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The physical environment influences neuropsychiatric symptoms and other outcomes in assisted living residents

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Abstract

Objective—Although the number of elderly residents living in assisted living (AL) facilities is rising, few studies have examined the AL physical environment and its impact on resident well-being. We sought to quantify the relationship of AL physical environment with resident outcomes including neuropsychiatric symptoms (NPS), quality of life (QOL), and fall risk, and to compare the effects for demented and non-demented residents.

Methods—Prospective cohort study of a stratified random sample of 326 AL residents living in 21 AL facilities. Measures included the Therapeutic Environmental Screening Scale for Nursing Homes and Residential Care (TESS-NH/RC) to rate facilities and in-person assessment of residents for diagnosis (and assessment of treatment) of dementia, ratings on standardized clinical,

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Author contributions

Drs Lyketsos, Rosenblatt, Brandt, and Rabins played a role in study concept and design, acquisition of subjects and data, analysis and interpretation of data, and preparation of paper. Ms Samus and Drs Baker, McNabney, and Onyike played a role in acquisition of subjects and data, analysis and interpretation of data, and preparation of paper. Dr Mayer played a role in analysis and interpretation of data and preparation of paper. Mr Bicket played a role in acquisition of data, analysis and interpretation of data, and preparation of paper.

Conflict of interest

None known.

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cognitive, and QOL measures. Regression models compared environmental measures with outcomes. TESS-NH/RC is modified into a scale for rating the AL physical environment AL-EQS.

Results—The AL Environmental Quality Score (AL-EQS) was strongly negatively associated with Neuropsychiatric Inventory (NPI) total score ($p < 0.001$), positively associated with Alzheimer Disease Related Quality of Life (ADRQL) score ($p = 0.010$), and negatively correlated with fall risk ($p = 0.042$). Factor analysis revealed an excellent two-factor solution, Dignity and Sensory. Both were strongly associated with NPI and associated with ADRQL.

Conclusion—The physical environment of AL facilities likely affects NPS and QOL in AL residents, and the effect may be stronger for residents without dementia than for residents with dementia. Environmental manipulations that increase resident privacy, as well as implementing call buttons and telephones, may improve resident well-being.

Keywords

physical environment; neuropsychiatric symptoms; assisted living; behavior; dementia

Introduction

Assisted living (AL) facilities represent a growing long-term care residence option for older persons who are unable to live independently, yet require less care than provided in a nursing home (NH). Though it is often thought that AL serves residents with minor functional limitations, recent research suggests AL facilities primarily house a cognitively disabled elderly population with considerable general medical morbidity (McNabney *et al.*, 2008), in which about two-thirds of the residents suffer from dementia (Rosenblatt *et al.*, 2004). In AL, dementia has been associated with greater functional impairment (Burdick *et al.*, 2005), reduced quality of life (Samus *et al.*, 2005; Samus *et al.*, 2006), and accelerated time to discharge (Lyketsos *et al.*, 2007). The AL physical environment represents an important determinant of psychosocial and health outcomes of elderly residents, especially those with dementia (Sloane *et al.*, 2002). Mitigating the adverse outcomes associated with dementia in the AL setting would be of significant benefit to elderly persons.

Although modifications of the AL physical environment may be one approach to mitigation, more attention has been paid to the physical environment in the NH setting. Features of the physical environment in NH settings at the multi-unit and building level that correlate with resident outcomes include: noise/stimulation and agitated behaviors (positive) (Nelson, 1995), signs and orientation (positive) (Namazi and Johnson, 1991; Namazi *et al.*, 1991), a home-like setting and nutritional status (positive) (Mathey *et al.*, 2001; Nijs *et al.*, 2006; Desai *et al.*, 2007), and lighting and falls risk (negative) (Vu *et al.*, 2005). For patients with dementia in the NH setting, features at the room or unit level that correlate with resident outcomes include: privacy with levels of aggression (negative), amount of common spaces with degree of social withdrawal (negative), and exit design with level of depression (negative) (Zeisel *et al.*, 2003).

While the physical environment has been shown to correlate with cognitive and physical well-being of residents in NHs (Rule *et al.*, 1992), few studies have systematically examined effects of the physical environment on well-being of residents in AL. Objective assessment of the physical environment in AL is challenging: the process of rating the environment can affect data accuracy through observation bias which, in turn, reduces the validity of data. Additionally, AL environments are amenable to change but may change in unexpected ways compared to measured outcomes of residents. To address these challenges, simple aspects of the physical environment may be examined. Using the number of beds in a facility, and dividing into *small* (≤ 15 beds) and *large* categories, we previously reported a higher rate of

dementia in residents of small facilities (81%) compared to large (63%) (Leroi *et al.*, 2007). To aid in systematic observation of the AL setting, standardized instruments have been developed (Sloane *et al.*, 2002; Zeisel *et al.*, 2003). In the largest AL study to date involving 2078 residents in 193 facilities, no association was found between physical environment and events including hospitalization, morbidity, NH transfer, or mortality (Zimmerman *et al.*, 2005).

Based on prior research relating the physical environment to resident outcomes in long-term care settings, we sought to extend the literature on the relationship of the physical environment with AL resident outcomes as part of the Maryland Assisted Living Study (MD-AL). The primary aim of this study was to relate systematic ratings of the AL physical environment to measures of resident well-being including neuropsychiatric symptoms (NPS), quality of life (QOL), and risk of falls.

Methods

Study design

This paper analyzes a subset of data from Cohort I and II of MD-AL (Rosenblatt *et al.*, 2004), a cross-sectional study of a stratified, random sample of current AL residents in central Maryland. The Johns Hopkins Institutional Review Board reviewed, approved, and monitored the study. Every resident, or a legal representative, provided informed consent for participation in accordance with guidelines developed by the Alzheimer's Association (Alzheimer's Association, 2004). The state of Maryland provided a list of all facilities meeting Maryland state licensure definition (COMAR, 1998) for AL that were licensed or had applied for a license. Thirty AL facilities, 13 large (≥ 16 beds) and 17 small (< 16 beds), were randomly selected from this list; this random sample was stratified by facility size to ensure sufficient numbers of residents from large and small facilities. For each large facility, fifteen residents were randomly selected according to room number regardless of dementia-specific care unit (DCSU, or facilities that self-identified as dementia care or Alzheimer's facility or area) designation. A resident in a DCSU was included if their room number was selected. For small facilities, all residents were asked to participate. In this way, the study was careful to represent both small and large facilities proportionate to the number of residents in each type of facility.

MD-AL includes baseline data on 30 facilities housing 401 residents, with 198 and 203 residents in Cohort I and Cohort II, respectively. This analysis includes data on 21 facilities housing 326 residents that had study residents at the time of TESS assessment (13 large and 8 small; 4 containing DCSUs) (Samus *et al.*, 2008). Of nine remaining facilities, four were not in operation and five had no residents remaining in the study. The demographics of the Maryland AL population and of the MD-AL population are consistent with characteristics reported in national surveys of AL facilities (Rosenblatt *et al.*, 2004). The longitudinal version of MD-AL commences this fall.

Assessment of AL residents

A trained study team consisting of a geriatric psychiatrist, a nurse, and a psychometric technician performed an on-site, in-person, baseline clinical evaluation of residents and obtained information from family members, staff, and chart reviews. Baseline assessments of residents in Cohorts I and II were identical, and took place upon resident enrollment between February 2002 and January 2003 and between February 2004 and February 2006, respectively. A psychiatrist administered the Mini-Mental Status Exam and the Structured Clinical Interview for DSM-IV for every resident with an MMSE score greater than 23. The

SCID was not administered to residents with lower cognitive function due to concerns about instrument validity in this population.

Other measures included:

- Neuropsychiatric Inventory (NPI), which assesses psychopathology in dementia patients by evaluating 12 neuropsychiatric domains: delusions, hallucinations, agitation, dysphoria, anxiety, apathy, irritability, euphoria, disinhibition, aberrant motor behavior, night-time behavior disturbances, and appetite and eating abnormalities. Higher scores indicate increased frequency and/or severity of symptoms;
- Alzheimer Disease Related Quality of Life (ADRQL), which assesses quality of life in dementia patients with a scale of 47 items across five domains: social interaction, awareness of self, feelings and mood, enjoyment of activities, and response to surroundings (Rabins *et al.*, 1999). Higher scores indicate better quality of life;
- Resident fall risk, whether or not a resident had fallen in the month preceding the baseline clinical evaluation, as recalled by the resident and chart review.

A multidisciplinary panel of experts used data collected from in-person assessments to diagnose dementia and other psychiatric conditions at a consensus conference using criteria set out in the DSM-IV, and to rate the completeness of dementia treatments for each resident.

Environmental evaluation

The physical environment of AL facilities was assessed by the Therapeutic Environment Screening Survey for Nursing Homes and Residential Care (TESS-NH/RC), an instrument designed to rate physical environments of nursing homes and residential centers, which includes AL facilities. TESS-NH/RC was developed from TESS-Nursing Home (TESS-NH) (Sloane *et al.*, 2002) and its refinement TESS-Residential Care (TESS-RC) (Zimmerman *et al.*, 2005). TESS-NH has good inter-rater reliability and strong concurrent validity with the Professional Environment Assessment Procedure (PEAP) (Lawton *et al.*, 2000) and the TESS-NH global rating item (Sloane *et al.*, 2002). TESS-RC has no published validity data, but good internal reliability (Sloane *et al.*, 1998).

TESS-NH/RC rates 15 environmental items presented in Table 1, with each item receiving a 0, 1, or 2 score. Items include: facility maintenance, cleanliness, handrails, call buttons, light intensity, light glare, light evenness, hallway length (shorter), homelikeness, room autonomy, telephones, tactile stimulation, visual stimulation, privacy, and outdoor areas. Summing scores from the 15 environmental items yield the AL Environmental Quality Score (AL-EQS), a summary score with range 0–30. Higher scores indicate better environmental quality.

TESS-NH/RC was administered between 10 and 31 July 2007, by the same rater. That rater reviewed TESS-NH/RC documentation thoroughly, using the manual as a strict guideline. Prior to data collection, the study team discussed all TESS-NH/RC items. In one case, a facility had only one resident in the study and access to the resident's room was not possible so consent was obtained to view a different resident room with the same layout and design.

Statistical analysis

Analyses were performed using SPSS v15.0 (SPSS Inc., Chicago, IL) statistical software. Continuous variables were examined for fit to the normal distribution. NPI was log

transformed to reduce the positive skew of its distribution. Fall risk was coded as a dichotomous variable (yes/no).

Our primary analyses tested several specific *a priori* hypotheses. We predicted that overall *higher* AL-EQS scores would be associated with *fewer* NPS (lower NPI), *better* quality of life (higher ADRQL), and *lower* risk of having fallen in the past month (lower fall risk). We also predicted the following associations between specific TESS-NH/RC items and resident ratings:

- Higher scores on maintenance, cleanliness, handrails, call buttons would be associated with lower NPI scores and lower risk of falls;
- Higher scores on room autonomy, hallway length, telephones, tactile stimulation, visual stimulation, privacy, outdoor areas would be associated with higher ADRQL scores.

Hypotheses were tested in a series of regression models. Dependent variables were NPI score, ADRQL score (linear models), or fall risk (a logistic model). Covariates included AL-EQS, individual TESS-NH/RC item scores, and the three sets of TESS-NH/RC item scores specified above. Hypotheses were examined with and without stratifying by dementia status.

In the secondary analyses, a factor analysis (with Varimax rotation) was used to estimate the underlying structure of the TESS-NH/RC instrument. Factor retention was based on the Scree criterion. The sample size satisfied the subject-to-variable ratio of at least 10:1. Of the 15 TESS-NH/RC items, three (light intensity, light glare, and outdoor areas) had individual Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy less than 0.5 and were excluded from further analysis. The strength of the relationship among the remaining items was strong (KMO = 0.723, Bartlett's test of sphericity $p < 0.001$). Two factors were extracted which were labeled 'Dignity' and 'Sensory'. Domain scores (not factor scores) were computed by summing scores of the TESS-NH/RC items that loaded significantly on each respective factor. The use of the scores of the variables that load highly on a factor rather than the factor scores reduces the sampling variability attributable to estimating the factor loading. The relationship between the factor derived domain scores and resident variables was estimated through univariable and multivariable regression models.

Results

A total of 21 AL facilities, including four that contain DSCUs, were evaluated using TESS-NH/RC, with baseline characteristics of residents presented in Table 2. The average number of resident rooms evaluated per facility was 2.44 (range 1–7). The mean AL-EQS score ($\pm$ SD) was 16.4 ± 4.4 (range 8–24). No significant differences were found in comparisons of AL-EQS scores among DSCUs and non-DSCUs ($t = -0.766$, $p = 0.452$); among urban, suburban, and rural AL facilities ($F = 2.253$, $p = 0.129$); or among large facilities opened before or after January 1987 ($F = 0.683$, $p = 0.524$).

AL-EQS correlated negatively with NPI for all residents ($r^2 = 0.075$, $p < 0.001$). TESS-NH/RC items significantly associated with NPI for all residents, those with dementia, and those without dementia included: facility maintenance, handrails, call buttons, hallway length, homelikeness, room autonomy, telephones, and privacy. Cleanliness was only significant for all residents, and those with dementia. In multivariable linear regression models controlling for age, gender, education, and dementia status, AL-EQS was significantly and negatively associated with NPI ($r^2 = 0.141$, $p < 0.001$). Table 3 shows results of multivariable analyses among environmental measures and resident outcomes including NPI.

AL-EQS correlated positively with ADRQL for all residents ($r^2 = 0.020$, $p = 0.010$). TESS-NH/RC items associated with ADRQL for all residents included: facility maintenance, call buttons, hallway length, homelikeness, room autonomy, telephones, and privacy. The third ADRQL subscale was the only ADRQL subscale significantly associated with AL-EQS for all residents ($r^2 = 0.038$, $p < 0.001$), residents with dementia ($r^2 = 0.038$, $p = 0.026$), and those without dementia ($r^2 = 0.031$, $p = 0.014$). AL-EQS was not associated with ADRQL in the regression models ($r^2 = 0.093$, $p = 0.185$).

AL-EQS correlated negatively with fall risk for all residents (Cox $r^2 = 0.013$, $p = 0.042$). TESS-NH/RC items associated with a higher risk of fall included: handrails, light glare, hallway length, and room autonomy. Of the three hypothesized AL-EQS derived item scores, only that for ADRQL was significant positively ($r^2 = 0.028$, $p = 0.003$) while those for NPI ($r^2 = 0.004$, $p = 0.283$) and fall risk (Cox $r^2 = 0.109$, $p = 0.053$) were not.

Table 4 shows results of correlational analyses between TESS-NH/RC item scores and resident outcomes by dementia status. Stratifying by dementia status, AL-EQS correlated negatively with NPI for residents with ($r^2 = 0.038$, $p = 0.006$) and those without dementia ($r^2 = 0.131$, $p < 0.001$). AL-EQS was not correlated with ADRQL for residents with ($r^2 = 0.014$, $p = 0.104$) or without dementia ($r^2 = 0.017$, $p = 0.138$). AL-EQS correlated negatively with fall risk for residents with (Cox $r^2 = 0.024$, $p = 0.035$) but not residents without dementia (Cox $r^2 = 0.004$, $p = 0.447$).

Factor analysis

Factor analysis of TESS-NH/RC items supported a two-factor solution (Table 5). The first factor named 'Dignity' explained 41.6% of the variance of the original items and included room autonomy, privacy, call buttons, phones, homelikeness, hallway length, and light evenness. The second factor named 'Sensory' explained 23.6% of the variance and included visual stimulation, tactile stimulation, maintenance, handrails, and cleanliness.

Dignity and Sensory scores were calculated by summing the scores for items that had significant loadings on the respective factors. We examined the relationship in regression models between these domain scores as independent variables and resident level dependent variables, specifically NPI, ADRQL (linear), and fall risk (log). In univariate models, Dignity was negatively associated with NPI ($r^2 = 0.139$, $p < 0.001$, Figure 1). Dignity was associated positively with ADRQL ($r^2 = 0.053$, $p < 0.001$), and negatively with fall risk (Cox $r^2 = 0.015$, $p = 0.043$). The Sensory score was significantly and negatively associated with NPI ($r^2 = 0.051$, $p < 0.001$) and positively associated with ADRQL ($r^2 = 0.014$, $p = 0.018$), but not associated with fall risk (Cox $r^2 = 0.008$, $p = 0.125$).

In multivariate models controlling for age, gender, education, and dementia status, Dignity was negatively associated with NPI ($r^2 = 0.188$; $\beta = -0.040$; $p < 0.001$) but Sensory was not ($\beta = -0.026$; $p = 0.149$). Dignity was positively associated with ADRQL ($r^2 = 0.108$; $\beta = 0.434$; $p = 0.047$) but Sensory was not ($\beta = 0.330$; $p = 0.449$). Neither Dignity nor Sensory was significantly associated with fall risk.

Discussion

The primary aim of this study was to relate systematic ratings of the AL physical environment to resident outcomes including NPS, QOL, and risk of falls. A higher quality physical environment was significantly and modestly associated with a reduced severity of NPS (as measured by NPI), especially in residents *without* dementia. Physical environment was also significantly associated with QOL in most models and less strongly associated with fall risk.

Several theoretical models attempt to describe the relationship between elderly persons and their environment (Lawton and Nahemow, 1973; Carp, 1987; Lawton, 1990; Lawton, 1998) with Lawton's ecological model of aging (EMA) relating behavior B as a function of person P , environment E , and person-environment interactions $P \times E$, $B = f(P, E, P \times E)$. This study quantifies this relationship by showing the impact of AL-EQS (E) on NPS (B). EMA stems from the environmental docility hypothesis, which posits that the environment becomes a more potent determinant of behavior as a person's competence decreases (Lawton and Simon, 1968). However, the environment's impact on NPS appears stronger for residents without dementia (or with greater competence). Explanations include the likelihood that residents with and without dementia have differing adaptive processes captured in the $P \times E$ interaction, which objective scales are unable to assess (Nahemow, 2000) and data from individual, social, and organizational components of the person-environment system have not been included.

The ability of TESS-NH/RC to relate the AL physical environment to NPS does suggest that this scale may differentiate AL environments associated with reduced resident NPS. In particular, items such as privacy, call buttons, and telephones have some of the highest correlations with NPS and ADQRL for residents with and without dementia. These three items may be important elements of the physical environment to examine in future studies that attempt to mitigate resident outcomes through environmental modifications.

Factor analysis yielded a two factor solution: Dignity, which included items that may relate to a resident's dignity such as respect (room autonomy, privacy, call buttons, and phones) and honor and esteem (homelikeness, hallway length, and light evenness), and Sensory, which related to the general facility ambiance (visual stimulation, tactile stimulation, maintenance, handrails, and cleanliness). Dignity explained 13.9% of the variance of NPS, suggesting that an increase in the Dignity Score from -4 to 2 could be associated with an average reduction in NPI from about 11 to 5 points (Figure 1). Such a reduction in average NPI has been suggested to be clinically significant (Cummings *et al.*, 2006), resulting in about 31 fewer total minutes per day of care provided to residents (Lyketsos, 2007).

Because NPS and QOL correlate closely in AL residents, the finding that the environment correlates with both NPS and QOL is not surprising. In our previous study by Samus *et al.* (2005), the overall homelike climate of AL facilities was captured using the Hopkins Homelike Environmental Rating Scale (HHERS) where facility size and 'homelikeness' were weakly correlated with NPS but not with QOL. Whereas HHERS was specifically designed to capture the overall homelike climate of each facility, TESS-NH/RC bases homelikeness on two data points: one, the 'homelike' appearance of activity rooms; two, the average 'homelike' appearance of resident room furniture. Such a simple scale may not adequately capture elements that constitute homelikeness. Indeed, homelikeness and hallway length (shorter) both load negatively on the dignity factor, unlike other items. Analysis of item scores for TESS has not been included in past studies, so no comparison can be made with prior data. The longitudinal version of MD-AL will revisit this issue in a follow-up study that is expected to commence this fall.

Certain components of the physical environment were weakly associated with increased fall risk, including increased handrails. Larger facilities had more handrails compared to small ($p = 0.002$), but also demonstrated a higher risk of falls ($p < 0.001$). Individual TESS-NH/RC items found to have significant associations with fall risk such as light glare, hallway risk, and room autonomy support prior research on environmental interventions meant to mitigate fall risk (Vu *et al.*, 2005).

Study strengths include the sizable sample derived randomly, use of a standardized instrument to evaluate the environment, and availability of resident level data. Several limitations should be noted. First, assessments of the physical environment relied on direct observation of one rater and were subject to observer bias; the TESS-NH/RC was used to reduce such bias, and future studies will include multiple raters. Second, AL facilities and resident rooms can be variable. Assessment of resident outcomes and environmental characteristics was not simultaneous, with environmental assessment taking place from one and one-half to five and one half-years after baseline assessment. Some characteristics of the environment may change over time. To standardize daily and seasonal changes in the environment, assessments were conducted at similar times in either late morning or early afternoon during a 3 week period. The study included AL facilities in Maryland only, but this sample is characteristic of AL facilities elsewhere (Rosenblatt *et al.*, 2004). The classification of large AL facilities as either board-and-care or purpose built facilities was approximated by date of facility opening before or after January 1987. Finally, the cross-sectional study design prevents the measurement of outcomes over time, though the longitudinal version of MD-AL will address this issue directly.

Conclusion

The physical environment of AL facilities that relate to greater resident dignity appear to be associated with fewer NPS and better QOL in residents, particularly those without dementia. NPS remain a central feature of dementia and an important treatment target (Lyketsos, 2007) so environmental manipulations in AL may have a significant therapeutic effect on AL residents. Environmental manipulations that increase the privacy of residents, as well as the implementation of call buttons and telephones, may reduce NPI and improve QOL. Exploring modifications that relate to a resident's dignity in the longitudinal version of MD-AL should further refine our understanding of this topic.

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	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Employment or affiliation	X		X		X		X		X		X		X		X		X	
Grants/funds	X		X		X		X		X		X		X	X			X	
Honoraria	X		X		X		X		X		X		X		X		X	
Speaker forum	X		X		X		X		X		X		X		X	X		
Consultant	X		X		X		X		X		X		X	X			X	
Stocks	X		X		X		X		X		X		X		X		X	
Royalties	X		X		X		X		X		X		X		X		X	
Expert testimony	X		X		X		X		X		X		X		X		X	
Board member	X		X		X		X		X		X		X		X		X	
Patents	X		X		X		X		X		X		X		X		X	
Personal relationship	X		X		X		X		X		X		X		X		X	

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Key points

- The influence of the environment on elderly residents, including those with dementia, has been established in long-term care settings such as nursing homes. However, few studies exist that address this topic in the assisted living (AL) setting.
- To examine the hypothesis that the environment impacts neuropsychiatric symptoms, quality of life, and fall risk, we systematically observed AL facilities using the Therapeutic Environment Screening Survey for Nursing Homes and Residential Care, an instrument designed for the AL setting.
- The environment affected resident behavior, impacting NPS strongly, quality of life less strongly, and fall risk weakly. Residents without dementia were affected by the environment more than those with dementia, contrary to Lawton's ecological model of aging.
- Studying the impact of the environment on AL resident outcomes over time may help better understand the relationship between the environment and the resident, especially regarding differences among patients with and without dementia.

Figure 1.

Scatterplot and Linear Regression of Dignity domain score by log (NPI total score). Using the computed Dignity score based on the dignity factor from the factor analysis on TESS-NH/RC elements, 13.9% of the variance of neuropsychiatric index (NPI) score is explained. Assuming causality is not in doubt, an increase in Dignity Score from -4 to 2 could be associated with an average reduction in NPI by about 50%: to 5 points from about 11. This point reduction in NPI is of similar value to neuropsychiatric benefits seen in patients with dementia who have been treated with Donepezil, that are small but significant (Cummings *et al.*, 2006). Further, this reduction in average NPI has also been suggested to result in about 31 fewer total minutes per day of care provided to residents (Lyketsos *et al.*, 2007).

Table 1

TESS-NH/RC item descriptions and rating criteria

TESS-NH/RC ^a item	Description and rating criteria
Facility maintenance	Rated 'in need of extensive repairs', 'in need of some repairs', and 'well maintained' for scores of 0, 1, or 2, respectively. Scores for activity/dining areas, halls, resident rooms and bathrooms averaged
Cleanliness	Rated 'poor level of cleanliness', 'moderately clean', or 'very clean' using same strategy as facility maintenance
Handrails	Rated 'little or none', 'somewhat', or 'extensively' for scores of 0, 1, or 2, respectively. Scores for halls and bathrooms averaged
Call buttons	Proportion of resident rooms and bathrooms with call buttons. Scores averaged
Light intensity	Rated 'barely adequate/inadequate', 'good', or 'ample' for scores of 0, 1, or 2, respectively. Scores for hallways, activity/dining areas and resident rooms averaged
Light glare	Rated 'in many areas', 'in a few areas', or 'a little or none' using same strategy for light intensity
Light evenness	Rated 'uneven; many shadows', 'mostly even', or 'even' using same strategy for light intensity
Hallway length	Rated 'long hallways', 'short hallways', or 'no hallways' for scores of 0, 1, or 2, respectively
Homelikeness	Reflecting (1) homelike furniture and other features in public areas, rated 'not/somewhat homelike', 'moderately homelike', or 'very homelike' for scores of 0, 1, or 2, respectively; (2) proportion of homelike furniture in resident rooms. Scores averaged
Room autonomy	Proportion of resident rooms with independent heating controls, air conditioning, and doors that lock inside and out. Scores averaged
Telephones	Proportion of resident rooms with telephones
Tactile stimulation	Reflecting availability of tactile stimulation in activity/dining areas and hallways, rated 'none', 'somewhat/quite a bit', or 'extensively' for scores of 0, 1, or 2, respectively
Visual stimulation	Reflecting availability of visual stimulation using same strategy for tactile stimulation
Privacy	Proportion of resident rooms that are private, proportion of residents with private toilets, and proportion of residents with private bath/shower facilities. Scores averaged
Outdoor area	Reflecting (1) attractiveness and (2) functionality of outdoor area(s), rated 'not at all', 'somewhat', or 'very' for scores of 0, 1, or 2, respectively. Scores averaged

^aTESS-NH/RC = Therapeutic Environment Screening Survey for Nursing Homes and Residential Care; scores may be 0, 1, or 2 with higher scores indicating increased quality. Source: Sloane et al., (2002).

Table 2

Baseline characteristics of residents with and without dementia

Characteristic	Total <i>n</i> = 326 ^a	Demented <i>n</i> = 194	Non-demented <i>n</i> = 131	<i>p</i> -value
Social demographic				
Age, mean $\pm$ SD ^b	85.4 $\pm$ 8.8	86.1 $\pm$ 8.1	84.3 $\pm$ 9.6	0.066
Education, mean $\pm$ SD	13.8 $\pm$ 3.2	13.6 $\pm$ 3.3	14.0 $\pm$ 3.2	0.233
Female (%)	75.5	77.8	72.5	0.275
White (%)	57.4	59.3	55.0	0.443
Assessment variable				
NPI ^c total score, mean $\pm$ SD	6.0 $\pm$ 9.6	7.3 $\pm$ 9.7	4.2 $\pm$ 9.2	<0.001
ADRQL ^d , mean $\pm$ SD	82.5 $\pm$ 12.3	79.9 $\pm$ 12.4	86.4 $\pm$ 11.3	<0.001
Resident fall risk (%)	22.4	24.6	19.4	0.027

^a One resident had a consensus diagnosis of dementia status missing and was excluded from analysis involving dementia status.

^b SD = standard deviation.

^c NPI = Neuropsychiatric Inventory; scores range from 0 to 120, with higher scores indicating increased frequency and/or severity.

^d ADRQL = Alzheimer Disease Related Quality of Life; scores range from 0 to 100, with higher scores indicating increased quality of life.

Table 3

Relationship between environmental score and resident measures by dementia status

	NPI ^b total score			ADRQL ^c			Fall risk	
	β	Std. β	p-value	β	Std. β	p-value	β	p-value
TESS-NH/RC model	$r^2 = 0.141$		<0.001	$r^2 = 0.093$		<0.001	Cox $r^2 = 0.023$	0.020
AL-EQS ^a total score	-0.030	-0.212	<0.001	0.248	0.076	0.185	0.064	0.113
Dementia status	0.292	0.269	<0.001	-6.431	-0.259	<0.001	0.370	0.198
Age	-0.003	-0.052	0.346	0.016	0.012	0.834	0.012	0.465
Gender	-0.015	-0.012	0.825	2.785	0.099	0.071	0.128	0.699
Education	-0.008	-0.047	0.390	0.272	0.073	0.190	0.048	0.285
Constant	1.257		<0.001	72.115		<0.001	-4.535	0.011
Domain score model	$r^2 = 0.188$		<0.001	$r^2 = 0.108$		<0.001	Cox $r^2 = 0.026$	0.224
Dignity domain score	-0.040	-0.269	<0.001	0.434	0.127	0.047	0.068	0.180
Sensory domain score	-0.026	-0.083	0.149	0.330	0.046	0.449	0.055	0.545
Dementia status	-0.265	0.244	<0.001	-6.069	-0.245	<0.001	0.396	0.171
Age	-0.002	-0.029	0.584	-0.007	-0.005	0.925	0.012	0.467
Gender	-0.010	-0.008	0.882	2.679	0.095	0.080	0.126	0.702
Education	-0.004	-0.022	0.675	0.206	0.056	0.318	0.046	0.308
Constant	0.957		0.005	74.778		<0.001	-4.141	0.022

^a AL-EQS = Assisted Living Environmental Quality Score; scores range from 0 to 30, with higher scores indicating increased physical environment quality.^b NPI = Neuropsychiatric Inventory; scores range from 0 to 120, with higher scores indicating increased frequency and/or severity.^c ADRQL = Alzheimer Disease Related Quality of Life; scores range from 0 to 100, with higher scores indicating increased quality of life.

Table 4

Relationship between TESS-NH/RC^b item scores and resident measures by dementia status

		NPI ^c total score		ADL ^d		Fall risk	
		No dementia	Dementia	No dementia	Dementia	No dementia	Dementia
Facility maintenance	<i>r</i>	-0.330 ^a	-0.226 ^a	0.147	0.147 ^a	0.008	0.161 ^a
	<i>p</i> -value	<0.001	0.002	0.097	0.041	0.931	0.028
	<i>n</i>	128	193	129	194	129	187
Cleanliness	<i>r</i>	-0.129	-0.189 ^a	0.007	0.085	-0.055	-0.007
	<i>p</i> -value	0.147	0.008	0.935	0.241	0.532	0.923
	<i>n</i>	128	193	129	194	129	187
Handrails	<i>r</i>	-0.269 ^a	-0.172 ^a	0.124	0.055	0.108	0.123
	<i>p</i> -value	0.002	0.017	0.16	0.444	0.222	0.092
	<i>n</i>	128	193	129	194	129	187
Call buttons	<i>r</i>	-0.536 ^a	-0.233 ^a	0.333 ^a	0.109	0.028	0.165 ^a
	<i>p</i> -value	<0.001	0.001	<0.001	0.131	0.751	0.024
	<i>n</i>	128	193	129	194	129	187
Light intensity	<i>r</i>	-0.100	0.053	0.068	-0.002	0.084	0.007
	<i>p</i> -value	0.261	0.461	0.445	0.976	0.343	0.928
	<i>n</i>	128	193	129	194	129	187
Light glare	<i>r</i>	0.011	-0.027	-0.067	0.095	-0.075	-0.159 ^a
	<i>p</i> -value	0.905	0.707	0.447	0.187	0.398	0.030
	<i>n</i>	128	193	129	194	129	187
Light evenness	<i>r</i>	-0.115	-0.031	0.035	0.012	0.074	0.108
	<i>p</i> -value	0.197	0.671	0.691	0.870	0.404	0.141
	<i>n</i>	128	193	129	194	129	187
Hallway length	<i>r</i>	0.501 ^a	0.168 ^a	-0.305 ^a	-0.131	-0.064	-0.177 ^a
	<i>p</i> -value	<0.001	0.019	<0.001	0.068	0.475	0.015
	<i>n</i>	128	193	129	194	129	187
Homelikeness	<i>r</i>	0.443 ^a	0.183 ^a	-0.399 ^a	-0.098	0.036	-0.033
	<i>p</i> -value	<0.001	0.011	<0.001	0.173	0.687	0.658
	<i>n</i>	128	193	129	194	129	187

	NPI ^c total score			ADRQL ^d			Fall risk		
	No dementia	Dementia		No dementia	Dementia		No dementia	Dementia	
Room autonomy	<i>n</i>	128	193	129	194		129	187	
	<i>r</i>	-0.497 ^a	-0.165 ^a	0.291 ^a	0.007		0.081	0.196 ^a	
	<i>p</i> -value	<0.001	0.022	0.001	0.928		0.361	0.007	
	<i>n</i>	128	193	129	194		129	187	
Telephones	<i>r</i>	-0.626 ^a	-0.240 ^a	0.377 ^a	0.129		0.009	0.147 ^a	
	<i>p</i> -value	<0.001	0.001	<0.001	0.072		0.917	0.045	
	<i>n</i>	128	193	129	194		129	187	
	<i>r</i>	-0.081	-0.118	0.005	0.143 ^a		-0.014	0.066	
Tactile stimulation	<i>p</i> -value	0.360	0.102	0.957	0.046		0.879	0.366	
	<i>n</i>	128	193	129	194		129	187	
	<i>r</i>	<0.001	-0.050	-0.124	0.151 ^a		-0.003	0.104	
	<i>p</i> -value	0.999	0.493	0.161	0.035		0.969	0.157	
Visual stimulation	<i>n</i>	128	193	129	194		129	187	
	<i>r</i>	0.022	-0.074	-0.084	0.067		0.075	0.105	
	<i>p</i> -value	0.808	0.306	0.341	0.352		0.399	0.153	
	<i>n</i>	128	193	129	194		129	187	
Outdoors	<i>r</i>	-0.543 ^a	-0.154 ^a	0.383 ^a	0.083		0.043	0.077	
	<i>p</i> -value	<0.001	0.033	<0.001	0.250		0.625	0.292	
	<i>n</i>	128	193	129	194		129	187	

^aCorrelation significant at the 0.05 level (2-tailed).

^bTESS-NH/RC = Therapeutic Environment Screening Survey for Nursing Homes and Residential Care; scores may be 0, 1, or 2 with higher scores indicating increased quality.

^cNPI = Neuropsychiatric Inventory; scores range from 0 to 120, with higher scores indicating increased frequency and/or severity.

^dADRQL = Alzheimer Disease Related Quality of Life; scores range from 0 to 100, with higher scores indicating increased quality of life.

Table 5

Factor loadings for TESS-NH/RC elements

Variable	Dignity factor	Sensory factor
Room autonomy	0.870	
Privacy	0.861	
Call buttons	0.857	
Telephones	0.831	
Homelikeness	−0.771	
Hallway length	−0.703	
Light evenness	0.636	
Visual stimulation		0.813
Tactile stimulation		0.796
Maintenance		0.649
Handrails		0.612
Cleanliness		0.587
Rotated eigenvalues	4.994	2.834
Explained variance (%)	41.6	23.6

Extraction method: principal components analysis. Rotation method: Varimax with Kaiser Normalization.