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How does the physical shape of long-term care units affect well-being? A psycho-spatial analysis

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**Abstract:** The increase in the average age of the population, accompanied by growth in the number of adults needing 24-hour assistance and an increased likelihood of admission to long-term care facilities (LTCFs), has led to much adaptation of well-being models. In consequence, a new field of research has developed, focused on the effect of LTCF environments on the well-being of elderly residents. These studies have enriched the knowledge of how various environmental variables affect well-being but, at the same time, have yielded conflicting results (e.g., for the recommended shape of hallways/lobbies, or the optimal position of nursing stations). They have also spawned LTCF assessment tools that use differing numbers of variables in a wide variety of combinations, and typically assume that each variable dichotomously affects only a single well-being domain, thereby abandoning much of the significance and weight associated with them. The need for a standardized quantitative measurement tool that accounts for the complex impact of these variables in more than one well-being domain has led to the development of the Psycho-Social Evaluation Tool (PSET) (Rom et al., 2022), which focuses on the effect of an LTCF’s physical layout on well-being. By analyzing 40 LTCF plans with PSET, we highlight how a layout’s support of well-being depends on a combination of variables. In addition, by focusing on the conflicting recommendations for the shape of hallways, which have a significant effect on a unit’s overall layout, we demonstrate that a single variable cannot predict a unit’s support of well-being and there is a need to measure and address all variables as a “bank” of resources in support of well-being throughout an LTCF’s entire lifecycle.

**Keywords:** Long-term care facility; well-being; assessment tool; social production function theory

1. Introduction

When planning long-term care facilities (LTCFs), architects strive to design buildings that support high well-being levels for 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 consider desirable, and guidelines based on published research. These often present conflicting results (e.g., recommended shape of lobbies/hallways, optimal position of nursing stations); architects would therefore benefit from assessment tools that help them improve, throughout the design process, the support provided by the physical layout (PL) to the desired well-being goals.

At present, most such tools address the different variables to varying degrees in a wide variety of combinations, and typically assume that each variable affects, dichotomously, just one domain of well-being. Thus, the relative significance and weight of each variable to a variety of domains, as recognized in established well-being models, risks being lost.

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). Unlike other models, SPF asserts that functional limitations, and illnesses associated with the aging process, do not affect everyone's well-being in the same way; people use the different resources available in diverse ways to improve their living conditions and achieve better well-being. The SPF model considers five well-being goals (domains) that are achieved through symbiotic relationships between a bank of resources, in which the presence of any given resource may compensate for a lack of some other one.

By analyzing 40 LTCF plans using PSET, the current research demonstrates that PL support for well-being is associated with a combination of different variables. In addition, by focusing on the conflicting recommendations for the shape of the hallway, which affects the overall layout during the design process, the current research reifies that a single variable cannot predict a unit’s support of well-being, and it is necessary to measure and address all variables as a bank throughout the design process. Such an approach should contribute to improving the quality of LTCF planning, benefitting residents and caregivers alike.

2. Theory and Method

Lawton (1983) was the first to create a model focused on the good life in old age. The increase in the average age of the population, accompanied by growth in the number of adults needing 24-hour assistance and an increased likelihood of admission to LTCFs, has since led to both new and adapted models of well-being for older adults (Alborz, 2017), which have incorporated fresh ideas centered on the importance of the environment in supporting such well-being.

 Environmental variables (e.g., privacy, autonomy, institutional vs. home-like atmosphere, orientation) have since been researched in terms of their effect on the subjective well-being of older adults, particularly among LTCF residents. These diverse and essential studies have enriched the field but, at the same time, have yielded inconsistent results that highlight the need for a more standardized approach to measurement.

For example, the impact on well-being of the shape of the main lobby/hallway in an LTCF has generated conflicting outcomes: on the one hand, Elmståhl et al. (1997) concluded that L-shaped hallways have a positive effect on the psychiatric symptoms of residents, while I-shaped hallways were associated with poorer results; on the other, Marquardt and Schmieg (2009) concluded that I-shaped hallways provide better orientation for residents and were preferable for those with dementia. Meanwhile, other studies have argued that I-shaped hallways increase residents’ (negative) sense of living in an institution (Bowes & Dawson, 2019).

Additional studies, focusing on the effect on cognition of different PL components, have analyzed the architectural plans of existing LTCFs. Such analysis, conducted using space syntax, has facilitated the quantitative comparison of levels of visuality, orientation, and spatial movement within facilities. Despite the importance of these, it has been argued that space syntax alone cannot be used to examine the support of well-being provided by the PLs of LTCFs. An attempt to cross-reference space syntax with other assessment tools (Quirke et al., 2021) has again led to the conclusion that there is a need for a tool that combines methodologies.

Nevertheless, these studies have generated a large body of knowledge and led to new assessment tools that seek to address the environmental variables that influence well-being. Many are based on observations and dichotomously examine the existence of hundreds of environmental variables that include, in addition to those of the PL, general environmental variables (e.g., smell, garden, home-like environment). As part of the assessment procedure, most such variables (e.g., 181 in the DDAT tool, 337 in the SCEAM tool; Elf et al., 2017) are grouped into different domains of well-being, effectively limiting their impact to just one such domain. Furthermore, the number and nature of these domains change from tool to tool.

These tools do not, for example, consider the absolute quantitative variables of the physical environment (e.g., walking distances, occupation densities, visibility in relation to control and privacy), nor do they analyze the architectural plans quantitatively. Therefore, understanding of the contribution of each variable and how it might be improved is limited. This lack of attention to the importance of physical quantification neglects the fact that while the environment in its broadest sense can be altered and improved (e.g., through changes to interior design and/or lighting), the PL (e.g., walls) of an LTCF is difficult and costly to change. It is therefore essential to measure and assess architectural plans during the design process, and, for existing LTCFs, to understand the inherent benefits and drawbacks of their PL when aiming to improve the well-being of residents in the most effective and efficient fashion.

To our knowledge, the only assessment tool to support such a quantitative methodology is the Psycho-Social Evaluation Tool (PSET) (Rom et al., 2022). This is based on the social production function (SPF) model (Lindenberg, 1996; Ormel et al., 1997), an age-related model that addresses well-being as a universal goal delivered through five domains (“instrumental goals”): comfort, stimulation, status, behavioral confirmation, and affection. According to SPF theory, diverse physical and non-physical resources (“means of production”:) support these five domains, which, in contrast to other frameworks, are thus treated as a pool or bank of resources. These resources are characterized by a symbiotic relationship that supports both physical and social well-being (PWB and SWB), in which one resource (or one of the domains' variables) may compensate for the lack of another.

By analyzing LTCF plans with this tool, the current research demonstrates that a PL’s support of well-being is associated with a combination of different variables. Further, by focusing on the conflicting recommendations for the shape of hallways, which clearly affect the overall layout of an LTCF, the research reifies the argument that a single variable cannot predict a unit’s support of well-being on its own. Thus, measuring and addressing all such variables in their context as a bank of resources is necessary throughout the design process.

2.1 Approach

Using PSET, we analyzed 40 randomly chosen architectural LTCFs either already built or in the process of being built. The inclusion criteria were: 1) housing 20–36 residents; 2) designed according to Israeli Ministry of Health guidelines and regulations. Using CAD files and space syntax, the tool evaluates 28 different quantitative variables of the PL according to their support of the five well-being domains:

*Comfort* (PWB) is measured by computing nine physical aspects: 1) area per person; 2) distance from bedrooms to the formal public rooms (FPRs) such as dayrooms and dining rooms; 3) distance from bedrooms to the nursing station (NS); 4) distance from bedrooms to the kitchen; 5) distance of door(s) of smell hazards from the main public hallway; 6) percentage of parallel bedroom doors; 7) visibility scope from NS; 8) visibility scope from bedroom entrances; 9) visibility into bedrooms from the main entrance.

*Stimulation* (PWB) is measured by computing 12 physical aspects: 1) ratio of FPRs to people; 2) total perceived area of FPRs per person; 3) distance from bedrooms to the FPRs; 4) distance from bedrooms to the kitchen; 5) maximum visual distance; 6) type of NS; 7) integration of public spaces; 8) choice of FPRs; 9) choice of spaces adjacent to FPRs; 10) intelligibility; 11) visibility scope from NS to FPRs; 12) visibility scope from FPRs.

*Status* (SWB) is measured by computing four physical aspects: 1) distance FPR; 2) maximum visual distance; 3) visibility scope from bedroom entrances; 4) visibility into bedrooms from the main entrance.

*Behavioral Confirmation* (SWB) is measured by computing seven physical aspects: 1) distance from bedrooms to NS; 2) distance from NS to all support rooms; 3) type of NS; 4) integration of FPRs; 5) integration of NS; 6) visibility scope from NS; 7) visibility scope from FPRs to NS.

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

The tool yields two complementary outputs. The first is general and divides the PL into four typologies according to their support of both PWB and SWB. The second output, used in this paper, quantifies each plan's attributes in the five domains and gives information (represented as a unique footprint) about its strengths and weaknesses (copies of PSET are available, on request, from the corresponding author).

2.2 Procedure

*A – Analyze the shape of the unit (the independent variable):* The 40 plans were divided into five groups according to the shape of their main hallway. Thus, L-shaped plans include double-winged hallways connecting next to an FPR; the angle between the wings must be greater than 30°, with the shorter wing including a minimum of four rooms. I-shaped plans include single hallways and double-winged hallways at angles of up to 30°; FPRs can be positioned anywhere along the hallway. O-shaped plans include a single hallway that allows residents to walk in a circle. T-shaped plans include three-winged hallways, with the wings connecting next to an FPR; only two of the wings are used for bedrooms, with the third used for service or paramedical rooms. Plans with hallways that do not match any of the above are designated as “Other”.

*B – Analyze the LTCF plans with PSET* *(the dependent variable):* Each plan received an identification number, used throughout the research. The CAD architectural plans (provided by the management of the LTCFs) were analyzed using PSET in terms of their support for the five well-being domains detailed above.

*C – Data analysis:* A one-way ANOVA of variance was performed to determine whether there were significant differences in the five well-being domain scores on the basis of the shape of the LTCFs’ hallways.

3. Results

As predicted by the SPF model, the results showed no significant correlation between the shapes of the LTCFs’ hallways and their support of the five domains. These results confirm the PSET tool's fundamental rationale, that the PL alone cannot predict an LTCF’s support for well-being. The results nevertheless highlight the importance of quantifying these variables in order to be able to focus on each footprint as a basis for an LTCF’s bank of resources and drawbacks in relation to well-being.

**3.1. Demonstration**

To demonstrate our contention, we compared the attributes of L-shaped plans, illustrating how different each can be in relation to the five well-being domains. For each domain, we selected two L-shaped plans that scored very differently and by examining these pairs, we demonstrate the nuances that differentiate them.

*L-shaped plans' support of Comfort*: An LTCF’s PL supports comfort by controlling visual, noise, and smell intrusions into bedrooms. Figure 1 shows the very different profiles of Plans #19 and #35 in support of comfort (red bars). The principal cause of this difference lies in the location of the main entrances and the visual intrusion into bedrooms that results. In Plan#19, the main entrance directly overlooks some of the bedrooms, which is not the case in Plan#35. Further, good lines of sight from the NS to bedroom doors may promote a feeling of safety and security, and Plan#19 offers lower visibility from the NS (Plan#19=20.1% vs. Plan#35=39.9%) and lower visual control from the bedroom doors (Plan#19=3.76% vs. Plan#35=5.6%). In addition, privacy levels are affected by the percentage of parallel bedroom doors that afford constant visual penetration (Plan#19=42% vs. Plan#35=85%).

Noise intrusion and foul smells are other aspects that affect comfort. Noise is captured by measuring the proximity of the bedrooms to the NS and FPR(s) as potential sources of noise. The bedrooms in Plan#19 are closer to the NS, but the distances to the FPRs in both plans are almost identical. The intrusion of foul smells is represented by the proximity of the bedrooms and other public spaces to sources of same. Thus, in Plan#19, the bedrooms are closer to the kitchen, and rooms with smell hazards (e.g., diaper or garbage rooms) are closer to public spaces. Finally, area per person may moderate the feeling of crowdedness in FPRs and promote privacy in double bedrooms, as well as offering more options for comfortable seating arrangements. Although official guidelines define the minimum area per room according to activity, the total areas differ between the two plans (Plan#19=26m2/person vs. Plan#35=30m2/person). Overall, Plan#35 provides better support for comfort.



Figure 1–Comparison of Plan#19 and Plan#35

*L-shaped plans' support of Stimulation:* Stimulation can affect well-being both negatively and positively. Overstimulation may impair residents' ability to concentrate, leading to frustration and agitation. Lack of stimulation creates stagnation. However, balanced amounts of stimulation encourage development and well-being. Plans #19 and #35 represent polar opposites in this respect (amber bars in Figure 1).

The visual overstimulation of Plan#35 mainly derives from the perception of an oversized FPR area, which includes the adjacent hallways and other spaces that overlap it, and from the overall visual characteristics of the unit as a whole. The results show differences in the FPR area per person (Plan#35=7.5m2/person vs. Plan#19=3m2/person), and in the visibility scope (Plan#35=35.4% vs. Plan#19=25.3%), which measures the percentage of the unit's floor area visible from the FPR, reflecting how excessive space may overstimulate.

Two further variables associated with overstimulation are “choice” variables, calculated using space syntax. The first represents the amount of exposure to the hallway adjacent to the FPR and the higher probability of movement through that part of the hallway. Thus, Plan#35’s FPR is significantly more exposed to the hallways (Plan#35=41,788 vs. Plan#19=7,394). The second variable of choice represents the probability of people using the FPR as a shortcut or a way to get to a specific room (Plan#35=11,218 vs. Plan#19=1,123).

Positive stimulation is associated with the support of autonomy through improved wayfinding, clearer orientation, shorter walking distances, and other stimuli such as proximity to the smell of food or the noise of 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 to the hallway's shape (calculated with space sysntax). The NS is emphasized as a landmark by its overall visibility and visual characteristics (prominent/inconspicuous) (Plan#19=20.1% vs. Plan#35=39.9%). The average distance per bedroom from the kitchen reflects the role of food smells as a positive stimulus (Plan#19=25.6m vs. Plan#35=31.87m).

Finally, encouragement of autonomous behavior is associated with the integration level of the FPRs (calculated with space syntax). Positioning the FPR(s) at the unit's center creates positive stimulation that may lead to increased willingness to participate in activities and heightened community feeling (Plan#19=1.23 vs. Plan#35=0.91). In conclusion, Plan#19 provides good support for stimulation whereas Plan#35 scores exceptionally poorly.

*L-shaped plans' support of Status:*The PL supports status by creating visual hierarchies that reflect the ability to create relatedness (positive or negative) of the bedrooms' locations within the unit (to landmarks in particular, and in terms of visibility scope in general). The causes of differentiation were examined through Plans #19 and #43, representing polar opposites in their support of this domain (yellow bars in Figure 2). Even though the maximum visual distances are similar, the total visibility scope (measured with space syntax) in Plan#43 is much higher due to its openness (Plan#43=9.52 vs. Plan#19=3.76) and the visibility of the bedroom doors from the main entrance (Plan#43=5.11 vs. Plan#19=0.01). In conclusion, Plan#43 provides much better support for status than Plan#19.



Figure 2–Comparison of Plan#19 and Plan#43

*L-shaped plans' support of Behavioral Confirmation:* A PL supports behavioral confirmation by enabling eye contact with staff to obtain non-verbal confirmation of one's actions. To demonstrate how this manifests, we compared Plans #19 and #34 (Figure 3; green bars). Research reports informal communication through eye contact with staff via a prominent and recognizable NS as a positive attribute, benefitting residents (Campo & Chaudhury, 2012; Machiels et al., 2017; Real et al., 2018; Stephan et al., 2015). Plan#19 has a prominent NS with direct sight lines to a large proportion of the unit, whereas Plan#34 has an inconspicuous NS and thus lower visual capacity (Plan#19=78.9 vs. Plan#34=19.83). In addition, Plan#19 offers higher visual capabilities throughout the unit (Plan#19=20.11 vs. Plan#34=13.5).

 Random eye contact as staff pass by bedrooms decreases when routine walking distances between bedrooms and support rooms increase. Plan#19 has shorter average distances from the NS to bedrooms (Plan#19=15.06m vs. Plan#34=19.7m) and to support rooms (Plan#19=47m vs. Plan#34=60m). The integration levels of the NS and the FPR, representing their centeredness in the unit and, therefore, the probability of eye contact, are higher in Plan#19. Overall, Plan#19 provides much better support than Plan#34 for behavioral confirmation.



Figure 3–Comparison of Plan#19 and Plan#34

*L-shaped plans' support of Affection:* A PL supports affection by promoting residents' ability to spend “quality time” with staff and guests. To demonstrate plan aspects that support this domain, we compared Plans #41 and #34, representing polar opposites in their support of affection (Figure 4, blue bars). Insufficient quality time spent by staff with residents may result from long, time-consuming walking distances within the unit. A lack of visual control from the NS (in relation to its integration and visual capabilities) may demand greater vigilance and give rise to excessive movement on the part of the staff, potentially increasing fatigue and affecting their capacity to behave affectionately (Becker, 2007; Hendrich et al., 2009). Plan#41 offers shorter average walking distances from the NS to bedrooms (Plan#41=19.7m vs. Plan#34=26m) and to the support room (Plan#41=60m vs. Plan#34=86m). In addition, the NS in Plan#41 has a higher level of integration (Plan#41=1.2 vs. Plan#34=0.72) and a better scope of visibility throughout the unit (Plan#41=31.2 vs. Plan#34=13.5).

The quality of time spent with guests can depend on the visiting experience. This may depend on initial impressions manifested in the form of low visibility of the FPR(s) from the main entrance (Plan#41=0.62 vs. Plan#34=41.01), and smell hazards close to the main entrance (in Plan#19, the garbage room adjoins the main entrance). The visiting experience may be influenced by the opportunity to choose between diverse meeting places; thus, Plan#41 has three balconies (Plan#34 has just one) and two FPRs (again, Plan#34 has just one). In conclusion, Plan#41 provides better support than Plan#34 for affection.



Figure 4–Comparison of Plan#41 and Plan#34

4. Discussion

Building on the traditions established by environmental gerontologists who regard the environment as a silent partner in the support of well-being in later life, the current study aimed to add another layer to existing knowledge. Analyzing 40 LTCF plans with PSET made it possible to visualize the significant variance among these plans and demonstrate how plans that look similar in size and shape can be very different when measured methodologically. The research reified that when planning an LTCF, a single PL variable cannot predict the environment's support of well-being; therefore, in order to maximize the support from the PL 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 thereby introduces empirical evidence into an area that has, until now, been largely governed by architects’ intuition in combination with institutional and/or governmental codes.

5. Conclusions

The fact that individual variables cannot predict a PL’s support of well-being underscores the need to use a quantitative research tool to examine the layout’s entire repertoire of strengths and weaknesses throughout the planning stages. Future research can use PSET’s outputs and focus on complementary solutions involving a variety of disciplines that can be used to compensate for a lack in any given domain, especially when upgrading existing facilities. Such solutions may include, for example, small building changes (e.g., relocating the garbage room or erecting a visual partition), changes in interior design (e.g., adding elements that facilitate orientation and support stimulation), and changes in workplace policies. Such research would benefit older adults in general, and residents and staff in particular.

**Contributor statement**

The authors confirm contributions 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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