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Does the shape of Long-Term Care Units support well-being?

A psycho-spatial analysis

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**Abstract:** The increasing average age of the population is accompanied by a growing number of adults needing 24-hour assistance and entering into long-term care facilities (LTCFs). This has led to adaptation of existing well-being models and a new field of research, focusing on the way LTCF environments affect the well-being of elderly residents. Such studies have enriched the knowledge on various environmental variables that affect well-being, but have yielded conflicting results (regarding, e.g., the recommended shape for hallways, the optimal position of the nursing station). The LTCF assessment tools used in these studies are limited, with each study using a different combination of variables and most measuring well-being in a dichotomous (yes/no) manner. The significance of each variable is therefore difficult to discern. The need for a uniform quantitative measurement tool has led to the development of new quantitative tools, including the Psycho-Social Evaluation Tool (PSET) (Rom et al., 2022), which measures the effect of a unit’s physical layout on well-being. By analyzing architectural plans from 40 long-term care units with the PSET, the current research highlights that the effect of physical layout on well-being is related to various variables in different domains. It focusses on the conflicting recommendations regarding hallway shape, which affects the overall unit’s layout during the design process. It also highlights the need to view well-being variables as a bank of resources to be assessed during the design process, since a single variable (like hallway shape) is not sufficient to predict how LTCF units support residents’ well-being.

**Keywords:** Long-term care units; well-being; assessment tools; the Social Production Function

1. Introduction

When planning long-term care facilities (LTCF), architects strive to design buildings that support the well-being of those who live and work there. They base this work on their subjective impressions of similar institutions, personal experience, subjective assumptions about what residents and caregivers may consider desirable, as well as guidelines based on published research, which often present conflicting results (regarding, e.g., the recommended shape for hallways or the optimal position of the nursing station). To properly design a space that supports well-being in LTCFs, architects need an assessment tool that will help them improve the physical layout (PL) optimally throughout the design process.

Most existing tools that measure the PL’s support of well-being address different amounts of variables in a wide variety of combinations, assuming that each variable has a dichotomous (yes/no) effect on a single domain of well-being. Thus, the significance and weight of each variable is unclear. Furthermore, the tools are not based on an accepted model but are chosen based on the preferences and assumptions of the researchers. The Psycho-Social Evaluation Tool (PSET) (Rom et al., 2022) is a quantitative assessment tool based on the social production function (SPF) model (Lindenberg, 1996).

The SPF, unlike other well-being models, asserts that age-related limitations in terms of health, cognition, and functionality do not affect everyone’s well-being in the same way. Therefore, people use different available resources in diverse ways to improve and achieve their well-being and living conditions. The SPF model refers to five well-being goals (domains) that are achieved through a symbiotic relationship between a bank of resources, where one resource compensates for the lack of others.

By analyzing plans from 40 long-term care units (LTCUs) using the PSET, the current research demonstrates that the PL’s support of well-being is related to a combination of variables. Focusing on the conflicting recommendations regarding hallway shape, which affects the overall unit layout during the design process, the current research demonstrates that a single variable cannot predict the PL’s support of well-being. It is therefore recommended to view the variables contributing to well-being as a bank of resources, with each one measured and assessed during the design process. The present research contributes to improving the quality of planning LTCUs, benefiting residents and caregivers alike.

2. Theories and Methods

The increasing average age of the population is accompanied by a growing number of adults needing 24-hour assistance and being admitted into LTCFs, which has led to adaptation of well-being models (Alborz, 2017). Lawton (1983) was the first to create a new model of the “good life” in old age. This unique model embedded new ideas centered on the importance of the environment in supporting well-being in older adults.

 Since then, research has examined the effects of environmental variables on the subjective well-being of older adults, particularly among LTCF residents (e.g., privacy, autonomy, institutional versus home-like atmosphere, and orientation). These important studies have enriched the field, but have also yielded inconsistent results, highlighting the need for uniform measurement tools.

The impact of hallway shape on residents’ well-being has been a subject of conflicting research. Elmståhl and Annerstedt (1997) concluded that L-shaped hallways positively affected psychiatric symptoms of residents, while I-shaped hallways provided the worst results. In contrast, Marquardt and Schmieg (2009) concluded that I-shaped hallways allow better orientation and are preferable for residents with dementia. Still other studies have argued that I-shaped hallways increase the residents’ negative experience of living in an institution (Bowes, A., Dawson, 2019).

Additional studies have focused on the effects of different PL components on cognition, analyzing the architectural plans of existing LTCUs. The analysis, using Space Syntax, compared quantitative levels of visuality, orientation, and movement in space. Despite the importance of these measurements, it has been argued that Space Syntax cannot be used as an individual assessment tool to examine the PL’s support of well-being in these units. The attempt to cross-reference Space Syntax with other assessment tools (Quirke et al., 2021) has again led to the conclusion that a combined methodological tool is needed.

The vast knowledge accumulated from these studies has led to new assessment tools addressing the environmental variables that support well-being. Many are based on observations, and dichotomously examine the existence of hundreds of environmental variables that include, in addition to the PL variables, general environmental variables (e.g., odors, garden, home-like environment). As a part of the assessment procedure, the observed variables in each tool (e.g., 181 variables measured in the DDAT, 337 in the SCEAM, in Elf et al., 2017) are grouped into different well-being domains (presumed to affect only a single domain). However, the amount and nature of these domains vary from tool to tool.

Furthermore, the tools do not examine absolute quantitative variables of the physical environment (such as walking distances, density of specific areas, visibility related to autonomy and privacy) nor do they analyze the architectural plans quantitatively. Therefore, insight is limited regarding the contribution of each variable and possible improvements. The importance of quantifying the PL lies in the fact that although certain environmental factors can be improved (e.g., interior design to improve atmosphere, improve lighting by replacing lighting fixtures), changing the PL itself (i.e., the walls) of the LTCU is costly. It is therefore essential to assess plans during the design process. And for existing LTCUs, the units' benefits and disadvantages must be considered when aiming to improve well-being among residents.

To our knowledge, the only quantitative methodological assessment tool is the PSET (Rom et al., 2022), based on the SPF model (Lindenberg, 1996; Ormel et al., 1997). The SPF is an age-related well-being model that addresses well-being as a universal goal achieved by five domains (“instrumental goals”): comfort, stimulation, status, behavioral confirmation, and affection. According to the theory, diverse physical and non-physical resources (“means of production”) comprise these five domains. Thus, contrary to other frameworks, the SPF treats these five domains as a bank of resources. The resources are characterized by a symbiotic relationship that supports physical well-being (PWB) and social well-being (SWB), where one resource (or one of the domain’s variables) may compensate for the lack of others.

By analyzing LTCF plans with the PSET, the current research demonstrates that the PL’s support of well-being is related to a combination of variables. It focusses on the conflicting recommendations regarding hallway shape, which affects the overall unit’s layout during the design process. It also highlights the need to view the variables contributing to well-being as a bank of resources, to be assessed during the design process, since a single variable is not sufficient to predict how LTCF units support residents’ well-being.

Participants: Forty randomly chosen architectural LTCUs, either already built or in the building process. Inclusion criteria: 1) housing between 20-36 residents; 2) designed according to the Israeli Ministry of Health guidelines and regulations.

Tool(s): PSET is a methodological assessment tool based on the SPF model (see above) (Rom et al., 2022). The tool evaluates twenty-eight quantitative variables of the PL (using CAD files and Space Syntax). The variables are measured according to their support of the five domains:

Comfort (PWB) is measured by computing nine physical aspects: 1) area per person (1); 2) distance from bedrooms (BR) to the formal public rooms (FPR) such as day room and dining room (1); 3) distance from BR to the nursing station (NS) (-1); 4) distance from BR to the kitchen (1); 5) distance of door of smell hazard from the main public hallway (1); 6) percent of parallel BR doors (-1); 7) visibility scale from NS (1); 8) visibility scale from BR entrance (-1);9) visibility from the main entrance into BR (-1).

Stimulation (PWB) is measured by computing twelve physical aspects: 1) number of FPR per person (1); 2) total perceived area of FPR per person (-1); 3) distance from BR to the FPR (-1) ;4) distance from bedroom to kitchen (-1); 5) maximum visual distance (-1); 6) type of NS (1); 7) integration of public spaces (1); 8) choice of FPR (-1); 9) choice of spaces adjacent to FPR (-1); 10) intelligibility (1); 11) visibility scale from NS FPR (1); 12) visibility scale from FPR (-1).

Status (SWB) is measured by computing four physical aspects: 1) distance to FPR (1); 2) maximum visual distance (1); 3) visibility scale from the bedroom entrance (1); 4) visibility from the main entrance into BR (-1).

Behavioral confirmation (SWB) is measured by computing seven physical aspects: 1) distance from bedroom to NS (-1); 2) distance from NS to all support rooms (-1); 3) type of NS (-1) ;4) integration of FPR (1); 5) integration of NS (1); 6) visibility scale from NS (1); 7) visibility scale from FPR to NS (1).

Affection (SWB) is measured by computing twelve physical aspects: 1) number of internal formal social interaction spaces (1); 2) number of internal informal social interaction spaces (1); 3) number of external social interaction spaces (1);); 4) distance from BR to NS (-1); 5) distance from NS to FPR (-1); 6) distance from NS to all support rooms (-1); 7) distance between closest smell hazard rooms and main entrance (1); 8) integration of NS (1); 9) visibility scale from NS (1); 10) visibility from main entrance to FPR (-1); 11) penetration experience (-1); 12) distance from closest NS to the main entrance (-1).

The tool yields two complementary outcomes. The first outcome is a division of the PL into four typologies according to their support of PWB and SWB. The second outcome, used in this paper, quantifies each plan’s attributes in the five domains and gives information (presented as a unique footprint) about their deficiencies and reserves (copies of the PSET are available upon request from the corresponding author).

**Procedure:**

**A: analyzing unit shape** (the independent value): The forty plans were divided into five groups by shape of the main hallway (L=1, I=2, O=3, T=4, other=5). L-shaped plans include a double-winged hallway connected next to an FPR. The angle between the wings must be over 30-degrees, and the shortest wing should include a minimum of four rooms. I-shaped plans include a single or double-winged hallway with an angle up to 30-degrees. The FPR are positioned anywhere along the hallway. O-shaped plans include a single hallway that allows residents to walk in circles. T-shaped plans include a three-winged hallway. The three wings are connected next to the FPR. Only two of the wings are used for bedrooms; the third wing is used for service or paramedical rooms. Designated as “Other” are all plans with hallways that do not follow the above.

**B: analyzing the LTCU using the PSET** (the dependent value): The forty randomly chosen LTCU plans received an identification number used throughout the research. The CAD architectural plans (provided to the researcher by the LTCF management) were analyzed according to their support of five well-being domains using the PSET (detailed above).

**C: Data analysis**: A one-way ANOVA was performed to determine whether there were differences in the scores for the five domains of well-being according to LTCU hallway shape.

3. Results

As predicted based on the SPF model, the results found no significant correlation between hallway shape and its support of the five domains. These results confirm the PSET tool’s claim that PL cannot predict its support of well-being. The results also highlight the importance of quantifying these variables in order to be able to focus on each domain’s footprint as the LTCU’s bank of resources and deficiencies.

3.1. Comparison of L-Shaped Plans

To demonstrate the lack of correlation between hallway shape and well-being scores in the five domains, a detailed comparison is presented between different pairs of L-shaped plans., demonstrating how they differ from one another. We have chosen two L-shaped plans that scored very differently for each domain. By examining these pairs of plans below, we demonstrate the nuances that differentiate them.

**Support of Comfort**: The PL of LTCUs can support comfort by controlling visual, noise, and smell intrusions in bedrooms. Plans #19 and #35 scored very differently in their support of comfort (Figure 1). The cause of this difference lies in the location of the unit’s main entrances and the visual intrusion created by this choice. In plan#19, the main entrance directly overlooks some of the bedrooms, while in plan #35, this is not the case. The lines of sight from the NS to the bedroom doors may support a feeling of safety and security. Thus, plan #19 has lower visibility from the NS (#19=20.1%<#35=39.9%) and provides lower visual control from the bedroom doors (#19=3.76 %<#35=5.6%). Privacy also differs between the two plans, expressed in the percent of parallel bedroom doors, which allow for visual penetration (#19=42%<#35=85%).



Figure 1–Comparing plan#19 and plan#35

Noise intrusion and foul smells also affect comfort. Noise is measured by the proximity of bedrooms to the NS and FPR, both sources of noise. The bedrooms in plan#19 are closer to the NS, but the distance to the FPR in both plans is similar. The intrusion of foul smells is represented by the proximity of bedrooms and other public spaces to foul smell sources. The bedrooms in plan#19 are closer to the kitchen, and rooms with smell hazards (e.g., diaper disposal or garbage rooms) are closer to public spaces. The area per person may moderate the feeling of crowdedness in the FPR and promote privacy in double bedrooms, offering more options for spacious sitting arrangements. Although guidelines limit the minimum area per room according to activity, each unit’s total area differs (#19= 26 sqm/person<#35=30 sqm/person). In conclusion, plan #35 provides better support for comfort.

**Support of Stimulation:** Stimulation optimally supports well-being both negatively and positively: Over-stimulation may affect residents’ concentration, leading to frustration and agitation, while lack of stimulation creates stagnation. However, the right amount of stimulation can encourage growth and thriving. Plans #19 and #35 represent polarity in their support of stimulation (Figure 1).

Visual over-stimulation is mainly related to the areas visible from the FPR, including adjacent hallways and other spaces with long overlapping edges, and to the overall visibility of the entire unit. The outcomes present a difference between the FPR’s area per person (#35=7.5 sqm/person>#19=3 sqm/person), and the visibility scale (#35=35.4%>#19=25.3%), which measures the percentage of the unit’s floor area visible from the FPR; a higher percentage of visible space can be overstimulating.

Two additional variables associated with overstimulation are “choice” variables calculated using Space Syntax. The first choice variable represents the amount of exposure to the FPR’s adjacent hallway and the heavier movement probability through that part of the hallway. Plan #35’s FPRs are significantly more exposed to the hallways (#35=41,788>#19=7394). The second variable of choice represents the probability of people walking through the FPR as a shortcut or to reach a specific room (#35=11218>#19=1123).

Positive stimulation relates to the support of autonomy by improved wayfinding, orientation, shorter walking distances, and other stimuli like proximity to food smells or noises from exciting activity. Wayfinding and orientation are measured by the presence of landmarks (such as a prominent NS), and the intelligibility of the PL, which is correlated with hallway shape (calculated using Space Syntax). The NS is emphasized as a landmark by its overall visibility and visual characteristics (protrusive/intrusive) (#19=20.1%<#35=39.9%). The added distance per room from the kitchen refers to food smells as a positive stimulus (#19=25.6m/BR<#19=31.87m/BR).

Encouraging autonomous behavior is associated with the FPRs’ integration level (calculated using Space Syntax). Positioning the FPR at the center of the unit creates positive stimulation, which may lead to a willingness to participate in activities and a feeling of being part of the unit’s community (#19=1.23>#35=0.91). In conclusion, plan#19 provides better support for stimulation, while plan#35 scores exceptionally low.



Figure 2–comparing plan#19 and plan#43

**Support of Status:** The PL supports status by creating visual hierarchies that refer to the ability to create relativeness (positive or negative) of the bedrooms' location in the unit (visibility scale in general and to landmarks in particular). The causes for these differentiations were examined through plans #19 and #43, representing polarity in their support of status (figure 2). Even though the maximum visual distance is similar, the total visibility scale (measured with Space Syntax) in plan #43 is much higher due to its openness (#43= 9.52>#19=3.76) and visibility from the main entrance to bedroom doors (#43=5.11>#19=0.01). In conclusion, plan #43 provides better support for status.

**Support of Behavioral Confirmation:** Behavioral confirmation refers to residents being able and likely to establish eye-contact with staff members, to get non-verbal confirmation of one’s actions. To demonstrate how this manifests in a plan, we examined plans #19 and #34 (figure 3). The research refers to eye-contact with staff members at a clear, noticeable NS as informal communication, a positive attribute that benefits the residents (Campo & Chaudhury, 2012; Machiels et al., 2017; Real et al., 2018; Stephan et al., 2015). Plan #19 has a protrusive NS with direct visibility lines to a large area of the unit, whereas plan #34 has an intrusive NS and thus lower visibility (#19=78.9>#34=19.83). In addition, plan #19 has higher visual abilities throughout the unit (#19 =20.11>#34=13.5).

 When routine walking distances between bedrooms and support rooms is greater, random eye contact with staff members (as they pass by bedrooms) decreases. Plan #19 has a shorter added distance from the NS to bedrooms per bedroom (#19=15.06m<#34=19.7m) and a shorter added distance to the support rooms (Plan#19=47m<Plan#34=60m). The integration level of the NS and FPR, representing their centrality within the unit and, therefore, the probability of eye contact, is higher in plan#19. In conclusion, plan #19 provides better support for behavioral confirmation.



Figure 3–comparing plan#19 and plan#34

**Support of Affection:** The PL supports affection by supporting residents’ ability to spend “quality time” with staff members and guests. To demonstrate aspects of plans that support this dimension, we examined plans #41 and #34, representing polarity in their support of affection (figure 4). In plan #34, the staff's insufficient quality time with residents may result from long, time-consuming walking distances within the unit. Lack of visual control from the NS (integration and visual abilities) may cause excessive movement by the staff, requiring greater vigilance and possibly causing fatigue, which may affect their ability to behave affectionately (Becker, 2007; Hendrich et al., 2009). Plan#41 presents a shorter walking added distance per room from NS to bedrooms (#41=19.7m<#34=26m) and added distance from NS to the support room (#41=60<# 34=86m). In addition, the NS in plan#41 has a higher level of integration (#41=1.2># 34=0.72) and a better visibility scale throughout the unit (#41=31.2># 34=13.5).

Quality time spent with guests may be affected by guests’ visitation experience, which likely depends on their impressions upon entering the unit, including visibility from the main entrance to the FPR (plan#41=0.62<plan#34=41.01) and smell hazards next to the main entrance (plan #19's garbage room is adjacent to the main entrance). Visitation experience may also be affected by the availability to choose between different kinds of meeting places. Plan #41 has three balconies (plan#34 has one) and two FPRs (plan #34 has one). In conclusion, plan #41 provides better support for affection.



Figure 4–comparing plan#41 and plan#34

4. Discussion

Building on the traditions established by environmental gerontologists, who see the environment as a silent partner in supporting well-being in older adults, the current study sought to add to the existing knowledge. With a methodological analysis of 40 LTCF plans using the PSET tool, this study presented the ways in which plans that seem similar in shape and size actually can be quite different from one another, as in the L-shaped plans described above. The research demonstrated that, when planning LTCFs, a single PL variable cannot predict the environment’s support of well-being. In order to maximize the ways in which a PL can support residents in achieving the desired well-being, there is a need to evaluate all variables as a symbiotic bank of well-being resources. The current research brings empirical evidence into an area that has been predominantly ruled by architects’ intuition combined with institutional or governmental codes.

5. Conclusions

The fact that individual PL variables cannot predict the PL’s support of well-being underscores the need to use quantitative research tools to examine a unit’s bank of resources and deficiencies throughout the planning stages. Based on outcomes from using these tools, future research can focus on complementary solutions to compensate for deficiencies in each domain, especially when upgrading existing facilities. Solutions may include, for example, small building changes (e.g., relocating the garbage room, or building a visual partition), interior design changes (e.g., adding elements that make orientation easier and support stimulation), or changes in workplace policies. Such research would benefit long-term care residents and staff, as well as the general population of older adults.

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**Contributor statement**

The authors confirm contribution to the paper as follows

Y. Rom and M. Isaacson: study conception and design

Y. Rom and E. Greenberg: data collection

Y. Rom and M. Isaacson: analysis and interpretation of results:

Y. Rom: draft manuscript preparation

Y. Rom, Y. Palgi, E. Greenberg, and M. Isaacson reviewed the results and approved the final version of the manuscript.

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