Autonomy-supportive environments for people with dementia: an evidence-based review

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Research Article

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Abstract

Background: As one of the core principles of Person-centered Care, supporting the autonomy of residents with dementia has received increasing attention worldwide. Supportive physical environments play an important role in promoting autonomy in the everyday life of residents in care facilities. However, there is no universal definition for autonomy in everyday life, nor focused research on autonomy-supportive environments. Thus, this study aims to systematically review the existing evidence of autonomy-supportive design features based on a synthesized concept analysis of autonomy in everyday life.

Methods: A synthesized concept analysis on autonomy was conducted based on related definitions of autonomy in design guidelines and environmental assessment tools of elderly care facilities. Using keywords from the concept analysis, multiple databases including PubMed, Web of Science, CINAHL, PsycINFO, and Dementia Design Info were used to carry out a systematic review on autonomy-supportive environmental design features for people with dementia. Additional guidelines and standards were manually searched. The design features supported by empirical studies and studies based on experts’ experience were extracted from the literature. The evidence intensity of each feature was assessed according to the quality and quantity of related studies.

Results: Four domains of autonomy, freedom, independence, control, and choice emerged based on the concept analysis. 78 autonomy-supportive design features were extracted from the literature. Features are summarized into eight categories: building layout, circulation space, living room, dining space, bathroom, bedroom, outdoor space, and details. 60% of design features in the category of building layout have been cross-validated by empirical studies, while only 25% of the overall design features have.

Conclusions: Results of this review show that numerous design features of the physical environment can support the autonomy of people with dementia in the four domains. Features of building layout are well researched and the evidence intensity for the rest design features still need to be improved through future empirical studies.

Background

Autonomy is a basic need of human beings [1]. As people get aged, many uncontrollable physical situations gradually occur, which make the need for autonomy even stronger. No matter in what health conditions, an individual always expects himself with freedom, privacy and can make decisions on his own [2]. Numerous studies have shown that the critical factor for older adults to maintain a high quality of life is autonomy [3-5]. However, in group living care facilities, which focus on operational efficiency, and have strict policies over risk management, residents’ control over their lives is often compromised, and their autonomy is easily violated. This is especially true for those with cognitive impairment, people with dementia. Their family members, caregivers often ignore or deprive them of autonomy and tend to make ‘better’ decisions for them [6-8]. According to the World Alzheimer Report 2019, 85% of people with dementia feel that their preferences are ignored [9]. More and more researchers and care practitioners are focusing on how the autonomy of residents can be better supported in care facilities, especially for people with dementia.

Autonomy of people living with dementia

Since the 1950s, supporting the autonomy of care recipients has been an important topic in the field of medical care. Collopy [6] believes that in the context of long-term care, autonomy includes a set of concepts as self-determination, freedom, independence, choice, and action. However, this ideal definition cannot be fully applied to individuals with disabilities, especially those with cognitive impairments. People with dementia may have some degree of deficit in rational thinking and decision-making, and sometimes they may even make decisions that hurt themselves. Therefore, some researchers believe that when a person with dementia cannot pay enough attention to his safety or does not have enough ability to avoid potential danger, then his autonomy needs to be controlled by caregivers to a certain extent [10]. However, the fact that many people with dementia rely on the support of others in many aspects of life, does not necessarily
contradict maintaining one's autonomy. Agich [11] believes that if an individual can accept and instigate the help of others, or drugs, to maintain a sense of self-integrity and dignity, one can still be regarded as independent.

Person-centered care (PCC) is widely adopted in dementia care all over the world, and supporting autonomy is among the core principles of PCC [12]. Shifting in the focus of power to residents is also a primary goal of Cultural Change in care facilities. Many care communities are transforming from their old model that makes decisions for residents (usually out of operational convenience) to a model that supports and respects residents to make more decisions for themselves. Numerous studies have shown that when using appropriate service strategies, caregivers can help residents improve their autonomy [13].

Except for the care environment, the physical environment also plays a critical role in supporting the autonomy of people with dementia. For example, in the Montessori for Aging and Dementia approach, prepared environments are used to support older adults in taking advantage of their remaining abilities [14]. One research in the U.K. on the environmental needs of residents in nursing homes showed that privacy, autonomy, and personal spatial choices are most valued by older adults. Residents need the opportunity to choose where they stay, having a sense of personal space, and thus physical environment needs to provide individuals with autonomy and choice [15]. However, by far there is no systematic research on this topic. Thus, the current study aims to find out potential autonomy-supportive environmental design features through a systematic literature review.

**Autonomy in everyday life**

Rather than some major life decisions (for example living arrangements), the focus of this study is autonomy in everyday life. Everyday life includes recreational activities, dining, toileting, resting, and outdoor activities. Autonomy in everyday life refers to whether people with dementia have choice and control over everyday life decisions, and whether they can act according to their preferences. To simplify the expression, autonomy is used to refer to autonomy in everyday life in this study.

A large number of studies have shown that the small things in everyday life, such as choosing the type of activities or meals have a strong impact on the quality of life of older adults [11, 16-21]. An assessment tool for everyday life preferences in nursing homes was developed, including more than 70 specific items, such as activities, diet, and toileting. When using the tool to evaluate the preferences of a large number of residents in nursing homes in the U.S., researchers found that older adults generally agreed that these items were important to them [22-24].

Autonomy in everyday life is an important way for individuals to express their unique beliefs, needs, preferences, and values. In the later stages of the disease, many people with dementia gradually lose their memory and personal identity. Having autonomy in everyday life can help them express their preferences and maintain a sense of self, thereby enhancing their dignity and integrity. Fischer and Arnold [25] argue that autonomy is an emphasis on self-continuity, and true autonomy resonates with the true self (including life history, habits, values, and life plans); while being forced to make choices undermines personal integrity and worth. Agich [11] pointed out that the lack of meaningful choices may be the reason for social withdrawal and depression of residents in care facilities. Conversely, when a resident perceives a high level of autonomy in everyday life, he may tend to participate more actively in activities that are important and meaningful to him. Thus, promoting the autonomy of residents in everyday life is the key to combating the sense of monotony in care facilities.

**Concept analysis of autonomy in a care facility**

Although much attention has been paid to the autonomy of residents in care facilities, by far there is no universal definition for autonomy in everyday life. It should be noted that the Perceived Enactment of Autonomy Scale [26] divided subjective autonomy into three aspects: freedom, individuality, and independence. However, the items focus on the subjective feelings
of the older adult and do not involve specific decisions in everyday life. Therefore, it is necessary to define the characteristics of autonomy in care facilities before conducting the literature review.

Referring to Walker and Avant’s six-step method of conceptual analysis and theory construction, this study attempts to identify the characteristics of autonomy by analyzing its definition in existing design guidelines and environmental assessment tools [27]. Design guidelines and assessment tools usually focus on the impact of the physical environments on behaviors (including autonomous behavior), which is in line with the research objective.

Table 1 shows principles, indicators, and definitions related to autonomy among 14 important design guidelines and environmental assessment tools of care facilities. There are many common items among guidelines and scales. Keywords include choice, independence, privacy, personalization, control, freedom, and self-continuity. Among them, freedom, independence, control, and choice are four domains that are most frequently mentioned. Although privacy and personalization of space are also frequently mentioned, both of them can be grouped under the concept of “control” (control of privacy and control over personal space). The four domains are comprehensive, yet mutually exclusive, that can best summarize attributes of autonomy mentioned in the guidelines and assessment tools. Therefore, this study takes freedom, independence, control, and choice as the four domains of autonomy.

Based on a synthesis of the definition of the four concepts in design guidelines and assessment tools, this study defines the four domains of autonomy of residents as follows:

1) Freedom: Acting within a certain realm without limitation or regulation.
2) Independence: Participating in daily activities, to the extent possible with the scope of individual abilities.
3) Control: Exerting influence on environment and events.
4) Choice: Selecting among meaningful options related to environments and activities.

**Methods**

**Eligibility criteria**

The goal of the literature review is to systematically review existing evidence of environmental features that support the autonomy of people with dementia. In evidence-based design, literature can be divided into six categories, with their validity ranging from strong to weak: systematic literature review or meta-analysis, experimental research and quasi-experimental research, systematic qualitative research, standards and guidelines based on research findings and peer review, opinions from experts and cases, and recommendations from manufacturers or consultants [28]. Since the literature of the last category may have a financial interest, this study focuses on the other five categories of studies. Studies that show evidence or opinions on design features that can support residents’ freedom, independence, control, or choice were selected.

**Search strategy and information source**

Systematic literature search and manual supplementary search were both adopted in the search. Two types of databases were searched in the systematic search. One is comprehensive databases of behavioral and social sciences, evidence-based medicine, and nursing, including PsycINFO, CINAHL, Medline, and Web of Science. The goal is to search review articles on the physical environment for people with dementia and extract autonomy-supported design features. Another database is Dementia Design Info (DDI), a database specifically devoted to dementia care environment research. DDI extracted more than 300 pieces of literature published before 2013 and coded design features by their location, behavioral outcomes, and research types. The scope of manual search includes guideline websites of evidence-based medicine and nursing, design standards released by local government, and websites of Alzheimer’s Associations in different countries. The main goal of the manual search is to supplementarily collect standards and guidelines related to dementia care environments.
Mixed methods were applied in the review process. The review of literature from the comprehensive databases followed the PRISMA process. Keywords related to the physical environment of people with dementia were used in the search of comprehensive databases through a combination of Boolean operators. For the physical environment, the author used the terms: environment, design, interior, architecture, building, space. For dementia, the author used the terms: dementia, Alzheimer's, cognitive impairment, memory loss. The search was carried out from April 2018 to Dec 2021, and no date limits were applied. The language was limited to English and Chinese.

The review of design features in DDI database began with narrowing down the scope of features. In DDI database, design features were categorized into 7 levels of scales. As the current review focus on architectural characteristics that can support autonomy, features of site, building, room/space, and details were included in the review, while features of finishes, furniture and experiential were excluded.

Data collection and analysis

For literature from the comprehensive databases, the author screened titles and abstracts first and then full articles were obtained to determine whether the study met the inclusion criteria. For each review article, design features that can support residents’ autonomy were retrieved. To assess the strength of evidence of different design features, studies were further classified into two categories. Systematic literature review, meta-analysis, experimental research, quasi-experimental research, and systematic qualitative research were classified as empirical studies, while design standards, guidelines, or expert opinions were classified as studies based on experience. For design features from DDI database, as design features and their outcome on residents were already coded, features that can support outcomes related to residents’ autonomy were included. The original study of each design feature was retrieved and also classified into two categories.

Result

Study selection

A flowchart of the search and selection process is shown in Fig.1. 26 review articles from the comprehensive database were eligible for the review. In the DDI database, 507 design features were retrieved after screening their level of scale, and 147 design features that have outcomes related to supporting the autonomy of people with dementia were included. In the manual search, 6 standards and guidelines were added, including the guidance and recommendations of the Alzheimer's Disease International, NICE guidelines of the United Kingdom, and design guidelines from the United States, the United Kingdom, Australia, and New Zealand. To simplify the review, similar features among the 147 design features from the DDI database were merged, and evidence from 26 review articles and six guidelines was added into each features accordingly. 78 Design features were finally included in the review (Table 2). Design features were then classified into eight categories, including building layout, circulation space, living room, dining space, bathroom, bedroom, outdoor space, and details. In the result synthesis of each category, design features are analyzed based on the four dimensions of autonomy.

Building layout

Numerous studies showed that the unit size, space configuration, and layout of the building have a greater impact on the autonomy of people with dementia. For the unit size, 11 empirical studies and four In found that a small-scale unit with less than 30 people, preferably 5-15 people, can provide a more comfortable and normal living environment for people with dementia, enhancing their sense of choice and control, promoting independent spatial orientation [29-43].

Regarding the configuration of the building, three empirical studies and six studies based on experience reported that it is necessary to provide a variety of spaces (living room, dining room, quiet corner, kitchen, and activity room) for people with dementia to choose where to stay, which makes activity arrangement more individualized and flexible [41, 42, 44-50].
In terms of building layout, three empirical studies and two studies based on experience showed that an open plan, or more than two-thirds of the bedroom doors connecting to shared living space, rather than being connected through corridors, can help people with dementia orientate independently [49, 51-54]. One empirical study argued that arranging places relevant to residents on the same floor is helpful for their independent wayfinding [51]. Three studies based on experience reported that when there is more than one unit, a different layout of each unit can avoid disorientation [41, 49, 55].

Circulation space

Research on circulation space mainly focused on supporting the orientation and movement of people with dementia. Supportive design features found in the literature include the form of a corridor, iconic target space, and security of the exit. An empirical study suggested that when the end of the corridor can be clearly identified (such as setting up a landmark at the end of the corridor), people with dementia can better orientate in space [37]. Three empirical studies and a study based on experience showed that a short corridor contributes to better orientation [39, 41, 56, 57]. In addition, one empirical study and two studies based on experience reported that in simple layout corridors, such as straight or L-shaped corridors, people with dementia performed better in wayfinding than those in loop-shaped or U-shaped corridors [37, 41, 43].

The recognizable design of the space also helps people with dementia to orient themselves. Six empirical studies and four studies based on experience showed that setting up memory boxes or memory boards near the door of the bedroom, and placing familiar objects or photos in it can help residents find their rooms independently [41, 56, 58-65]. Two empirical studies and two studies based on experience also showed that applying different colors or signs at the entrance of the bedroom can help resident find their rooms [41, 49, 66, 67]. In addition, a study based on experience argued that a buffer zone (such as a doorway) needs to be provided between bedroom and corridor to improve a sense of control over privacy [68]. Regarding the entrance design of shared living space, one empirical study and three studies based on experience suggested that the use of transparent partitions or glass doors can help residents to look into the space and identify their target space [41, 43, 69, 70].

In terms of supporting freedom of movement, most dementia care facilities or units use exit control to prevent residents with dementia from getting lost. However, different forms of entrance guard have different effects on residents’ autonomy. Four empirical studies and six studies based on experience showed that disguised entrance of units or spaces that are not open to residents (such as storage rooms) can avoid inducing residents to slip away, thereby enabling them to move with dignity within a safe area without restraints [41-43, 54, 63, 71-75]. One empirical study found that setting an unlocked door to a safe space out of the unit (such as a door leading to an enclosed garden) can provide residents with a certain degree of freedom, and can greatly reduce the feeling of confinement and related agitation [76]. In addition, three studies based on experience suggested that a location tracking system and an alarm system for residents' unexpected leaving can preserve the dignity of residents while ensuring their safety [41, 54, 63].

Living room

Two empirical studies and four studies based on experience suggested that providing abundant activity materials in living spaces, such as boxes with rummage objects or theme activity corners, can bring sensory stimulation to residents, thereby prompting them to carry out meaningful activities independently [41, 42, 63, 77-79]. In addition, Calkins [80] suggested that sufficient and accessible storage spaces for activity materials can also facilitate independent activities.

Regarding environmental stimulus control in the living room, one empirical and nine studies based on experience found that a rich level of public spaces is very important. A spatial sequence composed of private space, quiet space for being alone, space for watching other people’s activities, and space for group activities enables residents to choose activity space according to their preferred social density, and prevent residents from too much social stimulation which may trigger confusion and even agitation [41-43, 47, 48, 63, 68, 70, 81, 82]. Five studies based on experience suggested that quiet spaces with closed doors can help residents to calm down by controlling external stimuli [41-43, 54, 55]. Two empirical
studies and two studies based on experience showed that small alcoves around a large activity space can help residents control and choose their desired social density [44, 49, 68, 83]. Several research also suggested when there is only one large activity space, the use of half-height partition walls or movable partitions can also help residents control environmental stimuli [41, 47, 49, 55, 74, 84]. In addition, Van Haitsma and colleagues [49] pointed out that when there are multiple care units in the facility, a bigger activity space shared by units can provide social choices for residents.

In terms of finding and using activity spaces independently, an empirical study and a study based on experience found that the recognizable layout of each activity space can facilitate independent orientation [37, 43]. Calkins [45] argued that arranging living spaces close to bedrooms can promote finding activity spaces independently.

**Dining space**

Regarding the freedom of dining, Van Haitsma and colleagues [49] believed that rather than one common space used for dining and activity, a separated dining space can afford residents a comfortable dining experience without worrying that their eating speed will affect the follow-up activities.

Existing studies suggested that the variety of dining spaces can provide a sense of privacy and environmental control in the dining experience. Van Haitsma et al. [49] believed that it is necessary to set up two dining spaces for residents in different stages of dementia, one for residents who can eat independently, and the other for residents who need assistance so that the two groups can have a better dining experience. In addition, five empirical and four studies based on experience showed that dividing the dining space into small spaces, setting up separate dining corners, and using dining tables of different sizes can provide more dining and social options for residents [41, 49, 54, 76, 85-89].

The research found that the dining room and home kitchen that is easy to reach and use can promote independent dining and related housework. Van Haitsma and colleagues [49] believed that the visibility of dining space (such as open space or with opening windows) helps residents find it independently. Two empirical studies and two studies based on experience showed that the adjacent arrangement of dining space, home kitchen, and living room can help residents participate in pre- and post-meal preparation activities [41, 51, 53, 65]. One empirical study and four studies based on experience found that a home kitchen with adequate equipment and accessible countertop can create a sense of home and promote independent use by residents [41, 42, 49, 63, 90].

**Bathroom**

A bathroom that is accessible, easy to identify, and barrier-free can support residents in toileting independently. One empirical study and two studies based on experience showed that a public toilet close to the living space where residents normally stay can promote independent toileting. Conversely, if the toilet is too far, it may lead to incontinence and agitation of residents [41, 91, 92].

Regarding the identification of bathroom, three empirical studies and two studies based on experience found that when people with dementia can see directly into the bathroom from their bedside, the chance of independent toileting will increase significantly [49, 54, 59, 76, 85]. One empirical study and three studies based on experience reported that night lights installed in the bedroom can help residents find their way to the bathroom [41, 42, 93]. Also, one empirical study and three studies based on experience found that bathrooms with easy-to-read signs, good contrast (such as highlighting the toilet from the background color), and a toilet style familiar to residents can promote independent use of the bathroom [41, 49, 68, 94].

In terms of accessibility of bathroom, two empirical studies and a study based on experience found that space large enough to accommodate two caregivers is not only convenient for residents to use independently but also supports toileting with assistance [49, 59, 95]. A study based on experience also suggested that a flush threshold at the entry of the bathroom can promote independent toileting [49].
Regarding the bathing experience, a study based on experience argued that it is necessary to provide shower space and storage space within the bedroom to provide a private bathing experience for residents [49]. Two studies based on experience suggested that a heater should be installed in the bathroom so that residents can adjust the temperature according to their preference [49, 55]. A study based on experience argued that bathing areas need to be safe (for example good drainage system and stable shower chair), and meet the barrier-free standards [68] to support residents in bathing independently. Regarding the shared bathroom, a study based on experience stated that the bathing area needs to be blocked from sight and provide changing and storage areas to fully protect the privacy and promote a sense of control during the bathing process [49].

**Bedroom**

Studies showed that the privacy, personalization, flexibility, and recognizability of bedrooms are important autonomy-supportive design features for people with dementia.

Studies suggested that it is important to ensure residents’ control over their living privacy. Six empirical studies and three studies based on experience found that a single room (especially for residents with advanced dementia) can reduce conflicts with other residents, improve their level of activity, and provide convenience for family members’ accompany [41, 49, 54, 59, 96-101]. Two studies based on experience pointed out that when there is a double room, instead of using curtains for space division, more efforts are needed to be done to protect a sense of privacy, such as using a partition wall, wardrobe, or bathroom to divide living zone of two occupants, or using L-shaped plan, foot-to-foot plan layout [49]. A study based on experience suggested that it is not appropriate to design bedrooms with three or more beds for people with dementia [102].

Personalization of the bedroom provides people with dementia a sense of control over their living environment. Three studies based on experience pointed out that when the bedroom is large enough, it is convenient for residents to bring furniture according to their preferences, and is flexible for different placement of furniture (such as different bed positions). A large bedroom is also reported to be helpful for movement safety [42, 49, 55]. Two empirical studies and six studies based on experience showed that providing sufficient space for displaying and storing personal items in the bedroom (such as bay windows, shelves, or cabinets), can help residents recognize their bedrooms [41-43, 49, 63, 103-105]. Two studies based on experience also pointed out that providing sufficient storage space in the bathroom enables residents to place their toiletries in a visible way, which increases residents’ sense of environmental control, and promotes independent washing [49, 68].

Regarding the choice of living space, two empirical studies argued that the facility needs to offer at least two types of units, single room, and double room, so that residents can choose to have a roommate or not [59, 85]. A study based on experience suggested that it is necessary to provide a choice of interior design styles, such as different wall colors, curtains, bedspreads, and furniture styles so that residents can choose their living space according to their preferences [63]. An empirical study and a study based on experience found that using different colors or patterns on the wall to define the personal area in a double room can promote residents’ independent identification [41, 102].

**Outdoor Space**

Literature showed that an enclosed garden for people with dementia is critical to supporting freedom of movement in outdoor activities. Seven empirical studies and six studies based on experience suggested that a freely accessible garden will reduce residents’ feelings of confinement in the closed care unit, thereby reducing agitation and antipsychotic medication intake [30, 42, 43, 54, 55, 76, 106-112]. Although gardens for people with dementia are usually enclosed to prevent residents from unexpected leaving, four studies based on experience suggested unobtrusive fences can reduce the sense of being restricted and preserve dignity [42, 43, 63, 113].

A few empirical studies mentioned the environmental choice and control of outdoor activities. Two studies based on experience showed that providing rich outdoor spaces for people with dementia can meet different needs of individuals thus promoting the use of outdoor space [41, 113]. For example, providing different rest areas with sunlight or shade along the
walking path enables residents to choose a comfortable place to rest. Also, a semi-outdoor space adjacent to the building entrance can encourage outdoor activities for the residents who do not want to travel far. In addition, Cohen-Mansfield [114] suggested that various design features (like gazebo or benches) can promote the use of outdoor spaces. Three studies based on experience argued that multisensory stimulation can help residents overcome deficits in mobility and cognitive abilities [41, 42, 115].

Supporting people with dementia to find garden entrances independently was investigated in many studies. Two empirical studies and five studies based on experience suggested that a direct view from the care unit to the garden can promote independent use of the garden and also encourage care staff to help residents use the garden [37, 42, 49, 65, 68, 114, 116]. One empirical study and three studies based on experience also showed that the proximity of garden entrances to indoor common spaces can facilitate residents’ access to outdoor space independently and safely under caregiver’s supervision [42, 49, 113, 116]. Chalfont [117] believed that direct access to the garden from the bedroom can support independent use of outdoor space. The safety and identifiability of garden entrances also have a great impact on independent garden use. Grant and Wineman [116] proved through empirical research that steps or height differences at the garden entrance prevent caregivers from allowing residents to use the outdoor space alone. One empirical study and four studies based on experience suggested that signs or landmarks in the garden can help residents with wayfinding in the garden [41, 69, 107, 112]. Zeisel [118] further pointed out that when the building entrance can be observed at any point in the garden, the confusion of residents can be largely reduced. One empirical study and five studies based on experience found that a circular walkway starting from the main entrance of the garden can promote natural mapping of residents [41, 42, 51, 65, 113, 118].

Details

Details include lighting, noise control, signage, doors, windows, and appliance. Existing research showed that good detail design can provide support for independence.

Three studies based on experience suggested that sufficient lighting can support residents in carrying out daily activities more independently [41, 42, 119]. Two studies based on experience pointed out that it is important to reduce glare since people with dementia are prone to delusions. Venetian blinds and gauze curtains allow residents to adjust the light autonomously, thus can provide a controllable and comfortable level of lighting [41, 55]. Two empirical studies and two studies based on experience found that large windows can enhance residents’ orientation to time and space [41, 49, 62, 70]. Two studies based on experience also suggested that a window with a suitable sill height for residents in wheelchairs can support them to view the outdoor landscape independently [49, 55]. One empirical study and three studies based on experience found that windows that can be opened independently can help residents to adjust indoor ventilation, and an opening control device is needed to ensure safety [49, 54, 63, 120].

Four studies based on experience suggested that providing measures that can reduce noise can enhance residents’ sense of control, for example, sound-absorbing materials in walls and ceilings, furniture with soft surfaces that can absorb sound [41, 42, 49, 121].

Two empirical studies and five studies based on experience believed that a clear and consistent signage system can support independent wayfinding of residents. Highlighting important information with good contrast to background or irrelevant information was reported to be useful, such as highlighting the color contrast between handrail and wall [41, 42, 51, 54, 68, 122, 123].

Regarding the selection of appliances, two studies based on experience found that concealing dangerous items (such as knives, detergents) unobtrusively, or the use of safe cooking equipment (such as stoves with concealed master switches), can support residents in using the home kitchen independently and safely [68, 80]. A study based on experience suggested
that compensatory design, such as switches with large panels and lever door handles, can promote the independence of people with dementia [68].

**Discussion**

Results of this review paper show that physical environments can offer great support to the autonomy of people with dementia in care facilities. The evidence covers different spaces in the facility, as well as the four domains of autonomy: freedom, independence, control, and choice. However, the intensity of evidence for different design features and different spaces varies greatly. Some design features are supported by a lot of empirical studies, while some features only get support from a few experts. To compare the difference in evidence intensity between design features, a three-level classification was created based on the type and quantity of literature that supports the design feature. Design features with two or more supportive empirical studies were classified under level 3, suggesting that the feature can effectively support autonomy for people with dementia. Design features supported by only one empirical study or more than two studies based on experience were classified under level 2, implying the feature has a certain degree of empirical validity or a consensus of experts’ opinion. Design features supported by only one study based on experience were classified under level 1, indicating the current evidence is rather poor.

Table 3 shows the result of the intensity analysis of design features. It can be seen that nearly 75% of the design features are at intensity levels 1 or 2, while those at intensity level 3 are relatively few, especially in categories like dining space, bedroom, bathroom, outdoor space, and details. This result implicates that the effectiveness of many design features reviewed in this study has not been cross-validated by multiple empirical studies, while more than one-third of them are only suggested by one expert or a design guideline. Nevertheless, 60% of design features of the building layout category are at intensity level 3, indicating the impact of building layout on the autonomy of people with dementia has been well researched.

**Conclusion**

Following an evidence-based approach, the current study systematically reviewed environmental design features that can support the autonomy of residents with dementia in care facilities. Through concept analysis of autonomy in the care facility, freedom, independence, control, and choice were extracted as four domains of autonomy in everyday life. This clear definition of autonomy makes a systematic review of autonomy-supportive environments practical. Although this review extracted many autonomy-design features from literature, more than one-third of them are of poor strength considering the quantity and quality of the supporting studies. Analysis of evidence intensity in this article reveals that much research has been conducted on the building layout aspect, and more research effort is needed in aspects like living room, dining space, bedroom, bathroom, outdoor space, and details. As supporting residents’ autonomy has been critical to person-centered care, the results of the current study can contribute to creating a more autonomy-supportive environment for people living with dementia.

**Abbreviations**

PCC
person-centered care

**Declarations**

**Ethics approval and consent to participate**

Not applicable
Consent for publication

Not applicable

Availability of data and materials

The data are available in the articles included in the review.

Competing interests

The author declare that they have no conflicts of interest.

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Authors' contributions

JL conceptualized and designed the study, analyzed the data, and drafted the manuscript.

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**Tables**

*Table 1* Concepts related to autonomy in design guidelines and environmental assessment tools
<table>
<thead>
<tr>
<th>Category</th>
<th>Author, year</th>
<th>Concepts related to autonomy</th>
<th>Freedom</th>
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<th>Control</th>
<th>Choice</th>
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<td>DG</td>
<td>Calkins, 1988 [125]</td>
<td>Competence in daily activities, Privacy and socialization, Personalization</td>
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<tr>
<td>DG</td>
<td>Wilson, 1990 [126]</td>
<td>Independence, Choice/control/autonomy, Privacy, Serve the unique individual</td>
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<td>DG</td>
<td>Cohen and Weisman, 1991 [68]</td>
<td>Maximize autonomy and control, Protect the need for privacy</td>
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<tr>
<td>DG</td>
<td>Regnier and Pynoos, 1992 [127]</td>
<td>Control, choice/autonomy, Privacy, Personalization</td>
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<tr>
<td>DG</td>
<td>Diane Y. Carstens, 1993 [128]</td>
<td>Autonomy, independence, and a sense of usefulness, Personalize, change, and control the environment, Variety and choice</td>
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<tr>
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<td>Outdoor freedom, Exit control, Autonomy support, Supporting independence, Individual away places</td>
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<tr>
<td>DG</td>
<td>Brummett, 1997 [129]</td>
<td>Control/autonomy, Privacy/territory, Choice/opportunity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DG</td>
<td>Tyson, 1998 [130]</td>
<td>Freedom, Maximize a sense of independence, Provide opportunities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AT</td>
<td>Lawton, 1999 [131]</td>
<td>Support functional abilities, Personal control, Provision of privacy, Continuity of the Self</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>AT</td>
<td>Sloane, 2002 [132]</td>
<td>Provision of privacy, control, autonomy</td>
<td></td>
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<td>----------------------------------------</td>
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</tr>
<tr>
<td>AT</td>
<td>SCEAM, 2004 [133]</td>
<td>Choice and control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free access to garden/outside spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Privacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Personalization</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Personal control</td>
<td></td>
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</tr>
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<td></td>
<td></td>
<td>Privacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AT</td>
<td>Fleming and Bennett, 2011 [135]</td>
<td>Privacy and community</td>
<td></td>
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</tbody>
</table>

**Frequency of concepts**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>10</td>
<td>12</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2** Design Features and Supported Studies

AT = Assessment tool
DG = Design Guideline
<table>
<thead>
<tr>
<th>Design features</th>
<th>Empirical studies</th>
<th>Studies based on experience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building layout</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smaller residential units</td>
<td>▲▲▲▲▲▲▲▲▲▲▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Multiple places for meaningful activities</td>
<td>▲▲▲</td>
<td>●●●●●●●●●●●</td>
</tr>
<tr>
<td>Units designed with an open plan</td>
<td>▲▲▲</td>
<td>●●●●●●●</td>
</tr>
<tr>
<td>Distinguishable configuration of different units</td>
<td>▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Places relevant to residents are located on the same floor</td>
<td>▲</td>
<td>●</td>
</tr>
<tr>
<td><strong>Circulation space</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearly visible endings of corridors</td>
<td>▲</td>
<td>●</td>
</tr>
<tr>
<td>Short hallways</td>
<td>▲▲▲</td>
<td>●●●●●●●●●●●</td>
</tr>
<tr>
<td>Memory boxes or board besides bedroom entry</td>
<td>▲▲▲▲▲▲</td>
<td>●●●●●●●●●●●</td>
</tr>
<tr>
<td>Doorway at bedroom entrance</td>
<td>▲</td>
<td>●●●●●●●●●●●</td>
</tr>
<tr>
<td>Open doorways to destinations</td>
<td>▲</td>
<td>●●●●●●●</td>
</tr>
<tr>
<td>Wayfinding cues for bedroom</td>
<td>▲▲▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Geometrically simple floor layouts</td>
<td>▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Wanderer Monitoring Systems</td>
<td></td>
<td>●●●●●</td>
</tr>
<tr>
<td>Unobtrusive measures to prevent elopement</td>
<td>▲▲▲▲▲▲</td>
<td>●●●●●●●●●●●</td>
</tr>
<tr>
<td>Unlock unit door leading to safe area</td>
<td>▲</td>
<td>●</td>
</tr>
<tr>
<td><strong>Living room</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A full continuum from private to public spaces</td>
<td>▲</td>
<td>●●●●●●●●●●●</td>
</tr>
<tr>
<td>An enclosed quiet lounge</td>
<td></td>
<td>●●●●●●●</td>
</tr>
<tr>
<td>Alcoves around centralized activity area</td>
<td>▲▲▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Easily accessible storage for props</td>
<td></td>
<td>●●●●●</td>
</tr>
<tr>
<td>Shared activity space between units</td>
<td></td>
<td>●●●●●</td>
</tr>
<tr>
<td>Dividing large rooms into smaller area</td>
<td>▲▲▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>A variety of props offering stimulating sensory</td>
<td>▲▲▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Distinguishable living rooms</td>
<td>▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Communal spaces closed to bedrooms</td>
<td></td>
<td>●●●●●</td>
</tr>
<tr>
<td><strong>Dining Space</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dining space divided into smaller area</td>
<td>▲▲▲▲▲▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Dining space used mainly for meals</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Two dining rooms for residents with different cognitive statuses</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Providing different table sizes</td>
<td>▲</td>
<td>●●●●●</td>
</tr>
<tr>
<td>Feature</td>
<td>Level</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Sufficient dining space</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td>Therapeutic kitchens with plenty of appliances</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td>Kitchens with an accessible countertop</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Direct views to the dining space</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Distinguishable interior material</td>
<td>▲▲</td>
<td></td>
</tr>
<tr>
<td>Cooking, dining, and activities areas located close to one another</td>
<td>▲▲</td>
<td></td>
</tr>
<tr>
<td><strong>Bathroom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimal floor lip at entrance of bathroom</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Toilet rooms located near living space</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td>Partitions for the bathing area</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Space in the shower room to get changed</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Curtains separating bathing and toileting area</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Recognizable bathroom</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td>Accessible and safe bathing area</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Spacious toilet room</td>
<td>▲▲</td>
<td></td>
</tr>
<tr>
<td>Toilet immediately visible from bedside</td>
<td>▲▲▲</td>
<td></td>
</tr>
<tr>
<td>Amber-colored night lights in bedrooms</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td>Shower in en suite in bedroom</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Heater in the bathroom</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Bedroom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice of private room or shared room</td>
<td>▲▲</td>
<td></td>
</tr>
<tr>
<td>Private room</td>
<td>▲▲▲▲▲▲</td>
<td></td>
</tr>
<tr>
<td>Semi-private room with partitions</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Shared room for no more than two residents</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td>Provide options in resident room décor</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Large bedrooms flexible for arrangement</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Hotel-style connecting doors between some private rooms</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Places for displaying personal belongings</td>
<td>▲▲</td>
<td></td>
</tr>
<tr>
<td>Storage spaces in the toilet room</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Private room with Dutch door</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Different wall coverings for each resident's part in a shared room</td>
<td>▲</td>
<td></td>
</tr>
<tr>
<td><strong>Outdoor space</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessible and enclosed garden</td>
<td>▲▲▲▲▲▲</td>
<td></td>
</tr>
<tr>
<td>Sitting under sun or shade</td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>
Semi-outdoor space near entrance ●●
Various activity spaces ●
Easily viewed from indoor space ▲▲ ●●●●●
Entrance close to communal area ▲ ●●●
Resident rooms with doors to outdoor gardens ●
Flush threshold at garden entrance ▲
Unobtrusive fence ●●●●●
Multi-sensory stimulation ●●●
Entrance visible from any perspective ●
Pathway in loops ▲ ●●●●●
Landmarks and signage ▲ ●●●●
Details

Hidden and lockable storage for dangerous kitchenware ●●
Sufficient lightning ●●●●●
Clear signage ▲▲ ●●●●●
Easy to use hardware ●●●
Large windows ▲▲ ●●●
Window sill height suitable for residents in wheelchairs ●●
Windows that can be opened independently ▲ ●●●●
Minimum glare ●●●
Measures to control noise ●●●●

Note: The number of icons in each field indicated the number of studies.

**Table 3** Evidence intensity distribution of design feature

<table>
<thead>
<tr>
<th>Feature Category</th>
<th>Number of features</th>
<th>Intensity level 1</th>
<th>Intensity level 2</th>
<th>Intensity level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building layout</td>
<td>5</td>
<td>0.00%</td>
<td>40.00%</td>
<td>60.00%</td>
</tr>
<tr>
<td>Circulation space</td>
<td>10</td>
<td>20.00%</td>
<td>40.00%</td>
<td>40.00%</td>
</tr>
<tr>
<td>Living room</td>
<td>9</td>
<td>44.44%</td>
<td>22.22%</td>
<td>33.33%</td>
</tr>
<tr>
<td>Dining space</td>
<td>9</td>
<td>44.44%</td>
<td>33.33%</td>
<td>22.22%</td>
</tr>
<tr>
<td>Bedroom</td>
<td>11</td>
<td>18.18%</td>
<td>54.55%</td>
<td>27.27%</td>
</tr>
<tr>
<td>Bathroom</td>
<td>12</td>
<td>50.00%</td>
<td>33.33%</td>
<td>16.67%</td>
</tr>
<tr>
<td>Outdoor space</td>
<td>13</td>
<td>53.85%</td>
<td>30.77%</td>
<td>15.38%</td>
</tr>
<tr>
<td>Details</td>
<td>9</td>
<td>33.33%</td>
<td>55.56%</td>
<td>11.11%</td>
</tr>
<tr>
<td>Total</td>
<td>78</td>
<td>35.90%</td>
<td>38.46%</td>
<td>25.64%</td>
</tr>
</tbody>
</table>
Figures

Figure 1
Flow chart for the screening process

Supplementary Files
This is a list of supplementary files associated with this preprint. Click to download.

- Database.xlsx
- PRISMA2020checklistJL0909.docx