vision (Lighting/Electrical)
	To provide light upon room entry to increase safety and ability to discern the spatial qualities
[18]	Light switches are located just insider door entrances
	Light switches are placed at both ends of the corridor
	Light switches can be operated by thermal touch
	To provide adaptable levels of lighting
[16]	Flexible lighting options, e.g. dimmers, allow for diverse lighting levels
	Flexible light options increase up to 3x
	Flexible light options increase up to 6x
	To control color and light quality
[15]	Full spectrum bulbs are used in overhead lighting
	To ensure adequate light levels
[16]	Receptacles are placed every 12' maximum
	To ensure adequate light levels and to promote increased sensitivity to

Figure 1 continued from page 4

sustainability
Sensored lighting is provided

<u>Vision (Alarms/Signals)</u>
To communicate floor level location for visual impairment
Alarms provide auditory cues
Elevators communicate levels audibly

<u>Vision (Corridors)</u>
To minimize tripping hazards and maintain balance
[19] Corridors are free from clutter on at least one wall
[20] Handrails are incorporated on at least one wall

[17] <u>Vision (Signage/Text/Artwork)</u>
To provide clear wayfinding and to promote balance, which could be compromised if turning to locate places too quickly
Permanent signage is placed in a consistent location next to doors
Pictograms are used on permanent signage
Signage clearly directs a person in wayfinding
Exit signage is placed $\leq$27"AFF
Signage $\leq$80" extends $\leq$ 4" into the environment
Emergency exits are clearly noted

<u>Vision (Signage/Wayfinding)</u>
To provide clear wayfinding and to promote balance which could be compromised if turning to locate places too quickly
[21] The use of different colored walls is used to assist with wayfinding
The use of artwork, photographs, and/or memorabilia is used to assist with wayfinding

To help define the visibility of planes or contrast sensitivity
[15] Door hardware color/texture contrasts with the door
Door frames/moldings contrast with walls
Wall base contrasts with walls
Handrails contrast with walls
Window trim contrasts with walls
Glass is contrasted with the surrounding area
Restroom grab bars color contrast with surrounding area
The leading edge of steps is clearly noted
Floors are clearly defined from walls
Walls are clearly defined from the ceiling
Furniture is clearly defined from the floor
The switch plates contrast with wall surfaces
[17] One type of flooring is used in corridors and adjacent spaces

To help minimize glare but also to minimize disappearing boundaries such as dark surfaces placed adjacent to a window emitting an uncontrolled light source
[15] Windows are placed to minimize glare

<u>Vision (Stairwells)</u>
To promote balance
[18] Stairway handrails extend 12" beyond the top and bottom step
Steps have a consistent rise and run
Stairs are used to enter the space

To minimize trip hazards
Stair rises are closed
Headroom is at least 7' high

Figure 1 continued from page 5

Interior doors do not swing over stair steps

Vision (Stairwells)
To provide light upon entry to stairwell
Light switches are located at the top and bottom of stairs

Tactile (Miscellaneous- Furniture)
To promote stability and balance
[16]
All seating has arms
All seat cushions are firm
Seat heights are approximately 18"H or higher

To provide stable furnishings
Chairs have four legs
Chairs have back legs, and casters on front legs
Chairs do not have four legs with casters

Minimize injury from falls (as compared to rounded edges)
Furniture edges are square
Furniture edges are round

To promote balance that could be compromised if turning to locate places too quickly
[12]
Handrails provided messages regarding location on the back side
Handrails provided recessed finger grips

Tactile (Miscellaneous- Signage)
To promote balance that could be compromised if turning to located places too quickly
Braille is used on permanent signage

Hearing (Alarms/Signals)
To communicate an emergency for full vision impairment
Alarms provide visual cues

To communicate floor level location
Elevators communicate visually

On-site Process

One observer was assigned to complete the checklist instrument within each ALF. Upon arrival, the observer collected the signed consent form and facility demographic questionnaire from the ALF director. Facility demographics included the overall number of residents; the age of residents living within each ALF; the type of business formation for each facility; number of falls that had occurred in each room-type by residents in the last year; location of facility; and average length of time that residents had lived in the ALF. The observer then used the checklist instrument to assess the sensory cues present in each public space throughout the facility, making this a non-experimental, exploratory study.

Data Analysis/Scoring

Each ALF was assigned an overall number and each room type was coded with a room number. In order to identify ALF characteristics, the frequency of demographic variables were run first. Then, in order to determine how strongly sensory cues were incorporated into the environment, a preliminary statistical analysis was run.

Results

Preliminary Analysis: Overall Facility Sensory Cue Patterns

To clarify patterns of sensory cues within the ALFs, the frequency, mean, and standard deviation of individual cues was run for data cleaning and to determine overall patterns of distribution. To start the analysis, it was helpful to compare the frequency of falls in public versus private spaces to determine fall locations within ALFs. There were a total of 3,437 falls, with public spaces accounting for 26.4% (904) of the falls, and private spaces reporting 73.6% (2,530) of the falls. This averages to 24.55 falls for each of the 140 ALFs, and when public and private spaces were calculated separately, there were on average 6.48 of falls in public spaces and 18.60 in private residences, which makes a strong case for why research should continue in residential spaces, especially those within long-term care communities/facilities[22,23,24]. However, even less research has been completed in public spaces which also points to the need for expanding the body of knowledge relative to public spaces, which was the purpose of this study.

In public spaces, expectations were that the higher the number of cues within the environment, the lower the number of falls. When the initial screening of overall sensory cue frequency was completed, two things were immediately clear. First, tests analyzing the original list of environmental sensory cues within overall ALF facilities produced results that were contrary to expected outcomes. In other words, the higher the number of sensory cues, the higher the number of falls that were occurring within ALFs.

Additionally, when the checklist instrument data were analyzed, it was discovered that the wording of the coding method hindered an accurate description of the inclusion of cues in the ALF spaces. For instance, nearly two-thirds (65.7% - 92 of 140) of the ALFs had only one floor. An item on the checklist was developed in regards to stairway handrails extending at least 12” past the first and last steps. In 85.2% of the rooms (880 out of 1033), the observers responded with “0-this cue is not present.” However, it was not clear whether stairs did not exist because this ALF only had one floor making this cue “not applicable,” or whether there were indeed stairs where the handrails did not extend 12”, which would mean the cue is “not present”. In response to this ambiguity, any environmental sensory cues that might be unclear were omitted from further analyses.

In the short term, this coding method did not affect the use of the checklist as a design tool. However, it did impact its use as a research tool, making it desirable to remove multiple questions from further analysis. For future use, the checklist was expanded to include a category of "not applicable".

Secondary Analysis: Individual Room Patterns

After removing the affected cues, 18 visual cues and one auditory cue were selected to be used in the remaining analysis based on their suitability to all rooms. To confirm that these 19 cues were tapping a coherent construct, factor analysis using a principle component extraction was run on the 1033 ALF rooms to determine how well these sensory cues were associated. Most importantly, 15 of the 19 cues were grouped within the first component and had a factor loading above the absolute value of .3, as shown in Figure 2. In fact, most of the scores were above .5, .6 and .7, signaling that items in this component were measuring dynamics of the same latent coherent construct. Four components e.g., contrast, wayfinding, lighting/electrical, and floor graphics were identified, having Eigenvalues > 1.0,

	Four Factor Analysis Components			
Checklist Instrument # and Wording	**1 Contrast**	**2 Wayfinding**	**3 Lighting/ Electrical**	**4 Floor Graphics**
22: Matte finishes are used on furniture	.640			
23: Matte finishes are used on the floor	.567			
23: Matte finishes are used on the floor				.814
32: Graphic images are used on wall surfaces		.444		
50: Full spectrum bulbs are used on overhead lighting	.386		.408	
51: Electrical receptacles are located ≤ 12' apart	.522		.468	
52: Sensored lighting is provided		.548		
53: Room alarms include visual cues such as blinking lights	.602		-.600	
55: Room alarms include auditory cues	.590		-.584	
59: Permanent signage is placed in a consistent place by the door	.664			
66: Different colored walls assist with wayfinding	.312	.708		
67: Artwork, photographs,/memorabilia assist with wayfinding		.683		
68: Door hardware contrasts with the door	.653			
69: Door frames/moldings contrast with the walls	.635			
70: Handrails contrast with walls	.712			
76: Floors are clearly defined from walls	.708			
77: Walls are clearly defined from the ceiling	.740			
78: Furniture is clearly defined from the floor	.611			
79: Switch plates contrast with walls	.561			

Cases Valid	982	(95.1%)
Excluded	51	(4.9%)
Total	1033	(100.0%)
Cronbach's Alpha .846; N = 19		

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Figure 2: Component Matrix of the 19 Visual and Auditory Cues

which was the cutoff selected for this analysis. These four components represented a cumulative percentage of 52.93 of the variance between the 19 cues. To confirm that these cues were suitable, evidence needed to show a principle first component. The grouping of scores on the first factor demonstrated that there was a core construct underlying the measure and that it was not purely random. For further confirmation, Cronbach's Alpha was used to determine the internal reliability between these groups. Cronbach's Alpha scores range from 0 - 1.0. Scores above .7 suggest that the items are measuring something coherent at the underlying structure level[25]. The Cronbach's Alpha for these 19 sensory cues was .846, meaning that there was a high inter-item correlation, as shown in Figure 2.

Next, a common list of public rooms was distinguished in the checklist instrument with space on the checklist provided to identify the specific room that each sensory cue related to. Within the 140 ALFs, there was no one public room type, e.g., Living Room/Lounge, Dining Room, etc. that existed within all facilities. However, the five most common rooms within Facility Sizes 1, 2, and 3 included the Living Room/Lounge, Dining Room, Corridor, Public Restroom and Foyer and became the focus of analysis.

These five rooms were analyzed incorporating the 19 sensory cues used in the initial factor analysis. However, additional sensory cues were later analyzed for each room, as seemed appropriate to each space, as shown by an X in Figure 3. For example, it made sense that some type of seating would exist in the Living Room/Lounges and in the Dining Room. Therefore, any additional sensory cues that were seating-related were run in the factor analysis for the Living Room/Lounge and Dining Room. It was less clear whether seating in Public Restrooms, Corridors, or Foyers would be commonplace so factor analysis of the seating sensory cues did not occur in these latter rooms. This additional exploration allowed for selection of the sensory cues that were appropriate to each room type.

The close association of first factor scores and high Alpha levels within each room indicates that these items measured cues in meaningful ways, validating the checklist instrument. Overall, the following characteristics demonstrated positive close first associations within each room type: highly contrasting surface finishes and furnishings; using matte finishes as opposed to glossy finishes; and use of both visual and auditory alarms. Additionally, the overall Alpha level was over .83 for each room and was higher than the Alpha level reported for overall facility rooms. To determine whether the patterns of association continued when rooms were collapsed into subsets by facility size, additional ALF data were analyzed.

Secondary Analysis: Facility Sensory Cue Patterns

As previously mentioned, the first tests analyzing all 110 environmental sensory cues within ALFs produced results that were contrary to expected outcomes, regardless of facility size. In an effort to assess whether the cue patterns were different across all ALFs based on facility size, mean scores were analyzed and results are shown in Figure 4. When facility size was controlled, the mean number of sensory cues increased significantly as facility size increased, showing that this was not by chance. For example, Facility Size 1 had a mean of 19.52 sensory cues in each room, while Facility Size 4 had a mean number of 29.04.

In relation to falls, the following demographic variables were analyzed in an effort to explain the variability of results: ALF business formation type (sole ownership, corporation, for-profit vs. non-profit; age of residents; personal care level choice; average time residents lived in the ALF; number of floor levels in the ALFs; the inclusion in a chain; and the accessibility of public spaces. ALF size and sensory cues were still controlled in order to find any instances of significance.

19 Cues Selected for Analysis: Checklist Instrument # And Wording	Living Room/ Lounge	Dining	Corridor	Public Restroom	Foyer
22: Matte finishes are used on walls	X*	X*	X*	X*	X*
23: Matte finishes are used on the floor	X*	X	X*	X	X*
31: Graphics are not used on flooring surfaces	X	X	X	X	X
32: Graphic images are used on wall surfaces	X	X	X	X	X
50: Full spectrum bulbs are used in overhead lighting	X	X	X	X*	X*
51: Receptacles are located ≤ 12'	X*	X*	X*	X	X*
52: Sensored lighting is provided	X	X	X	X*	X*
53: Alarms include visual cues	X*	X*	X*	X*	X*
55: Alarms include auditory cues	X*	X*	X*	X*	X*
59: Permanent signage is consistently placed by doors	X*	X*	X*	X*	X*
66: Different colored walls assist with wayfinding	X	X	X*	X	X
67: Artwork, photographs/memorabilia assist with wayfinding	X	X	X*	X	X
68: Door hardware contrast with the door	X*	X*	X*	X*	X*
69: Door frames/moldings contrast with walls	X*	X*	X*	X*	X*
70: Handrails contrast with walls	X*	X*	X*	X*	X*
76: Floors are clearly defined from walls	X*	X*	X*	X*	X*
77: Walls are clearly defined from the ceiling	X*	X*	X*	X*	X*
78: Furniture is clearly defined from the floor	X*	X*	X*	X*	X*
79: Switch plates contrast with walls	X*	X*	X*	X*	X*
Additional Sensory Cues					
21: Matte finishes are used on furniture.	X*	X*			
24: Tinted glass is used on windows					X
29: Flooring material transitions are ≤1/4"			X*	X*	X*
34: Lighting is located by exterior entrances					X*
57: Corridors are free from clutter on 1 wall			X*		
58: Handrails are on at least 1 corridor wall			X*		
61: Signage directs people for wayfinding			X*		
62: Exit signage is placed ≤27" AFF			X*		
63: Signage ≤80" extends ≤4" into the space			X*		
64: Signage letters and background contrast			X*		
65: Emergency exits are clearly noted			X*		
71: Handrails contrast with the walls			X*		
74: Restroom grab bars contrast with walls				X*	
80: One type of flooring is used in corridors			X*		
81: Windows are placed to minimize glare					X
86: Stairs are used to enter this space					X
98: All seating has arms	X*	X*			
99: All seat cushions are firm	X*	X*			
100: Seat heights are ~18"H or higher	X*	X*			
101: Chairs have four legs	X*	X*			
114: Handrails provide messages on back side			X		
115: Handrails provide recessed fingertip grip			X*		

* Indicates cue was strongly associated with other first component sensory cues.

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Figure 3: Sensory Cues Factored in Five Rooms.

*Indicates cue was strongly associated with other first component sensory cues.

The major finding of these analyses ultimately described the relationship of ALF facility size to the number of falls. The significance was at $p < .001$, indicating the number of falls was unquestionably impacted by the facility size. The ANOVA test also supported that facility size was overpowering the impact of all other variables. Finally, the ANOVA test indicated a significant relationship between falls, the age of residents, and the size of the

Facility Size (# of Residents)	Number of ALF Rooms	Mean # of Sensory cues (Std. Dev)	F	Level of Significance
1 (1-11)	175	19.52 (7.41)	44.61	.000
2 (12-62)	498	25.61 (7.00)		
3 (63-225)	282	26.93 (7.69)		
4 (>226)	27	29.04 (2.19)		
Total	982	25.00 (7.66)		

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Figure 4: Sensory Cue Data within Each Facility Size

facility (p=.006), further demonstrating the impact of facility size.

Falls were not significantly related to the caregiver ratio within overall facilities or within the different facility sizes. Therefore, other characteristics that might be influencing falls were then analyzed. A correlation test was run between falls and ALF characteristics and found accessible public spaces, sensory cues, and facility size had an association with falls. When public spaces were accessible, there were a higher number of falls; when sensory cues were most prevalent, the amount of falls increased; and the larger the facility, the higher the fall count. Clearly, ALFs are complex environments, and these results show that falls are impacted by a wide range of variables

Significance of Interior Design: Predictive Validity

Correlation does not necessarily imply causation so it cannot be said that a greater number of sensory cues was contributing to an increased number of falls. However, it does highlight the fact that design professionals should have knowledge of the role of sensory cues in ALF facility design, and especially in the lives of their residents.

To clarify this impact, an independent t-test was run. Some facility directors did not have knowledge of whether a design professional was used in the construction/renovation of their facility, but of those who did, nearly 70% used a design professional in original construction and 35.7% engaged a design professional in subsequent renovations. Consistent with expectations, ALFs constructed with design consultants had significantly more sensory cues per room than ALFs not employing design professionals, $t(135) = 4.268$, $p < .001$. Similarly, ALFs that had been renovated by a design professional also had significantly more sensory cues per room than ALFs not employing design professionals, $t(74) = 4.752$, $p < .001$. Overall, there was a greater mean amount of sensory cues incorporated into original construction/renovation when a design professional was present than when they were not.

As research continues to highlight the impact of design professionals' inclusion of sensory cues in ALF environments, it is essential to recognize the impact of making simple associations or assumptions from overall cue data. Increased knowledge that sensory cues within facility size are now a predictive variable helps to clarify the need to control some factors in facilities and in rooms that could lead to spurious results.

Discussion

The purpose of this exploratory study was to develop, test, and evaluate the validity of the checklist instrument as a design and research tool for the interior design and architectural community. This was in order to provide a systematic method for evaluating environmental risk factors and sensory cues within ALFs, with visual cues being the focus of this particular study. Some of the checklist items were shown to influence resident fall risks while other checklist items serve to minimize injuries resulting from falls. Support was shown for the validity of the measurement tool, in spite of the fact that it did not serve as a fall prediction instrument. Some might ask, "If sensory cues were not shown to significantly influence/decrease falls, then why keep using the tool?" The answer is that in previous studies, measurements might not have been fine enough to tease out the appropriate relationship between sensory cues and falls. Continued use of the checklist means several factors are being investigated, therefore, not eliminating or focusing on one or two individual factors. It is relevant and appropriate to continue this investigation, even though no causation was shown.

Further research will aid in fine tuning the checklist instrument and increasing the sample size. In this study, 140 ALFs were toured within the Lower Peninsula of Michigan. This restricted geographic setting may limit the generalizability of the findings, although demographic information was aligned with findings documented in the literature review. In addition, bias may have been introduced into the results based on the facilities that did not participate, with possible systematic differences being inherent in the directors who chose to participate in this study.

In total, there were 9869 residents housed in these 140 ALFs. Although the numbers of residents in each age category were requested, this information was not always documented accurately by the director. Therefore, only age categories of residents residing within the facility at the time of the survey were used in data analysis.

The final, and most important limitation, was the issue with the initial coding method used on the checklist instrument, as previously mentioned. The checklist was of value but had some initial constraints due to the need to modify the checklist instrument. To that end, the checklist instrument should continue to be refined as a measure in identifying demographic characteristics and sensory cues, and research should begin to expand to include qualitative studies. The final checklist instrument results in this study consisted of 18 visual cues and one auditory cue. Future research utilizing the checklist instrument should expand to include additional auditory and tactile cues, especially since the literature identified that balance is increasingly dependent on touch receptors in addition to visual cues[8,10,11,13]. Finally, running factor analysis of the revised checklist instrument to begin assessing whether the instrument can be condensed will also enhance future research.

Analysis showed that the larger the ALF, the more mean number of cues were included in the overall environment. Throughout analysis, inconsistent fall and cue patterns emerged for overall facility type, but also when room type was analyzed separately. For example, the Dining Room and Foyer had the lowest mean number of sensory cues out of all five rooms and did not show a significant relationship when sensory cues and falls were analyzed. One thought to consider is that ALFs by definition usually house fairly healthy older adults, but residents who are not feeling well may not be visiting these areas. They may choose instead to eat in their room or require assistance from caregivers in traveling to meals. In addition, unless they are leaving the ALF to seek medical treatment options, they may be spending more time convalescing in their room instead of walking to the foyer to await guests, joining in conversation with other residents/staff, or exiting from the foyer to the outdoors to travel into the community. To contrast this thought, the Dining Room is often used for a variety of activities such as parties and other social events. These more dynamic activities may attract an increased number of healthier older adults, minimizing the number of falls occurring within this environment.

The sensory cues in the Living Room/Lounge of every facility size had a significant positive relationship to falls. In order to determine why this ran contrary to the original hypothesis, it helped again to look at the activities occurring within this environment. For example, the Living Room/Lounge could be typically utilized as an area for residents to gather and socialize or participate in other activities. As more residents spend more time in this room, more falls could be the result. Another aspect to consider is that in community care facilities, older adults with higher dependency tend to spend more time in public social spaces (i.e. Living Room/Lounge)[26]. One theory as to why this occurs is because it may be easier for caregivers to monitor and care for the needs of multiple residents in one environmental setting[27]. A direction for research could include looking at the diverse needs of residents spending time in the Living Room/Lounge, and comparing that with a measurement of sedentary or activity levels.

Future research within Living Room/Lounges could explore the impact of personal assistance and caregiver roles within diverse facility sizes and room types to determine their influence on fall rates. For example, a Facility Size 1 (smallest) director stated that because she helps residents to move throughout the facility, it is much more unlikely that they will fall.

In both the Corridor and Public Restroom, when there was a high number of sensory cues, there was a lower number of falls, which was the initial predicted pattern. When contemplating why the Corridor might have a different pattern than the Living Room/Lounge, Dining Room, or Foyer, it made sense to look at other factors that might influence fall rates such as who might be using the Corridors. Once more, one explanation to consider is that healthier residents would be more likely to use the Corridors to travel to other destinations within and outside of the ALF, and are better able to respond to available environmental cues. This contrasts with residents who do not have a high level of health, who are less likely to travel through the Corridors, and are also not as likely to be able to respond to environmental cues. Therefore, a next step in research would be to establish a method for behavioral observation in room types to increase overall understanding of resident health and room use relative to falls.

With regard to use of the Public Restroom, a point to highlight is that some of the residents chose to use the public restrooms even though they may have their own personal restrooms. A line of reasoning to consider related to fall rates could be that residents may move more quickly to use the facilities due to urinary urgency since they made the choice not to return to their rooms. In addition, most men choose to stand while urinating, which could lead to a loss of balance while they focus on other activities. It is fairly common that restrooms would have white toilets, white floor tile and white walls. Future research can explore the benefit of integrating wall surfaces that contrast with floors and door frames and whether these strong vertical and horizontal cues influence fall rates. Another area for more focused research could be to analyze the fall rates in men's and women's restrooms to see if there is a significant gender difference. Conversely, due to their smaller size, Facility Size 1 ALFs may not have public restrooms or may only have a shared restroom. Caregivers from this facility size have pointed out that they may assist residents in returning to use these amenities. This relates to the suggestion that facility size may impact fall rates[28]. Smaller facilities may mean that staff have more opportunities to directly supervise residents. Future research may help to clarify the multitude of factors that influence resident falls.

Another factor in explaining why ALFs that showed an increase in environmental sensory cues also showed an increase in falls may relate to age because as older adults age, their physical and cognitive abilities often decrease. This may not only increase the difficulty for older adults to move within a space, but also could impair their ability to process sensory information in their environment. Eventually, this impairment can become so significant that neither the environment, nor caregivers, can provide enough support to regularly prevent falls. Many directors indicated that ALF residents are moving in at an older age and with more health challenges, illustrating the need to recognize that environment may only serve as a support up to a certain point when care needs are acute, reducing the interaction between residents and environmental cues.

Future research could establish whether residents in different facility sizes have differing care needs, and/or document whether residents are delaying the decision to move to environments that are better equipped to support declining physical and cognitive abilities. For example, residents choose to move to assisted living facilities from a variety of settings, including the community, home care, hospitals, and nursing facilities. Residents of small facilities (10 or fewer residents) were more likely to have moved from another ALF than were residents of large facilities, and residents of large facilities were more likely to have come from hospitals than were residents of small facilities[29].

The value of continued use of the checklist provides the opportunity for all aspects of the physical environmental to be investigated. Further knowledge of the factors that influence aging adults' ability to safely maneuver an environment highlight the need for continued investigation. It was found that good design cannot overcome all impairments. For example, enhanced lighting levels cannot compensate for an ALF resident in a weakened state who trips and falls due to a gait issue, or who cannot rise from a chair to exit a room through a door frame that contrasts with the wall. Further research could identify a level of influence sensory cues can have on specific levels of impairments.

Knowledge of these outcomes will assist in developing evidence-based solutions, which is a goal of ongoing research. As a research tool, this checklist instrument will also benefit the ability of researchers to analyze quantitative data within diverse room types and ALF facility sizes. Knowledge is power, and design professionals and directors who are able to affect the living environments of residents in such a significant manner will be essential team players in managing the ability of the facility to promote safety, health, and quality of life issues for ALF residents.

Conclusion

The purpose of this study was to develop, test, and evaluate the face and predictive validity of a sensory cue checklist instrument developed as a design and research tool in the design of ALFs. By completing the checklist, researchers and designers can document the number and types of visual sensory cues in an existing facility or in a new ALF design. Research has shown that sensory cues can positively influence residents' falls. Therefore, it was predicted that ALF residents who are prone to falls, will be less likely to fall due to sufficient number and type of environmental sensory cues. However, contrary to the hypothesis, a positive correlation was found between sensory cues and reported falls in most spaces, i.e., as the number of cues increased, the number of falls also increased. Although there is no causal relationship identified, this finding indicates that investigation of additional fall influences must be conducted. At the same time, the checklist instrument demonstrated face and predictive validity as a research tool, which will benefit researchers' ability to collect and analyze sensory cue data in existing or proposed spaces. This seems to be a good first step the development of a valid sensory cue instrument.

By 2030, the older adult population will be nearly twice as large as it is today. The years between now and then will be the most impactful in providing opportunities to implement significant changes to the ALF environment. No doubt, over time, design professionals will be called upon to creatively address these dynamic issues at both an individual and societal level. By understanding the diverse relationships affecting ALFs, both in public and private areas, designers can identify solutions that positively support the health and well-being of the individuals who reside and work within ALFs.

This knowledge of older adults' interaction with the environment can help to prioritize budgets when developing projects related to ALFs, especially when the budget is restricted. Even more notably, knowledge of these environmental outcomes can lead to an increase in the ease of residents to safely move around their environment. As the population ages, identifying design recommendations for room types within diverse Facility Sizes based on informed decision making will benefit residents, family members, staff members, ALF directors, and society as a whole.

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