Built environment impact on people with dementia (PwD) health and well-being outcomes: a systematic review of the literature

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Abstract. *Background and aim:* The number of People with Dementia (PwD) is rising worldwide and represents a complex figure because of the changes in the cognitive sphere, altering perceptions of the Built Environment (BE). Even though the role of the Built Environment in the health and well-being of people is very important, few studies analyze and evaluate the impact of specific Architectural Features. This study aims to underline the impacts of BE on the Health and Well-being of PwD and set a matrix of the relationship with measurable outcomes. *Methods:* A Systematic Review has been conducted on scientific databases, such as Scopus, PubMed, and Web of Science. *Results:* 26 studies that relate health outcomes and BE aspects have been identified and organized on a comparison matrix that clearly shows the relationships between Architectural Features of BE and Health and Wellbeing Outcomes. This matrix allows us to identify the aspects that can impact PwD as well as understudies topics. Many aspects appear to be widely explored, such as Behavioral and Psychological Symptoms of Dementia (BPSD) or wandering. In addition, significant gaps in the relationship between recognized aspects of the built environment recognized as relevant to the well-being of people with dementia and the real impacts on health outcomes such as the location and personalization of spaces. *Conclusions*: This review collected the most recent studies to underline the relationship between BE and dementia, providing a set of outcomes and architectural features that can be analyzed to assess the quality of BE for PwD. (www.actabiomedica.it)

Key words: Dementia, built environment, well-being, health, evidence-based design, healthcare design, clinical outcomes

Introduction

Dementia Facts and Numbers

Dementia is a significant health issue in Europe and Italy, and the number of people affected is expected to increase in the coming years. According to the World Health Organization (WHO), there were approximately 10 million people with dementia in Europe in 2018, and this number is projected to reach 14 million by 2050.

In recent years, thanks to advances in medicine and the role of prevention that occupy more and more space in healthcare, life expectancy has experienced rapid growth, rising from 77.6 to 80.4 years in Europe from 2002 to 2020 (1). Despite advances in medicine, as well as preventive approaches and the use of digital technologies, the aging population will lead to an increasing need for long-term care.

Dementia affects about 7 million people in Europe, and the number is set to double by 2050 (2) About 60-80% of people with dementia have Alzheimer's disease.

Dementia is a disease that brings serious changes in the cognitive sphere, altering perceptions of the living space. Due to the age and multimorbidity of the patient, is one of the most frequent visitors of healthcare facilities, and long-term care in many cases becomes their home. These structures often do not consider the real needs of the patient who, because of the pathology, relates differently to the environment than other kinds of patients (3–5).

Dementia is defined as "a syndrome – usually of a chronic or progressive nature – that leads to deterioration in cognitive function (i.e. the ability to process thought) beyond what might be expected from the usual consequences of biological aging. It affects memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgment" (6).

Dementia is an umbrella term that contains several different meanings, for example, Alzheimer, that is the most frequent with 60% of total diagnoses, such as Lewy Body Dementia, Vascular Dementia, Frontotemporal Dementia, and others like Parkinson's disease. Discovered for the first time in 1906 by Alois Alzheimer's, it predominantly affects people in their elderly years (over 65 years old) and the World Health Organization (WHO) estimates that about 60% affected by a state of dementia are affected by this disease.

The onset symptom is short-term memory loss which affects mental health.

All the different implications of a social and behavioral nature, such as the phenomenon of depression, must be associated in parallel with this common symptom. For the patient, the result is a complex social discomfort both in their family dimension and in the community.

At the same time, Alzheimer's disease also affects the physical abilities of the patient over time. This incidence can be seen in the loss of autonomy in carrying out the common activities of daily living with the consequent need for ongoing assistance.

Cognitive disorders affect the normal performance of daily activities. The main cognitive functions can be classified into:
- Memory. It includes the function of learning and acquiring new knowledge and the function of recalling information learned over a time frame. The deficit is manifested by a progressive inability in the faculty to act and impairs the ability to memorize the sequence of steps to be followed to perform an activity;
- Attention. Ability to detect, distinguish and choose. Alzheimer's disease reduces this faculty in individuals by making it possible to maintain a good degree of attention only for an extremely limited time;
- Acting. Represents the ability to perform actions and concerns how a person translates a will or idea into actual action. The disease, in its early stages, impairs the ability to perform complex tasks (such as driving). Its progression prevents the sick person from performing even simpler actions (such as taking care of his or her hygiene or getting dressed);
- Language. Alzheimer's disease causes a language deficit which results in an initial difficulty in the production stage to the use of passe-partout words (the "thing," the "thing").
- Recognizing. Activity that allows one to understand the stimuli of the world in which one lives and be able to categorize them. The most extreme case of deficit concerning the activity of recognizing is represented by the difficulty of recognizing one's family members.
- Psychological disorders, on the other hand, are distinguished into difficulties concerning:
- Thought and perception. Manifestation causes delusions and incongruous beliefs. concerning reality (hallucinations) that may manifest visually, audibly, or olfactively.
- Affects. Anxiety and depression are two typical consequences of Alzheimer's disease. Anxiety, a feeling of inner turmoil, may manifest itself mainly in the fear of being left alone by one's family members. Depression, on the other hand, is translated into a significant decline in mood that can lead to constant thoughts of death.
- Behavior and conduct disorders. Behavior is the sphere most affected by Alzheimer's disease. Often, the typical feeling of agitation that occurs in the sufferer, can affect not only the psychological but also the motor domain (walking around the house without having a specific purpose, trying to go out). Apathy and euphoria, on the other hand, accompany the entire growth process of the disease.

Research Gap and Objective

Nowadays it is clear that the built environment can play an important role in the health and well-being of users, especially frail or people with disability (7–10).

However, often the built environment is not designed according to the needs and abilities of users (11).

This is the case for example of people with dementia and cognitive disabilities that face problems in the architectural environment due to their physical, psychological, and cognitive disabilities, related to their disease (12). People with dementia, due to the comorbidities and symptoms related to the disease, often live within residential care facilities. 70% of Italian Long-term Care (LTC) residents are suffering from a form of dementia (13).

Even if these people are the main users of Long-term care facilities, most of these structures are not suitable for their needs and lack quality spaces (14). Healthcare facilities for Alzheimer's patients are, as never before, a social infrastructure to consider fundamental for a country like Italy (15). The data on the disease marks a continuous increase on a global scale and the trend does not show signs of decreasing, with a 50% increase from 2005 to 2013 (16).

There is growing evidence that the built environment can play a role in the development and progression of dementia (17).

Research has shown that certain aspects of the built environment can impact cognitive function and contribute to the risk of developing dementia.

On the other hand, the built environment can also be designed to support cognitive health (9). For example, environments that are well-lit, quiet, and provide opportunities for physical activity have been shown to have positive effects on cognitive function. In addition, the use of natural elements, such as greenery and water, has been shown to improve mood and reduce stress, which can be beneficial for cognitive health (18).

Although there is much research, many aspects are still under-investigated.

Therefore, there is a need for a more holistic and experienced-based method, moving from descriptive, based on regulations, to a performance approach that can assess the quality of spaces using measurable criteria to support stakeholders and decision makers (19,20).

This research aims to analyze how many and what are the relationships between the built environment and health and well-being outcomes in patients with dementia.

To assess this relationship a Systematic Review has been conducted.

Methods

A Systematic review has been conducted to investigate the relationship between the built environment and dementia as well as to assess the relationship between architectural features and health and well-being outcomes in PwD.

The Systematic review methodology was adopted to identify a broad area of existing literature and identify what relationships may exist between the built environment and the health and well-being of patients with dementia (21,22).

The review started from the definition of the research question that was, as already presented, "*What is the impact of the built environment on the health and wellbeing of PwD?*"

The second step, the search strategy, was conducted through the electronic databases Scopus, Web of Science, and PubMed and was developed in September/October 2022.

The study started from a previous analysis that has been conducted to set relevant Architectural Features (AF) that are broadly studied in the literature and emerged as crucial for PwD (23) (Table 1).

These Architectural Features became the basis to investigate the impacts on PwD.

To deeply investigate which impacts Architectural Features can have on PwD's Health and Well-being outcomes, a systematic literature review has been conducted.

To specifically select the part of the literature which deals with this topic, it was fundamental to select a group of words that belong to different research

Table 1. Architectural Features (AF)

Macro areas	Criteria	Sub Criteria
PHYSICAL ASPECTS	**General Aspects**	P.01.1 LOCATION
		P.01.2 ACCESSIBILITY
		P.01.3 BUILDING TYPE
		P.01.4 ACCESS
		P.01.5 SIZE
		P.01.6 FLEXIBILITY
	Indoor Environmental Quality	P.02.1 INDOOR AIR QUALITY (IAQ)
		P.02.2 TEMPERATURE
		P.02.3 LIGHT
		P.02.4 WATER
		C.02.5 NOISE
		C.02.6 ODORS
COGNITIVE ASPECTS	**Psychological**	C.01.1 HOMELIKE
		C.01.2 PERSONALIZATION
		C.01.3 FURNITURE
	Visual	C.02.1 COLORS AND FINISHING
		C.02.2 WAYFINDING
		C.03.3 VIEW
SOCIAL ASPECTS	**Connection**	S.01.1 COMMUNITY
		S.01.2 SHARED SPACES
	Activity	S.02.1 PHYSICAL ACTIVITY
		S.02.2 ACTIVITIES (OCCUPATIONAL)
	Safety/Security	S.03.1 TECHNOLOGIES
		S.03.2 SAFETY

fields to combine them. The main research field has been analyzed using three levels of keywords.

The search string that has been used was (dementia OR Alzheimer OR "memory loss") AND ("built environment*" OR design OR space*) AND (wellbeing OR health OR impact*).

The strategy was first developed in Scopus and then adapted for use in the other databases (Appendix A).

Then the inclusion and exclusion criteria have been selected.

Studies published in English and published after 2002 have only been included. Studies related to other cognitive impairments or mental health notes related to dementia have been excluded (such as autism, schizophrenia, and others). Studies that do not refer to the outcomes that involve directly the built environment have been excluded. Both reviews and original articles have been included.

In addition, further studies were retrieved from a reference listing of relevant articles and consultation with experts in the field, since the aim of a Systematic review is to be as wider as possible.

Additional information has been gathered from secondary sources, known as "grey literature", using search engines that merge both scientific literature and documents not published in an official database. For example, WHO and associations' reports (like Alzheimer's reports) have been collected and screened.

The search finally resulted in 312 articles.

The Study Selection has been performed according to the PRISMA (preferred reporting items for systematic reviews and meta-analyses) (24,25) flowchart and identified studies were independently reviewed for eligibility by two authors (S.M., A.B.).

The review process was performed using the platform *covidence,* in a two-step process: A first screening was performed based on the title and abstract, and then full texts were retrieved for a second screening. At both stages, disagreements among reviewers were resolved by consensus. Data were extracted by two authors (S.M., A.B.) and supervised by a third author (S.C.).

As shown in the Prisma flow chart (Figure 1), 60 duplicates have been removed.

184 studies have been removed after abstract reading as well as papers that were not in English or Italian or published before 2002.

68 full texts have been screened, obtaining 26 studies relevant for the review, after the application of eligibility criteria and availability of the full texts.

The last step, Data extraction, was performed on an Excel file divided into 5 sections (Table 2):
- Section 1 Authors;
- Section 2 Title;
- Section 3 Year of publication;
- Section 4 Journal;
- Section 5 Country: the country in which the study was performed.

From the grid developed by the authors, the following preliminary clusterization
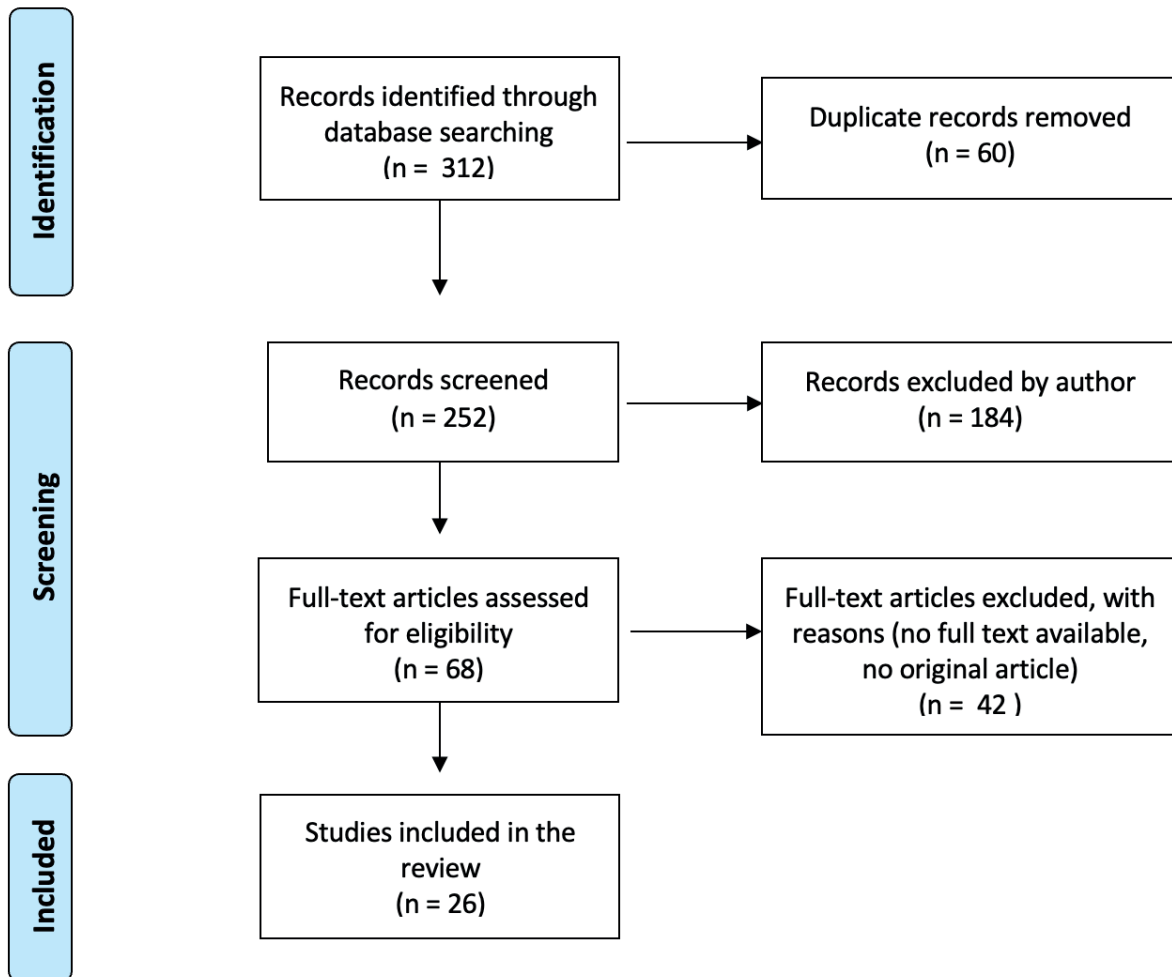
Figure 1. Prisma flow chart

Emerged. The 26 studies analyzed have been sub-divided into:
- publication date:
  n=16 have been published in the last 10 years (61,5%);
  n=10 have been published before 2012 (38,5%).
- geographical localization:
  n = 10 studies were conducted in the European Union (EU)(38,5%),
  n = 5 in the USA (19%);
  n = 3 in Canada (11,5%);
  n = 5 in Australia (19%);
  the remaining 3 are from China (1) and Hong Kong (2).

Results

This research is focused specifically on the relationship that occurs between the built environment and patients with dementia, analyzing the problem statement and trying to provide which specific criteria can determine the relationship. This research has shown the specific needs that a structure for elderly patients has to provide.

The review investigated also whether there are studies in the literature that correlate architectural aspects and the health of people with dementia, outlining a comparison matrix.

The matrix allowed us to analyze how architectural aspects that emerged as important to the well-being of

Table 2. Studies that met inclusion criteria for systematic review

N	Author	Title	Year	Journal	Article Type
1	Aarts MPJ, Aries MBC, Straathof J, Hoof J van.	Dynamic lighting systems in psychogeriatric care facilities in the Netherlands: A quantitative and qualitative analysis of stakeholders' responses and applied technology	2015	Indoor and Built Environment.	Research Article
2	Calkins MP.	Evidence-based long term care design	2009	NeuroRehabilitation	Research Article
3	Chau H wah, Newton C, Woo C, Ma N, Wang J, Aye L.	Design Lessons from Three Australian Dementia Support Facilities	2018	Buildings	Research Article
4	Davis S, Byers S, Nay R, Koch S.	Guiding design of dementia friendly environments in residential care settings: Considering the living experiences	2009	Dementia	Research Article
5	Fleming R, Goodenough B, Low L-F, Chenoweth L, Brodaty H.	The relationship between the quality of the built environment and the quality of life of people with dementia in residential care	2016	Dementia	Research Article
6	Gascon M, et al	Long-term exposure to residential green and blue spaces and anxiety and depression in adults: A cross-sectional study	2018	Environ Res	Research Article
7	Graf A, Wallner C, Schubert V, Willeit M, Wlk W, Fischer P, et al.	The effects of light therapy on mini-mental state examination scores in demented patients	2001	Biological Psychiatry	Research Article
8	Harrison, S. L., Dyer, S. M., Laver, K. E., Milte, R. K., Fleming, R. & Crotty, M.	Physical environmental designs in residential care to improve quality of life of older people	2017	Cochrane Database Syst Rev	Research Article
9	J. van Hoof, A.M.C. Schoutens, M.P.J. Aarts	High colour temperature lighting for institutionalised older people with dementia	2009	Building and Environment	Research Article
10	Johansson, K., Borell, L., & Rosenberg, L.	Qualities of the environment that support a sense of home and belonging in nursing homes for older people	2022	Ageing & Society	Research Article
11	Kane RA, Lum TY, Cutler LJ, Degenholtz HB, Yu TC.	Resident Outcomes in Small-House Nursing Homes: A Longitudinal Evaluation of the Initial Green House Program: GREEN HOUSE RESIDENT OUTCOMES	2007	Journal of the American Geriatrics Society	Research Article
12	Kok JS, van Heuvelen MJG, Berg IJ, Scherder EJA.	Small scale homelike special care units and traditional special care units: effects on cognition in dementia; a longitudinal controlled intervention study	2016	BMC Geriatr	Research Article
13	Lee KH, Boltz M, Lee H, Algase DL.	Is an Engaging or Soothing Environment Associated With the Psychological Well-Being of People With Dementia in Long-Term Care?	2017	J Nurs Scholarsh	Research Article
14	Lee SY, Chaudhury H, Hung L.	Effects of Physical Environment on Health and Behaviors of Residents With Dementia in Long-Term Care Facilities: A Longitudinal Study	2016	Research in Gerontological Nursing	Research Article
15	Leung M yung, Wang C, Chan IYS.	A qualitative and quantitative investigation of effects of indoor built environment for people with dementia in care and attention homes	2019	Building and Environment	Research Article
16	Leung, M.-Y.; Wang, C.; Wei, X.	Structural model for the relationships between indoor built environment and behaviors of residents with dementia in care and attention homes	2020	Building and Environment	Research Article

Table 2. Studies that met inclusion criteria for systematic review

N	Author	Title	Year	Journal	Article Type
17	Mazzei F, Gillan R, Cloutier D.	Exploring the Influence of Environment on the Spatial Behavior of Older Adults in a Purpose-Built Acute Care Dementia Unit	2014	Am J Alzheimers Dis Other Demen	Research Article
18	Mobley, C., Leigh, K., & Malinin, L.	Examining Relationships between Physical Environments and Behaviors of Residents with Dementia in a Retrofit Special Care Unit	2017	Journal of Interior Design	Research Article
19	Mu, J., Zhang, S. & Kang, J.	Estimation of the quality of life in housing for the elderly based on a structural equation model	2022	J Hous and the Built Environ	Research Article
20	Olson NL, Albensi BC.	Dementia-Friendly "Design": Impact on COVID-19 Death Rates in Long-Term Care Facilities Around the World	2021	J Alzheimers Dis	Research Article
21	Riemersma-van der Lek RF.	Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities: A Randomized Controlled Trial	2008	JAMA	Research Article
22	te Boekhorst S, Depla MFIA, de Lange J, Pot AM, Eefsting JA.	The effects of group living homes on older people with dementia: a comparison with traditional nursing home care	2009	Int J Geriat Psychiatry	Research Article
23	van Buuren LPG, Mohammadi M.	Dementia-Friendly Design: A Set of Design Criteria and Design Typologies Supporting Wayfinding	2022	HERD	Research Article
24	van Hoof J, Aarts MPJ, Rense CG, Schoutens AMC.	Ambient bright light in dementia: Effects on behaviour and circadian rhythmicity	2009	Building and Environment	Research Article
25	Verbeek H, Zwakhalen SM, van Rossum E, Ambergen T, Kempen GI, Hamers JP.	Small-scale, homelike facilities versus regular psychogeriatric nursing home wards: a cross-sectional study into residents' characteristics	2010	BMC Health Serv Res	Research Article
26	Wilkes L, Fleming A, Wilkes BL, Cioffi JM, Le Miere J.	Environmental approach to reducing agitation in older persons with dementia in a nursing home	2005	Australas J Ageing	Research Article

people with dementia may impact various clinical and well-being outcomes in PwD.

General information

After the full analysis of the studies that emerged from the literature, the criteria and architectural features were compared with the possible outcome in PwD.

This process has been done based on the findings of the Systematic Review.

Through the comprehensive analysis of the texts that emerged in the literature, it was possible to connect previously emerged architectural aspects with multiple outcomes in patients with dementia.

The outcomes

In this phase, it was also crucial the analysis of the most used evaluation tool that establishes the cognitive state of PwD (i.e. MMS (Mini-Mental Status), ADL (Activities of Daily Living), QOL (Quality of life), and Barthel. The analysis of these tools allows us to understand which are the main outcome and interactions in the pathology of dementia.

In this way, it was possible to unambiguously highlight the points most analyzed in the literature and those with gaps.

16 outcomes emerged from the literature and an additional one (patient falls) has been added as crucial in the health of the elderly.

• O.00 Quality of life (QOL): By Quality of Life

(QOL) we mean being healthy, having peace, living in harmony, feeling happy, being satisfied with life, and keeping busy, whether through hobbies, volunteering, or work, measurable by WHOQOL-OLD

- O.01 FALLS: falls are one of the most problematic aspects of residential facilities
- O.02 SLEEP QUALITY: people with dementia often have disturbances in sleep quality, leading to frequent awakenings and difficulty falling asleep
- O.03 GENERAL COGNITIVE STATUS: General cognitive status (GCS) is a set of cognitive abilities that reflect the full function
- O.04 STRESS/DELIRIUM: Stress and agitation are frequent complaints that the patient with dementia may experience. The environment plays a key role in creating a place that instills tranquility and relaxation
- O.05 BPSD (Behavioral and Psychological Symptoms of Dementia): Comprise a range of behavioral disorders in the patient with dementia that include mood alterations, aggression, appetite disturbances
- O.06 DELIRIUM: Acute-onset transient symptomatology involving altered state of consciousness (e.g., agitation and aggression or, conversely, lethargy and drowsiness)
- O.07 WANDERING: wandering, is the tendency of the patient with dementia to move aimlessly within space
- O.08 SOCIAL RELATIONSHIP: social relationships within the facility with both guests and family members are to be fostered, as is the conduct of other activities involving outside people (e.g., youth, associations, volunteers)
- O.09 PSYCHOLOGICAL HEALTH: The psychological health of the patient is to be preserved and maintained by implementing various strategies adapted to the needs of the individual
- O.10 PHYSICAL HEALTH: the patient's physical health is complex and brings together both issues present due to possible comorbidity and those purely related to the physical activity performed within the facility as it is closely related to health.
- O.11 ADL -MOTILITY: The patient must be free to move safely within the facility
- O.12 ADL -FOOD: the patient must maintain autonomy in feeding himself as long as possible, as well as be able to enjoy a balanced diet and the consump-

tion of meals in a comfortable and welcoming place, whether in a group or alone

- O.13 ADL -TOILET: The patient must maintain the ability to use toilets independently for as long as possible. For this reason, these must be easy to identify and use
- O.14 ADL -WASH: the act of washing must also be able to be performed by the patient in a safe place
- O.15 ADL -INCONTINENCE: incontinence can be a symptom associated with cognitive decline, so autonomy must be promoted and preserved within healthcare facilities
- O.16 ADL -DRESS UP: the act of dressing independently, when possible, should be encouraged as it provides independence for the patient
- O.17 PRIVACY: the feeling of protection and privacy induced by a space

Comparison Matrix

The study used a comparison matrix with affixing architectural criteria in the horizontal portion and health and wellbeing outcomes in the vertical portion (Table 3).

The analysis of the literature has identified how some studies relate health outcomes and the built environment. Many aspects seem to be widely explored, both from a clinical and architectural perspective. This is the case, for example, with stress and agitation, BPSD (Behavioral and Psychological Symptoms of Dementia), or wandering from the outcomes point of view, the number of rooms per household, light, or the creation of a familiar (homelike) environment.

Many of the studies, however, do not analyze the impact that specific features of the built environment may have on people with dementia, including health outcomes.

The matrix highlights which are the Architectural Features that are investigated in the literature, the health and well-being outcomes that can be influenced by AF, and the incidence of both pieces of evidence.

Table 3. The matrix combines Architectural Features and Health & Wellbeing Outcomes in People with Dementia.

H&W O	P.01.1 LOCATION	P.01.2 ACCESSIBILITY	P.01.3 BUILDING TYPE	P.01.4 ACCESS	P.01.5 SCALE	P.01.6 FLEXIBILITY	P.02.1 IAQ	P.02.2 TEMPERATURE	P.02.3 LIGHT	P.02.4 WATER	C.02.5 NOISE	C.02.6 ODORS	C.01.1 HOMELIKE	C.01.2 PERSONALIZATION	C.01.3 FURNITURE	C.02.1 COLORS AND FINISHING	C.02.2 WAYFINDING	C.03.3 VIEW	S.01.1 COMMUNITY	S.01.2 SHARED SPACES	S.02.1 PHYSICAL ACTIVITY	S.02.2 ACTIVITIES (OCCUPATIONAL)	S.03.1 TECHNOLOGIES	S.03.2 SAFETY	AF that are investigated in literature	Incidence
O.0 QOL (QUALITY OF LIFE)					X				X		X		X									X			5	21%
O.01 FALLS									X																1	4%
O.02 SLEEP QUALITY									X																1	4%
O.03 GENERAL COGNITIVE STATUS			X		X				X				X		X	X			X	X		X			9	38%
O.04 STRESS/AGITATION					X		X	X	X	X			X		X	X									8	33%
O.05 BPSD			X		X		X	X	X	X	X		X		X	X				X					11	46%
O.06 DELIRIUM													X		X	X									3	13%
O.07 WANDERING			X		X						X		X			X	X								6	25%
O.08 SOCIAL RELATIONSHIP					X						X									X					3	13%
O.09 PSYCHOLOGICAL HEALTH			X		X				X				X												4	17%
O.10 PHYSICAL HEALTH			X		X				X											X					4	17%
O.11 ADL - MOTILITY					X												X								2	8%
O.12 ADL - FOOD					X																				1	4%
O.13 ADL - TOILETTE					X																				1	4%
O.14 ADL - WASH					X																				1	4%
O.15 ADL - INCONTINENCE					X																				1	4%
O.16 ADL - DRESS UP					X																				1	4%
O.17 PRIVACY					X																				1	4%
H&W O that can be influenced by AF	0	0	5	0	15	0	2	2	8	2	4	0	7	0	4	6	1	0	1	4	0	2	0	0		
Incidence	0%	0%	29%	0%	88%	0%	12%	12%	47%	12%	24%	0%	41%	0%	24%	35%	6%	0%	6%	24%	0%	12%	0%	0%		

Column groupings: **PHYSICAL ASPECTS** — General Aspects (P.01.1–P.01.6), Indoor Environmental Quality (P.02.1–C.02.6); **COGNITIVE ASPECTS** — Psychological (C.01.1–C.01.3), Visual (C.02.1–C.03.3); **SOCIAL ASPECTS** — Connection (S.01.1–S.01.2), Activity (S.02.1–S.02.2), Safety (S.03.1–S.03.2).

Discussion

The Systematic Review highlights the following important 4 aspects that the structure for PwD must possess to promote Health and Well-being Outcomes in different domains:

I Scale

Studies regarding the dimension of the structures for PwD (especially for Special Care Units SCU) analyzed how in a group of patients, transferred from a regular unit of nursing homes to a small-scale SCU, there is a significantly less cognitive decline three months after transfer. Aspects of cognition also can be improved, like visual memory, image recognition, the cognitive decline observed by the representatives, and global cognitive functioning (26,27).

An increase in the ability related to ADL and social engagement can be also seen in these facilities with a low number of residents (6-8 per unit) (28,29)

Clear evidence is highlighted also in the positive effects on residents' quality of life while entering a small group (30).

A smaller environment can have a better impact on QOL (31).

II Light

The management of light, both natural and artificial, it have been found relevant in terms of several agitation/physical aggression, screaming, the decrease of mean duration of wandering episodes, and incrementing psychological health and social relationships. (32–38)

III Homelike

The environment should be designed to be as homelike as possible, creating a familiar place that can be easily understood by residents. Access to a homelike environment has been associated with a reduction in anxiety and an increase in interest in the surroundings as compared with levels found in residents of traditional nursing homes (9,12,39).

Some studies have shown that residents that live in small-scale, homelike facilities had a significantly higher functional status and cognitive performance compared with residents in regular psychogeriatric wards (40).

Behaviors, like aggression, noisiness, and wandering, emerged as decreasing in situations when persons with dementia were relocated from a classical nursing home to an SCU that is designed to have a homelike feeling (41).

Homelike environments are related to positive effects also on ADLs, more engagement in activities, and independence in activities.

IV Colors and Finishing

The proper use of color contrast and furniture has been seen as prosthetics for PwD.

For example, the use of colored walls or paneling to highlight or hide doors has led to a reduction in undesirable behavior (17).

Color can also be used by residents as a cue to locate their room, common areas, etc., and improve wayfinding (3,42).

Other aspects

Social connection can be relevant for promote in resident better physical and mental health and it emerged as an important aspect of the quality of care for nursing home residents (43).

Green space exposition and the view are associated with anxiety and depression reduction in people that live in LTC (44).

Environments that support engaging activities inside the structures emerged as associated with more positive emotional expressions (45).

Lighting, lifts, and water supply can impact PwD emotions, sleeping disturbance, and limited mobility, and loneliness can be related to furniture (46).

The limited living environment can play and contributes to cognitive function problems.

Research shows that old, institutionalized buildings that have poor lighting, poor ventilation, long dead-end hallways, poor visual cues, lack of homelike environments, shared bedrooms, and bathrooms, and are often dense and overcrowded can contribute to apathy, anxiety, agitation, and aggression on PwD, and they also contributed to the rapid spread of COVID-19 in these facilities the world over (47).

Gaps

On the contrary, 10 architectural features emerged as not being in deep investigated in the literature.

These are:

i.   Location of the structure (reachability): the place where a structure stand can play a crucial role. An ideal facility must necessarily be well connected to the urban center to enable caregivers to travel to it easily

ii. Accessibility: easy accessibility must be allowed (e.g., bus stops and large parking areas), and environments must be easily used by different users (considering the distance, size, weight, and number of people)

iii. Type and control of access: access should be controlled 24/7 and be placed in strategic locations

iv. Spaces Flexibility: space should be able to be repurposed as needed, for example, the creation of several small areas for activities

v.   Odors: Odors should be used as positive stimulation for patients, and bad odors should be contained through, for example, appropriate storage of soiled material

vi. Personalization: the facility should allow, within the limits of the legal provisions on fire prevention, for personalization of spaces, especially the most private ones such as patient rooms

vii. Pleasant View to Outside/inside: a view toward the cornerstones of the city or town where the facility is located allows the patient to understand where he or she is and identify with a known context

viii. Promote Physical activity: physical activity must be allowed and guaranteed within the facility, either through the presence of special gyms or by encouraging movement through protected and safe circular paths

ix. Provision of Technologies: the use of various technologies to monitor patients' health conditions, and movements, and provide rehabilitation strategies as needed

x.   Risk management: ensuring safety in both emergency and common situations for different users, without stigmatized solutions and minimizing risk

Limits and future developments

During the research emerged that future development in long-term care facilities requires a better understanding of staff experiences and staff involved in the physical design of care settings confirming previous studies on this topic (48,49).

The future step will try to improve the matrix, collecting other insights to deeper investigate the relationships between Architectural Features and Health & Wellbeing Outcomes in People with Dementia according to different stakeholders and experts in the field of dementia, collecting different experiences (clinicians, therapists, and technicians).

Conclusions

The analysis has made it possible to outline the main characteristics that the environment dedicated to the dementia patient must possess to be prosthetic and define which aspects may impact people with dementia.

These aspects should be prioritized in the design and renovation of healthcare and residential facilities.

It emerged also that the main aspects that can have a relationship in promoting the health and well-being of PwD are the provision of a small-scale environment (8 to 10 beds per unit) have a great and on-purpose control of light (both daylight and artificial).

The environment should be like one of the houses and use proper and correctly designed colors and finishing to make the environment easily to be understood.

The study confirms that the relationship between the built environment and dementia is complex and multi-faceted. While certain aspects of the built environment can contribute to the risk of developing dementia, the environment can also be designed to support cognitive health.

The research needs new and holistic studies that assess more in detail the various and heterogeneous relationships between the built environment and outcomes in PwD (50) because nowadays it's clear that the environment can have a therapeutic or a debilitating impact on individuals living with dementia (51).

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Appendix A. Scopus search strategy adapted for use in the other databases.

Set	Scopus
1	Dementia
2	Alzheimer
3	Memory loss
4	Sets 1-3 were combined with "OR"
5	Built environment*
6	Design
7	Space*
8	Sets 5-7 were combined with "OR"
9	Wellbeing
10	Health
11	Impact*
12	Sets 9-11 were combined with "OR"
13	Sets 4 and 8 and 12 were combined with "AND"
14	Set 13 was limited to (Date, 2002/2022) English language