

Therapeutic Gardens – A healing environment for optimizing the health care experience of Alzheimer’s and dementia patients: A narrative review

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Abstract

Purpose: This paper extends previous works to include the role of therapeutic gardens in the healing environment as an intervention for bettering the clinical outcomes of Alzheimer’s and dementia patients, the positive impact of healing gardens and the innovative application of technologies with nature, for promoting cognitive rehabilitation in this particular patient population.

Methods: Using ISI Web of Science, PubMed, ProQuest Central, MEDLIN, Scopus and Google Scholar, a relevant literature search on the positive health implications of therapeutic gardens on Alzheimer’s and dementia patients’ in the healthcare milieu was conducted.

Results: Health implication of therapeutic gardens on Alzheimer's and dementia patients' spans across physical, social, psychological and cognitive effects. Virtual reality (VR) technologies offer positive cognitive outcomes to Alzheimer's disease (AD) and dementia patients.

Conclusion: Therapeutic gardens should be extended for speedier recovery of other patient populations. Future directions in the design of healthcare gardens with a focus on patient experience are inferred.

Keywords: Alzheimer's disease; dementia; therapeutic environment; Virtual reality; Stress recovery; therapeutic gardens.

1. Introduction and background

The roots of healing environment commenced with the Florence Nightingale concept and could be traced back to the 1860s when the provision of fresh air was placed as the very first canon for linking the hospital physical environment with the improvement of patients, staff safety, wellness and satisfaction. This concept extends to include the importance of quiet, proper lighting, warmth and fresh water, as well as the ability for the room of the sick to curtail distress and optimize a patient recuperating process. Florence Nightingale theory is prioritized on how the hospital environments can promote speedier recovery in patients [1], which has largely given birth to Evidence-Based Design (EBD). EBD approach is a design movement for healthcare environments that support social, physical and psychological well-being. It is based on sourcing available information from both research and project evaluations to create spaces that are therapeutic, supportive for family involvement, efficient for staff performance, restorative for patient and healthcare workers under stress [2], as well as for improving the design of hospital environment, healthcare management and policymaking [3].

Earlier studies have supported the idea that natural environments have a restorative property on several health outcomes [4,5]. Research evidence found that patients experience less pain when exposed to a view of nature from their hospital rooms [6], suffered fewer complications, used less pain medication and were discharged sooner than those who looked out onto a brick wall [7]. Consistent with this, [8] remarked, that improving patients and staff experience of health care services and environments with positive design, have a profound impact on their physical and mental status. These improvements have involved a range of non-pharmacological approaches to improve the discomfort associated with stress and the duration of stay in the hospital environment [9]. For example, therapeutic gardens and healing gardens as a non-

pharmacological intervention have been shown to improve wellness, reduce the level of pain, agitation and anxiety of patient in the healthcare setting [10 – 12].

It has been theorized that humans have a positive response to the features of natural environments [13], which is closely related to the Biophilia theory, suggesting that humans have an inherent love for nature and other forms of life, including environments that are essential for survival [14]. [15] found that people who live closer to green space had fewer health complaints and live longer and that the green space itself is a stress buffer, helping people cope better with life's adversities. There is also growing supporting research and evidence from various disciplines such as horticultural therapy [16], ecological psychology [17], environmental psychology [18,7,19] and medical geography [20] that has highlighted the significance of natural views and landscape sceneries in terms of how and why they may alter people's mood and reduce stress. Additionally, a healthcare physical environment designed with appropriate gardens, may provide pleasant nature views, calming effect, access to social support and privacy as well as contributing in reducing stress [21].

Prior studies pointed out that documenting more research on gardens in the health care settings is important to harness the potential of the therapeutic benefits of well-designed outdoor spaces and gardens that can increase exercise and mobility, minimize feelings of isolation, vulnerability, loss of capabilities, improve depression and enhance self-esteem of individuals with Alzheimer's disease and dementia [22,23]. [22] suggests that strategic planning should include gardens and outside spaces to preserve the health and maximize the abilities of individuals with cognitive impairment. [24] noted that despite considerable attention paid to the utilization of sensory garden and other horticultural or nature-based therapeutic programmes, only few specific investigations have been conducted within dementia care with researchers mainly focusing on the United States. [25] proposed that future research needs to place greater emphasis on environmental intervention-based studies, diverse sample populations, inclusion of residents in different stages and with multiple types of dementia and on longitudinal study design. The same work also indicates that greater recognition is necessary for creating physical environments appropriate and responsive to residents' cognitive abilities and functioning.

Based on these views, this paper stimulates research into the role of therapeutic gardens as an evidence-based practice for improving the physical and mental status of specific patient groups such as Alzheimer's and dementia. It further explored the extent to which researchers have postulated the positive health impacts of therapeutic gardens and horticultural therapy as a non-invasive intervention for Alzheimer's and dementia patients as well as the innovative technological advances used for promoting healing with nature in the clinical ecosystem.

1.1. Aim and article structure

This paper recognizes the role of healing gardens, the benefits of therapeutic gardens and the extent to which researchers have postulated the positive interventions of therapeutic gardens as they contribute to achieving positive outcomes for users in the healthcare ecosystem. It further highlights evidences on the impacts of therapeutic gardens for selected mental illness such as Alzheimer's and dementia. As shown in (Fig. 1), this paper sorts the literature and main issues into themes including: describing the therapeutic environment; healing and therapeutic gardens as an environmental design construct; the health effects of horticultural therapy and therapeutic gardens on Alzheimer's and dementia patients; non-invasive technological interventions for improving clinical outcomes of Alzheimer's and dementia patients, as well as a summary of the literature review findings and suggestions for the design of gardens in healthcare.

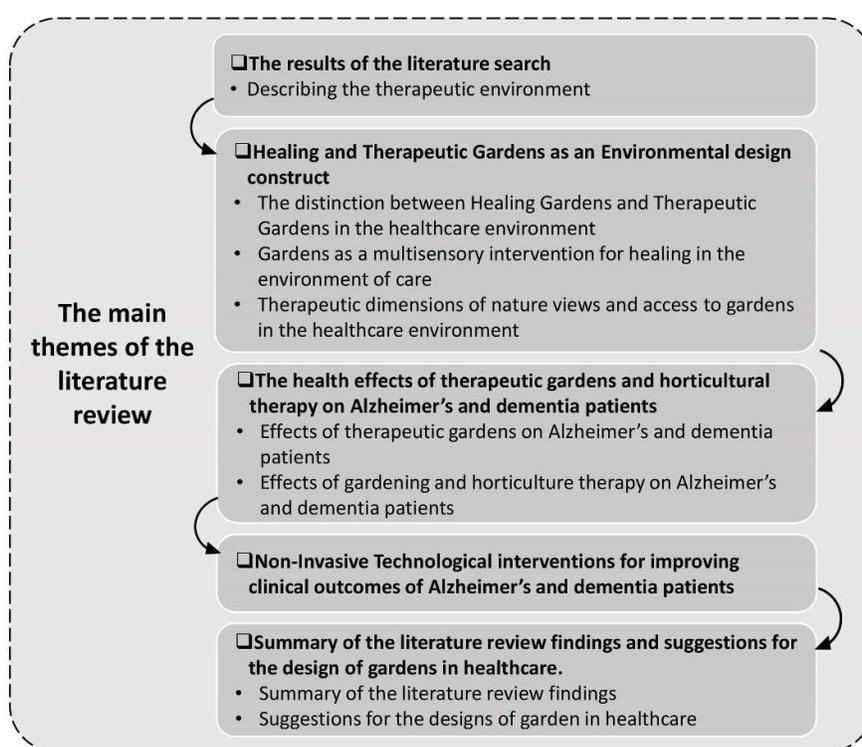


Fig.1. The structure and main themes of the literature review

2. Literature review search method

2.1. Study selection procedure

This study was undertaken between October 2017 and September 2018 comprising an electronic database search considering a wide scope of interdisciplinary subjects, including psychology, multisensory architecture, horticulture, hospital management, nursing, technology and collective concerns within the hospital contexts. Data sources include results from the

Scopus (1984 to August 2015); Google Scholar (1989 to April 2017); Web of Science index (1991 to June 2018); MEDLINE (January 2008 to February 2018); PubMed (2014 to February 2017); ProQuest Central (2013 to May 2015); and Google (2012 to February 2018). There was no restriction to article publication dates. Book reviews, monographs, duplicates, encyclopedia articles, non-English publication and editorials were excluded.

A broad publication period was considered, to include earlier relevant material and historical sources that significantly contributed in determining the objective of the current subject matter. Although there is a substantial amount of literature on the healing benefits of gardens within the healthcare setting, there is not enough evidence to support the use of therapeutic gardens as an alternative medicine, or as a non-invasive intervention especially for specific patient user groups. It has however been adopted in the care of Alzheimer's and dementia patients to promote physical, emotional and mental health of patients, but has not fully gained recognition for application to a wider range of patient groups. The poor adoption could be due to the fact that the practice is still in its developing stage for therapeutic rehabilitation of patients, discrepancies and deficiencies in their reporting to guide clinicians, designers, policy makers and researchers.

This work is interdisciplinary and covers a wide range that includes nursing, physical therapy, horticulture and architecture. This permits a more comprehensive understanding of the role of therapeutic gardens in terms of improving the health care experience, as well as its peculiar health implications for older adults in the clinical ecosystem. It also helped assess the state of knowledge in the area under investigation, to find out whether greater acknowledgement of therapeutic garden applications for rehabilitation in the clinical setting is occurring and to determine how this informs healthcare design, research and praxis. This further revealed an advancement in technological innovations for healing with nature to enhance cognitive gains in dementia care facilities.

2.2. Searching procedures and keywords

As presented in Fig. 2, a five (5) phase iterative process was employed to describe the research design.

Phase 1

The search for empirical articles was divided into sections. In the first section, the selection criteria for included articles was that all articles discussed the concept of healing in healthcare, the construct of healing and therapeutic gardens in healthcare and design factors for improving the user experience in the environment of care. The main search terms include: "*Evidence-based*

design,” *“healthcare,”* *“innovative design practice and healthcare,”* *“hospital environment,”* *“sensory gardens,”* and *“multisensory gardens,”* but are not exclusive to the aforementioned.

Phase 2

In this section, specific terms including *“hospital environment,”* *“healthcare facilities,”* *“complementary design interventions”* and *“patients’ user groups,”* were used to search for related publications in combination with the terms *“healing garden,”* *“therapeutic gardens,”* *“gardening,”* *“nature,”* and *“healing environment.”* This yielded a total of twelve (n=11) papers highlighted in an extraction data sheet which characterize the final data set into ‘Selected reference (s)/medical specialty’, ‘Study Design’, ‘Participant size’, ‘Design Intervention type’, and ‘Results/Reports on health outcome(s) presented in table 2. Additionally, the ‘snowball’ method of using the most recent published works to extract articles cited in them was used to obtain relevant papers that help in shaping the topic under investigation. *“therapeutic gardens and physical activities,”* *“garden and wellbeing,”* *“healing garden and mental health,”* *“therapeutic garden and mental wellbeing,”* *“gardens and physical health,”* *“children’s garden,”* *“Alzheimer’s gardens,”* *“dementia gardens,”* *“cancer gardens,”* *“patient experience,”* *“horticulture therapy,”* *“emotional comfort,”* *“health care experience,”* *“health care occupants.”*

Phase 3

A new set of search phrase combining horticulture and therapeutic gardens with factors including physical, social, psychological and emotional impacts on Alzheimer’s and dementia patients, was coined. These served as keywords towards identifying the clinical/health impacts of therapeutic gardens and gardening activities such as horticulture practices on the focus patient user groups, (Alzheimer’s and dementia), presented in table 3 and yielded a total of (n=18) papers. The databases used were the same as described earlier in the study selection procedure.

Phase 4

Furthermore, one of the goals of this review is to synthesize the findings from various disciplines to inform and suggest research directions for the designs of healthcare garden. Using search phrases including; *“garden and technology,”* *“gardens and non-invasive interventions,”* *“gardens and geriatric homes,”* papers centered on recent trends in the use of non-invasive technological interventions for healing with nature within the healthcare milieu were reviewed. This yielded a total of (n=7) papers highlighted in table 4.

Phase 5

This phase presented a summary of the literature review findings as well as a highlight of recent studies that further identified papers which discuss the therapeutic use of gardens with a focus on suggestions for the garden design and their application in clinical environments, under main themes including: “Ease of Access, Movement & Orientation”, “Sensory Stimulus, positive distraction and Mental Mapping”, “Shelter and Shade”, as well as “Safety Considerations and Maintenance”.

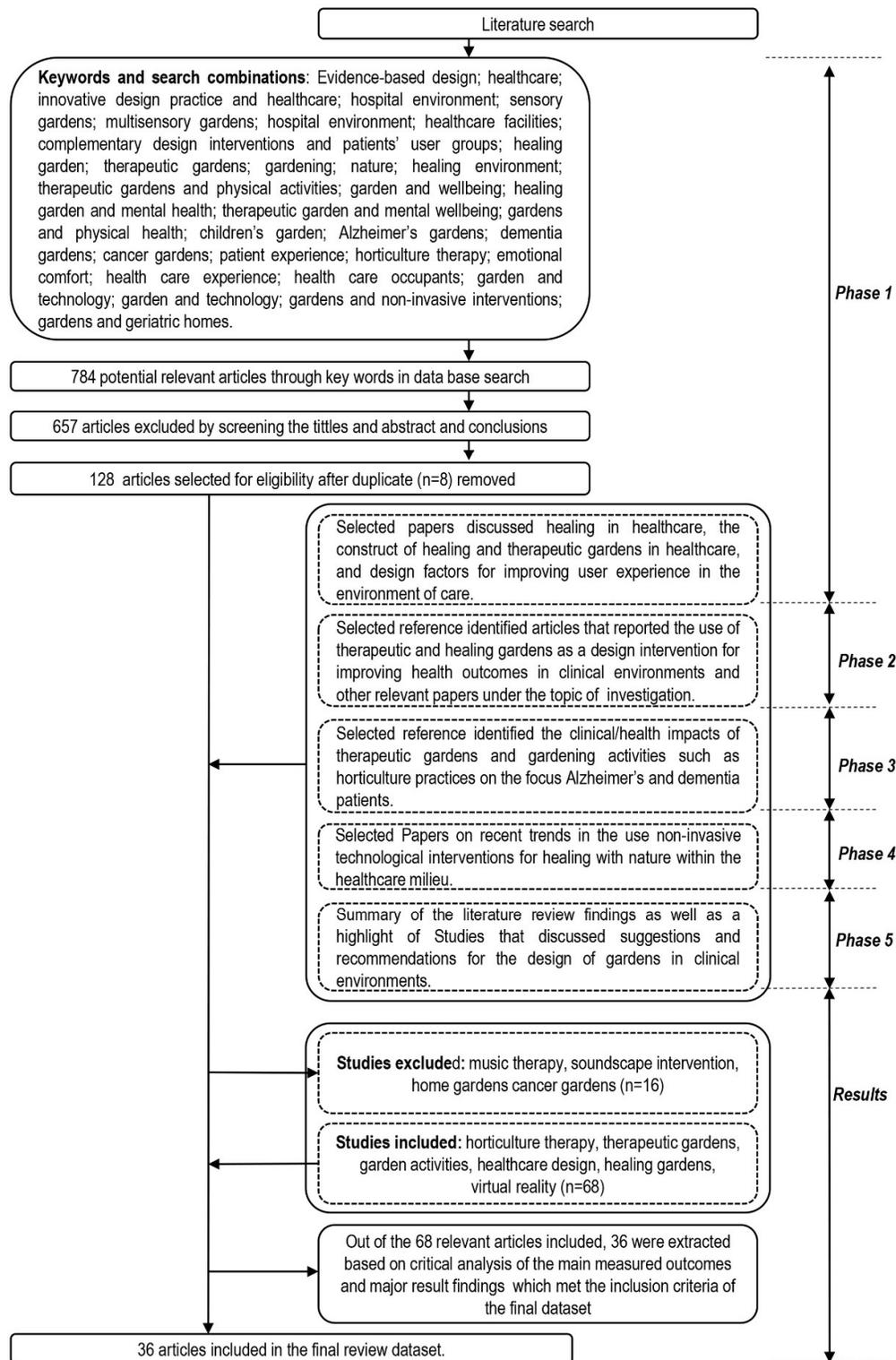


Fig. 2. Literature search flow chart

3. The results of the literature search

As of September 2018, the initial search results yielded about 784 references. A closer look on papers relevant to the main issue under investigation yielded, a total of 128 selected articles

utilized in this review. The primary criteria for inclusion were that the papers retrieved contained significant content concerning therapeutic environment in health care, healing and therapeutic gardens and non-invasive technological intervention for healing with nature. Of the 128 references identified by the search strategy, 36 were further extracted for more detailed evaluation based on analyzing the title, abstract and conclusion of each manuscript to include works that deal with gardening, horticulture therapy, multisensory application of gardens as well as views and access to nature, garden design for specific patient user groups which met the inclusion benchmark of the final dataset.

Furthermore, to identify the 'publication type and 'database sources,' references were grouped according to studies that deals with 'Therapeutic Gardens and Healing Environment Materials (n = 92),' 'Horticulture Therapy Materials (n = 16),' 'Healthcare Design Materials (n = 7),' 'Non-Invasive Technological interventions (n = 12),' and 'Other Relevant and Health-Related Materials (n = 1)'. Out of the 128 total references included in this paper, 110 were journal articles, 13 were books, 1 Master Thesis, 4 where Doctoral dissertations, as well as 1 blog report (<https://bit.ly/2I22v2K>, 25 February 2018).

As presented in Table 1-4, an extraction data sheet was formulated to characterize the final data set into 'selected reference(s)/medical specialty'; 'study design'; 'participant size'; 'design intervention type'; 'results/reports on health outcome(s)'; 'measured outcome'; were grouped into the following themes: 'horticulture therapy impact on Alzheimer's and dementia patients'; 'therapeutic gardens impact on Alzheimer's and dementia patients'; and 'VR technology interventions and intelligent environments'.

3.1. Describing the therapeutic environment

Hospitals are often perceived as stressful places for both patients, staff and family members. However, the hospital physical environment can be therapeutic if they are designed to foster psychological, spiritual, physical environmental factors, social and behavioral aspects of healthcare support, as well as kindles the body's innate capacity to heal itself [26,27] (see Fig. 3). This suggests that an environment which promotes healing is essential to improve the user experience.

Interestingly, regardless of the prominence of studies on healing environment, as yet a holistic framework has not been properly integrated into the healthcare built environment to guide designers [28]. Though, substantial research has documented the positive impact of the healing environment on user experience in the healthcare settings [29 – 33]. This conforms with

the view that a therapeutic environment can profoundly reduce patients' anxiety and stress, pain and medication use, provide privacy and security, accelerate recovery, foster shorter hospitalizations, fewer negative comments on nursing notes as well as promote a sense of well-being for patients, family members and clinicians [34 – 36].

Indeed, the role of gardens for therapeutic purposes has been well documented in the past few decades [30,37]. Studies have reported the need to consider other environmental factors that contribute to a healing environment. These include daylight [38], fresh air and quiet [39], art therapy [40], music therapy [41] and horticulture therapy [16]. The conscientious integration of these environmental factors and alternative therapies can generate an optimal healing environment [42]. The effectiveness of how hospital designs can improve patient therapeutic wellbeing or experience has been discussed in the literature [43,44].

Having recognized the positive outcomes of the healing environment, it is also reasonable to explore other aspects of the healthcare physical environment that are requisites to improve the design of healthcare facilities.

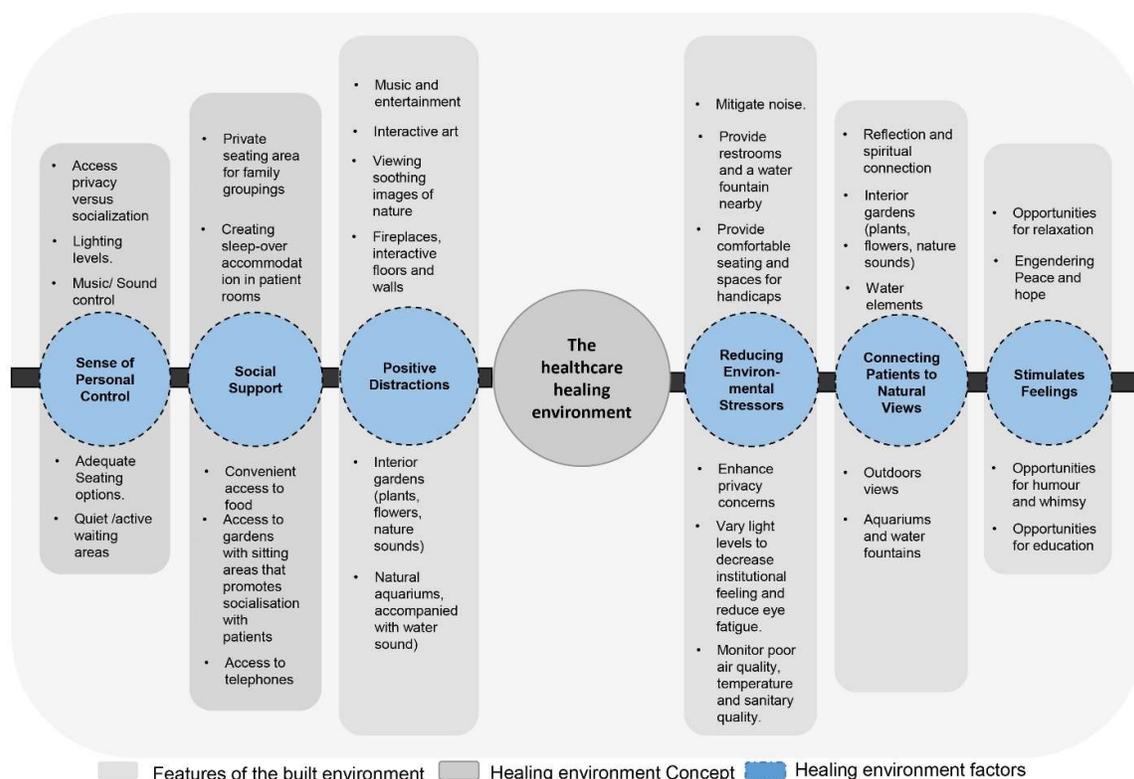


Fig. 3. A model for understanding a therapeutic environment (adapted from [19,30,27,32,31,33]).

3.2. Healing and therapeutic gardens as an environmental design construct

3.2.1. The distinction between healing gardens and therapeutic gardens in the healthcare environment

The phrase healing garden or therapeutic gardens have often been used interchangeably. Nonetheless, few studies have documented clarification regarding the use of these terms [45]. A healing garden has been described as a space designed with the intention of providing certain therapeutic benefits for most of its users [46]. The distinction between healing gardens and therapeutic gardens is that, the design of a healing garden is aimed at achieving a general set of goals, while the design of a therapeutic garden is chiefly dictated by the demands of one or more specific patient group [47]. However, horticultural therapists often refer to healing gardens or therapeutic gardens as environments that offer places for gardening activities and encourage physical movements [11].

3.2.2. Gardens as a multisensory intervention for healing in the environment of care

Subjectively, all gardens can stimulate the senses, however, sensory gardens do this to a greater degree, when compared to others. Frequent encounter and experience with a natural environment evokes all our senses, thereby reducing stress, anxiety and pain [46]. A garden that provides a multi-sensory experience through incorporating nature elements, contact with different natural shades and textures, may stimulate the senses (sight, vision, hearing, smell and touch) as well as enhance wellness [48]. Sensory garden has been classified as either 'passive' or 'active.' Passive use refers to simply being in the sensory garden, for example, enjoying various forms of sensory stimulation such as fresh air, fragrances, sights, birdsong, sunshine and warmth. Whilst active use refers to a more purposeful activity such as gardening, communal games and horticultural practices [24].

Exposure to sensory gardens in the clinical environment has been shown to have a positive impact on health outcomes. For instance, in dementia facilities, wander gardens have been employed to increase sensory stimulation by providing frequent access to nature for high elopement risk residents [49]. An earlier study suggests that in the presence of a visually dominant sensory garden environment, we simply need to close our eyes and wait for the other senses to be awakened in order to experience and appreciate the presence of other senses [50]. This implies that, of all the senses, sight has been regarded as the most dominant [51]. However, gardens should be designed to provide both mentally and physically stimulating environments which engenders a rich sensory experience.

The act of viewing nature through a window may help alleviate isolation and loneliness, which may have a positive impact on patients [52]. Similarly, studies have demonstrated that listening to soothing nature sounds such as birdsong can reduce patient anxiety and agitation [53,54]. Additionally, an environment with flowering plants, aquariums and wall murals of nature scenes will evoke positive stimuli to the senses and engender a calming effect on anxiety in dental waiting rooms and psychiatric units [55,4]. The healthcare environments should be designed to include nature-based interventions that promote socialization, rehabilitation and overall wellness, which may be an important appurtenance to other psychological therapies [56].

3.2.3. Therapeutic dimensions of nature views and access to gardens in the healthcare environment

Evidence exists that living near green spaces or viewing nature through a window can promote positive health benefits [57], reduce health care costs [58] and help in recovering from mental stress [59]. Thus, healthcare designers should lay emphasis on the relationship between the building and the landscape to integrate the interior and exterior environments [60]. This implies that the theory of transparency can be used to indicate a spatial continuity between the exterior and interior design of healthcare spaces [61]. This conforms that human beings are biologically connected to nature [62]. For example, outdoor gardens that incorporate pleasant views with aquatic elements, copious seating elements, play areas, as well as extensive greenery creates transparency in a two-way continuum between interior and exterior spaces [63,64]. This proposes that the design of the environment of care which integrate nature environment can arouse users' sensory experience.

Clinical procedures are often associated with anxiety, pain and discomfort, which may call for the use of tranquillizers and painkillers. Evidence has shown that nature-based interventions, including natural landscapes and images of nature can minimize stress related outcomes [9], as well as improve physical and mental health [27]. Therapeutic landscapes and healing gardens with a variety of features have the tendency to stimulate restoration and other positive influences on healthcare occupants [21, 45]. Research evidence found that hospital garden users reported positive mood change and experience from time spent in observing nature [52]. Similarly, studies have shown that therapeutic gardens can assist dementia patients to reduce behavior problems caused by fear and anxiety during post-stroke rehabilitation procedures [49,65]. Therapeutic gardens have been shown to offer elderly residents the choice of leaving their residential dwellings for a natural healthcare setting designed to promote physical activities, ambulation, positive reminiscences, stabilized sleep-wake cycles and reduce stress [16]. A post-occupancy

evaluation found there is a need for incorporating therapeutic gardens as a complementary element for dementia patients in assisted living facilities [66].

Visitors and family members have often referred to the beauty of gardens in hospital environments as a peaceful place that provides a sense of time out [64]. This suggests that the combination of serene and refuge offers a solitary experience that promotes a restorative healthcare environment [67,68]. Similarly, nursing staff reported a preference for contact with nature and privacy and suggested archetypal landscape features such as thresholds, contemplative paths and garden benches. They likewise proposed symbolic creek and sacred springs that provide restorative spatial experiences [69]. Staff and family members also reported that therapeutic gardens provided three main types of relief activities such as low-level activity (sitting indoors and looking out to the garden); mid-level activity (sitting outdoors and a place to smoke) and high-level activity (picking flowers, planting and physically gardening) [66]. Indeed, therapeutic gardens that allow relaxation, stimulate activities and memories, provides a normalizing context for interactions within the hospital ecosystem [70].

An inquiry on a “Fairy Garden” demonstrated that therapeutic attributes of a garden can offer children and their families a unique opportunity to heal, elevate clinical outcomes and improve wellness [30]. A research conducted on access to gardens and activities in a children's hospital healing garden, revealed perceived restoration and increased consumer satisfaction [71]. In the same study, changes such as the inclusion of more trees and greenery, as well as interactive activities, were recommended. This supports the opinion that a garden facility with seating elements, water fountain, a variety of natural plants and walls with colorful murals, as well as play equipment and smaller spaces for children to explore, can promote a positive experience [30,37]. Similarly, [72] reported that designers and administrative staff perceived high accessibility to a garden, compared with patients and clinicians who reported low accessibility. Additionally, patients reported high satisfaction, when matched to caregivers who reported less time for garden use. This was due to poor maintenance decisions, resulting in reduced functional and aesthetic value. Several researches have demonstrated that exposure to the natural environment can serve as a non-pharmacological intervention in dementia patients with inappropriate behaviors in dementia care [73,49,74]. Likewise, a wander garden has been used to reduce agitation in dementia patient, allowing them the freedom to remain inside or to exit into the garden, resulting in improved quality of life [49,75]. Additionally, a study on the impact of a wander garden on dementia patients with a focus on patient falls and changes in scheduled psychiatric medication, reported no change in antidepressant, hypnotic and anxiolytic use,

reduced number of falls and fall severity scores as well as a significant reduction in high-dose antipsychotics [76]. Evidences from literature have suggested that dementia patients may experience substantial positive responses to specifically designed environments in the health care facilities using design interventions such as gardens and natural environments (table 2).

Table 1

Selected studies that highlights the impact of natural views, access to healing gardens and therapeutic gardens

Selected reference(s)/medical specialty	Study Design	Participant size	Design Intervention type	Results/Reports on health outcome(s)
[67]; Restorative natural environments in care settings.	Photo-questionnaire.	<ul style="list-style-type: none"> • A total number of 124 participants were involved in the analyses. • The participants comprised 43 males and 81 females. 	<ul style="list-style-type: none"> ▪ Therapeutic natural environment. 	<ul style="list-style-type: none"> • This study determined that perceived sensory dimensions (PSDs) affect restoration in natural care settings. • The PSDs influencing restoration are described as; Serene, Nature, Refuge (positively) and Rich in species and Social (negatively). • The combination of Serene, Nature and Refuge with the absence of Rich in species and Social, were recognized as qualities of restorative environments.
[64]; LCCH Children's Hospital	The use of comments left in visitors' books	<ul style="list-style-type: none"> • The number of participants included was not mentioned in the study. 	<ul style="list-style-type: none"> ▪ Healing gardens. • Bench Diaries were left in four types of the garden: <ol style="list-style-type: none"> 1. <i>Secret garden [SG]</i>. 2. <i>Adventure garden [AG]</i>. 3. <i>Staff garden [StG]</i>. 4. <i>Babies garden [BG]</i>. 	<ul style="list-style-type: none"> • The study demonstrates that hospitals with significant space constraints can consider restricting ground-level gardens and integrated podium and rooftop gardens which were utilized in the LCCH, to support the development of healing gardens in a dense urban environment. • Participants' comments reflected an appreciation of natural elements such as fresh air, gardens and nature views, which provides a sense of normalcy, a different perspective and a break from focusing on their trauma and ill status. • Specific, comments left in Bench Diaries indicated that having the garden setting located outdoors, with attractive views, substantial seating, places for play, as well as users appreciate extensive greenery. • Emphasis was laid on the use of plants to create a sense of seclusion, visual amenity and verdant greenery in the design of the gardens.
[30,32]; Pediatric ward.	Narrative inquiry (NI) design.	<ul style="list-style-type: none"> • A total of 16 participants were interviewed involving 4 focus group interviews with family members. 	<ul style="list-style-type: none"> ▪ Access to a garden environment. • <i>'Fairy Garden'</i> (FG). • Semi-structured interviews centered upon the things users liked about the FG, such as: 	<ul style="list-style-type: none"> • The study revealed that the Fairy Garden (FG) was a non-clinical environment for play and relaxation. • Family members reported enhanced physical and social engagement on the children. • The Fairy garden promoted interaction amongst the children, parents and caregivers.

		<ul style="list-style-type: none"> • Mothers (N=4), Fathers (N=3) and grandparent (N=1) who spent, or had spent, considerable time at the bedside of the children. • Head nurses (N=2) • Ward nurses (N=3) • Administrative nurse (N=3). 	<ul style="list-style-type: none"> • What benefits were observed for the children who used the garden? • Positive attributes noticed or experienced in the fairy garden. • Negative attributes noticed or experienced in the fairy garden. • Had the FG changed the behaviors of the children? • How was the garden used and who used it? • What were the things they did not like about the fairy garden? • Difficulties or barriers encountered in the garden • In their opinion, what was missing from the garden? 	<ul style="list-style-type: none"> • It was deduced that the Fairy Garden healing haven model may be the answer to the puzzle of holistic care for sick children, especially those with a chronic illness. • The comments of the FG users suggest that the garden creates a space for children and families that counterbalanced the clinical environment of the hospital as an alien place and improved the hospital experience for sick children and their families as well. • Both studies also deduced that the Fairy Garden presented alternatives for children, staying long term in the hospital. Such alternatives include psycho-social and physical benefits that improve their hospital stay and provide the potential for improved clinical outcomes. • The study advocates that the addition of natural and activity spaces to support sick children and their families should be a major hospital environment design consideration.
[37]; Pediatric Hospital.	Exploratory data analysis	<ul style="list-style-type: none"> • A total of 184 participants was involved in the survey. • 82 staff, 53 children and 49 adult family members. 	<ul style="list-style-type: none"> ▪ Physical activity in gardens 	<ul style="list-style-type: none"> • The study reports that the quality of design can influence levels of physical activity in pediatric hospital gardens. • The behavioral culture of most gardens is related to their design characteristics. • Results demonstrated that gardens with higher substantial planting, properly designed layout and pathways and amenities for children generally had more active behavior cultures. • It emphasizes that less physical activity does not necessarily translate into less therapeutic benefits, as the passive use of healing gardens such as; introducing sounds and views into the interior spaces, can also have valuable therapeutic benefits for hospital visitors, patients and staff.
[72]; Surgery center	Post-Occupancy Evaluation (POE)	<ul style="list-style-type: none"> • A total of 20 participants were involved in the survey. 	<ul style="list-style-type: none"> ▪ Access to a garden environment. 	<ul style="list-style-type: none"> • The study reports that garden elements possess multi-dimensional meaning and values to users seeking to escape the indoor environment. This places more importance on evidence-based site design. • The evaluation suggested the need for multiple perspectives to be considered in facility and garden master planning.

[75]; dementia unit.	Observational study	<ul style="list-style-type: none"> • (N = 28) participated out of the original 34. 	<ul style="list-style-type: none"> ▪ Wander Garden 	<ul style="list-style-type: none"> • The study recommends that designers and horticultural therapists be retained in garden management to preserve and enhance garden functionality. • A reduction in the number of patients fall and severity as well as a reduction in psychiatric medications and high and intermediate-dose antipsychotics, contributed to an improved quality of life for residents with dementia. • Dementia residents reported a decrease in agitation with access to a wander garden. • Wander garden can be used to improve the quality of life for residents with dementia by using appropriate designs based on existing guidelines.
[69]; Health Care Center	Traditional landscape architecture data-base design method. <ul style="list-style-type: none"> ▪ <i>This can be synonymous to Evidence-Based Landscape Architecture (EBLA).</i> 	<ul style="list-style-type: none"> • A total of 61 participants was involved. 	<ul style="list-style-type: none"> ▪ Healing Garden 	<ul style="list-style-type: none"> • The study reports that nursing staffs preferred significant contact with nature and privacy. • Their findings advocate the incorporation of archetypal landscape features such as thresholds, contemplative paths, garden benches, a symbolic creek and sacred springs, in the garden design to encourage exposure and enhance the restorative spatial experiences of nursing staff.
[66]; Dementia Special Care Units.	Multi-method qualitative research and post-occupancy evaluation (POE).	<ul style="list-style-type: none"> • A total of 45 participants was involved. 	<ul style="list-style-type: none"> ▪ Therapeutic Garden 	<ul style="list-style-type: none"> • This research concluded that there is a need for therapeutic gardens to be incorporated as 'standard' complementary element in special care units for people with dementia. • Staff and family members reported that the garden spaces provide three main types of relief activities: • Low-level activity (Sitting Indoors and Looking Out to the Garden). • Mid-level activity for Redirection and Relief from Stress and Agitation (Sitting Outdoors and places to smoke). • High-level activity (Picking Flowers, Planting and Physically Gardening). • The study also found that other activities performed in the garden such as; music therapy, picnics and Ritual activities related to reminiscence, can connect people

(75); Geriatric Home.	An intervention study	<ul style="list-style-type: none"> • A total of 15 participants were involved. 	<ul style="list-style-type: none"> ▪ Exposure to gardens. 	<p>with dementia to their past, to provide the therapeutic goal of retaining old memories and familial ties.</p> <ul style="list-style-type: none"> • The results revealed that the powers of concentration increased for very elderly people after a visit to a garden outside the geriatric home in which they live, when compared to after resting indoors in their favorite room. • The intervention deduced that exposure to gardens nor resting in a room, had no effects on blood pressure or heart rate. • Both the outdoor environment and the indoor environment at the home were highly valued by participants.
[68]; Pediatric cancer centers.	Behavioral observations and post-occupancy evaluation (POE).	<ul style="list-style-type: none"> • A total number of 1400 people were observed. 	<ul style="list-style-type: none"> ▪ Exposure to healing gardens. • A group of three healing gardens called Carley's Magical Gardens: <ol style="list-style-type: none"> 1. <i>Garden of Dreams.</i> 2. <i>Friendship Garden.</i> 3. <i>Buggy Garden.</i> 	<ul style="list-style-type: none"> • The study suggests that to reduce the low rate of garden usage by children, hospitals should include programs that actively encourage garden use by children and families. • Design features like structural elements will encourage children to engage in interactive activities in the garden. • Incorporating design features that enable adults to sit and socialize or to relax while enjoying the sounds of running water, as well as paths to walk around the garden will increase garden usage. • Private relaxation and restoration spaces, separate from patients and visitor spaces should be designed for of staff use on their break. • Privacy emerged as a key consideration for patients as demonstrated by the fact that as the number of people in the gardens increases, patients are more likely to close their window blinds. • The study suggests that the use of plant screens may maximize both privacy and window views for patients.
[71]; Children's Hospital Garden	Post-Occupancy Evaluation (POE)	<ul style="list-style-type: none"> • A total of 105 participants were involved. • Adults (N=83) • Children and adolescent (N=22) 	<ul style="list-style-type: none"> ▪ Garden use and activity. 	<ul style="list-style-type: none"> • The findings of the study suggested that chronically ill and handicapped children may have very different requirements for a hospital garden environment. • It documented that very few severely or chronically ill children were found using the garden.

- Results from this evaluation suggested that well-designed gardens can have a positive impact on the sense of well-being of users in the hospital environment.
 - The study reports that there is evidence that gardens can increase consumer and staff satisfaction within the hospital.
 - It indicated that features of garden, such as greenery, shades, the sound of water and adequate seating in the garden, were particularly helpful preferences for emotional healing.
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3.3. The health effects of therapeutic gardens and horticultural therapy on Alzheimer's and dementia patients

3.3.1. Effects of therapeutic gardens on Alzheimer's and dementia patients

In the specialized healthcare setting, therapeutic gardens have been found to have a positive impact on Alzheimer's and dementia patients. This suggests that a therapeutic garden within a healthcare environment can induce a profound effect on agitation and behaviour of Alzheimer's patients [77]. Additionally, it has been reported that older adults with Alzheimer's disease (AD) derive benefits from exposure to gardens that provide opportunities for walking, socialization, improving depression and aggressive behaviors, self-esteem, as well as reducing isolation and vulnerability [78,75,73]. There are research assertions in the findings of studies, that patients with late-stage AD who viewed an indoor Japanese garden at a nursing home reported significantly reduced heart rate, improved short-term and long-term memories and improved behavioral symptoms [79 – 81].

Therapeutic gardens may provide health benefits needed for maintaining functional abilities, higher level of independence and quality of life. For example, a recent study reveals that plant cultivation-based horticultural therapy programs may improve the stress levels and physical functional abilities of elderly patients with mental health problems [82]. Furthermore, the effects of gardens in populations with dementia includes outcomes such as decreased agitation [73,49,16]. A similar study based on ambulation criteria in a therapeutic wander garden revealed lower levels of agitation in dementia patients [83]. In addition, staff and family members reported a significant reduction in agitation and stress levels, as well as an overall improved quality of life for dementia patients' in a therapeutic garden [84]. Gardening may be a way of facilitating reminiscence [85] and increasing activity participation for patients with dementia [86]. Having discussed the effect of therapeutic gardens on Alzheimer's and dementia, it is likewise reasonable to highlight the health effects of horticulture therapy, which has been a prominent gardening practice for promoting the wellbeing and health care experience of older adults in the hospital environment.

3.3.2. Effects of gardening and horticulture therapy on Alzheimer's and dementia patients

Gardening has been shown to have both psychological and spiritual benefits and may be cost-effective for improving the well-being for elderly patients [49]. The benefits and health implication of physical activities in gardens has been highly acknowledged by older adults to elicit therapeutic rehabilitation such as reduced agitation [78], inappropriate or aggressive behaviors [73] and increased mental status [75]. Additionally, gardening activity may likewise

promote general health and quality of life, cognitive function [87,88], as well as physical strength and socialization [85,89].

Research evidence supports the reduction of stress through active or passive experience with nature through horticulture therapy, by modulation of the central nervous, endocrine and immune systems [90]. Similarly, participating in gardening groups have positive impacts on well-being through promoting coping, facilitating change and providing opportunities for skill development for all gardeners and group facilitators [91]. For example, horticulture therapy is one of the preventive and alternative nature therapies that has gained full attention and application in medicine for its therapeutic effects and rehabilitation for patients and elderly people [92]. It has also been regarded as an open program or process through which participants utilize plant-related and other activities through active and passive involvement [93], including actual gardening, imagining and viewing nature, as well as visiting a hospital healing garden to improve their well-being [94]. Studies reporting the practice of horticulture therapy for rehabilitation recommend the incorporation of horticultural therapy programs in long-term care homes for about five (5) to ten (10) minutes, to maintain patients' cognitive functioning and encourage participation in horticultural activities which may promote a sense of self-worth and expression of feelings [86]. Also, the findings of a recent study on the psychopathological effects of participation in a 10-session horticultural therapy program revealed a significant improvement in the clinical symptoms of patients with schizophrenia [95].

Several studies have reported that horticultural therapy and active participation in gardening by older adults has health effects on anxiety, depression and improved self-identity in middle-aged women. [96,93], as well as improved hand and body strength and flexibility [85,97]. This is consistent with [98] who comment that horticultural therapy can affect the physical, social, psychological and cognitive functions of dementia patients, including: improved strength and stamina, coping skills and motivation, concentration and focus, as well as reduced stress and anxiety (see table 3).

Table 3

Selected studies that summarize the health effects of therapeutic gardens and horticultural therapy on Alzheimer's and dementia patients

Theme	Selected references	Measured outcome	Result on health outcome(s)
Therapeutic gardens impact on Alzheimer's and Dementia patients	[16,49,73, 75, 77 –81,83 – 86,]	<ul style="list-style-type: none"> Physical, Social, Psychological and Cognitive effects 	<ul style="list-style-type: none"> Therapeutic gardens reduced agitation, isolation and vulnerability, provided opportunity for walking and socialization, improved depression, aggressive behaviors and self-esteem.

Horticulture therapy impact on Alzheimer's and dementia patients	[85, 86,89,93,94, 97,98]	<ul style="list-style-type: none"> • Physical, Social, Psychological and Cognitive effects 	<ul style="list-style-type: none"> • Promoted physical activities, ambulation, positive reminiscences, stabilized sleep-wake cycles and reduced stress. • Reduced heart rate, improved short-term and long-term memories and improved behavioral symptoms. • Overall improvement in quality of life. • Horticulture therapy improved strength and stamina, mobility, flexibility and endurance. • Enhanced coordination and social interaction, improved coping skills and motivation. • Reduced depression and anxiety, increased confidence and hope, rewards nurturing behavior and stimulates the sense through touching, tasting and smelling of plants. • Improved concentration and focus, problem-solving and planning skills and promotes positive thinking.
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3.4. Current options and future directions in the treatment of Alzheimer's and dementia patients

Several studies have revealed that recent phase 3 clinical trials aimed to directly eliminate the most predominant pathologies of AD, amyloid plaques and neurofibrillary tangles, have failed to improve clinical outcomes, suggesting that once symptoms appear, the brain is already substantially affected by neuronal death, significantly limiting the efficacy of these drugs [99 – 102]. Likewise, the results of clinical trials have suggested several pitfalls including, the choice of biomarkers, as well as the interaction of drug-targeted molecules which may be caused by the deficiency in the understanding of the pathogenesis of AD, thus, stimulating an anticipated increase on the need to develop better treatment options for AD patients [103]. As such, a recent study has suggested that the utilization of preclinical treatment which involves non-pharmacological trials for AD patients such as virtual reality-based cognitive-motor training during prevention may still be possible, and could offer better health outcomes [104]. Similarly, a study revealed that using multisensory technology to create a therapeutic environment for People with dementia served as a useful non-pharmacological therapy for reducing anxiety and agitation [105].

3.4.1. Non-Invasive Technological interventions for improving clinical outcomes of Alzheimer's and dementia patients

Technological advancements in health provision have recorded substantial outcomes in the healthcare setting, especially for cognitive rehabilitation. This is consistent with research

evidences which suggest that interventions promoting neural plasticity can induce significant cognitive gains especially in patients with mild AD [106]. These improvements have involved various non-invasive, or non-pharmacological interventions which have increasingly gained attention in recent years [107,108], such as in virtual reality, 3D simulation technologies and intelligent environments [43,109]. Furthermore, investigators have revealed that optimizing personal control of spaces by patients, contributes to their emotional comfort which facilitates the therapeutic process of hospitalized patients [110].

Virtual reality technologies in the healthcare milieu have provided a three-dimensional, computer generated environment which can be explored and interacted with by a patient. For example, the Ashford and St Peter's hospitals NHS Foundation Trust (ASPH) have introduced a pioneering new technology to improve the experience of patients suffering from dementia. The technology features a virtual reality headset as shown in Fig. 4, that provides a visual and auditory experience which includes a nostalgic beach scene, a forest full of animals and an underwater experience of coral reef and dolphins. Users become part of this virtual world immersed within this environment which has been shown to improve patients' moods and can leave long lasting calming effects sometimes hours after the experience [111].



Fig. 4. A Virtual Reality headset for Dementia Patients at St Peter's Hospital | Ashford and St Peter's Hospitals NHS Foundation [111].

VR technology has also been applied from a 3D simulation perspective in the hospital environment as mock-up tools to compare and assess patient responses in a real-world design [112]. These aspects range from testing different interior design elements in a hospital room, emotional responses of participants through 3D simulations and the application of photographic sky compositions as an alternative to other forms of nature stimuli [43,113]. Similarly, a feasibility study with image-based rendered VR in Patients with mild cognitive impairment and dementia revealed that patients reported high satisfaction, interest in tasks and high feelings of

security, as well as low discomfort, anxiety and fatigue [114]. VR test can also be used to evaluate cognitive functions in a way that is relevant to the patients' subjective deficits in pathological aging through tests that are more related to daily life events, when compared with conventional verbal tests [115]. A pre-test and post-test study in questionable dementia patients involving a VR and non-VR group, demonstrated positive training effects, such as a higher improvement in objective memory performance in both groups [116]. It could be indicated that healthcare facilities await a global revolution as more research comes to the fore where VR and other technologies will thrive in all aspects of medicine and patient care.

Table 4

Selected studies that highlights the use of Virtual reality (VR) technology as a non-invasive rehabilitative intervention for Alzheimer's and dementia patients

Theme	Selected references	Study Design	Participant size	Measured outcome	Result on health outcome(s)
Non-Invasive Technologies: • VR Technology interventions and Intelligent Environments	[104]	Randomized controlled trial	<ul style="list-style-type: none"> • A total of 55 participants were involved. • Active participants (N=35) and Passive participants (N=20) 	<ul style="list-style-type: none"> ▪ Primary and secondary cognitive outcome. ▪ Primary and secondary neurobiological outcome. 	<ul style="list-style-type: none"> • VR-based cognitive-motor training improves cognitive function. • A more ecologically valid cognitive-motor VR setting may augment transfer of trained skills. • VR training has benefited clinical cohorts, but benefit in asymptomatic high-risk individuals is unknown.
	[114]	Self-report questionnaire	<ul style="list-style-type: none"> • A total of 57 participants were involved. • (N=13) Female and (N=15) male with Mild Cognitive Impairment (MCI). • (N=12) Female and (N=17) male patients with dementia. 	<ul style="list-style-type: none"> ▪ Cognitive and behavior impairment 	<ul style="list-style-type: none"> • The study revealed that participants with MCI and dementia reported high satisfaction and interest in task, high feelings of security, low discomfort, as well as anxiety and fatigue.
	[113]	A Review and analysis of the literature	<ul style="list-style-type: none"> • Not specified. 	<ul style="list-style-type: none"> ▪ Not specified. 	<ul style="list-style-type: none"> • The study suggests that there is an urgent need for the continuous use of VR and 3D technologies, as well the development of the existing early stage medical VR applications.
	[103]	Review of literature	<ul style="list-style-type: none"> • Not specified. 	<ul style="list-style-type: none"> ▪ Not specified. 	<ul style="list-style-type: none"> • AD is a disorder that is too intricate and factor-driven to be entirely understood from its pathogenesis. • The conventional “one protein, one drug, one disease” hypothesis would not work for Alzheimer’s disease. • The review aroused concerns on the potential deficiency in the understanding of pathogenesis of AD and ultimately stimulated the Need to develop better non-invasive therapies.
	[105]	Quantitative pilot study	<p>A total of 12 participants were involved.</p> <p>Older adults (N=8) caregivers (N=4) with behavioral and psychological</p>	<ul style="list-style-type: none"> ▪ Participant’s reaction to Agitation. ▪ Participant’s multisensory environment (MSE), 	<ul style="list-style-type: none"> • Results indicated that most participants enjoyed the MSE and improvements in some BPSD were observed after using the MSE. • Caregivers’ reported that the MSE was a useful nonpharmacological therapy for reducing anxiety and agitation among participants who exhibited BPSD.

[116]	A pre-test and post-test design	symptoms of dementia (BPSD). A total of 24 older adults' participants.	<ul style="list-style-type: none"> ▪ Caregiver satisfaction with MSE as a management strategy for older adults with BPSD ▪ Multifactorial Memory Questionnaire and Fuld Object Memory Evaluation. 	<ul style="list-style-type: none"> • The study reported that both groups demonstrated positive training effects, with the VR group showing greater improvement in objective memory performance and the non-VR group showing better subjective memory subtest results in the Multifactorial Memory Questionnaire.
[115]	Participants and experimental design	A total of 51 participants were involved. Healthy older male participants (N=17) and Female (N=4). aMCI patients (N=7) male and (N=8) female. AD patients (N=2) male and (N=13) female	<ul style="list-style-type: none"> ▪ Neuropsychological assessment. VR episodic memory assessment 	<ul style="list-style-type: none"> • VR was used to depict multifaceted episodic memory of aMCI and AD which revealed that normal aging, aMCI and AD present different profiles (factual, temporal, spatial and binding). • The study highlights specific cognitive differences additional insight into the early diagnosis and rehabilitation of pathological aging. • Neuropsychological studies would assist the use of virtual tests and a multi-component approach to assess episodic memory and encourage active encoding of information in patients suffering from mild or severe age-related memory impairment.

Note. VR indicates Virtual Reality; BPSD, Behavioral and Psychological Symptoms of Dementia; MSE, Multisensory Environment; MCI; Mild Cognitive Impairment; aMCI, amnesic Mild Cognitive Impairment.

3.5. Summary of the literature review findings and suggestions for the design of gardens in healthcare.

3.5.1. Summary of the literature review findings

Indeed, spending time in natural environments or a pleasant and comfortable setting can provide a range of health benefits that reduces stress, physiological changes in blood pressure and heart activity [117] as well as provides a general sense of well-being. Environments that integrates therapeutic or healing gardens and horticulture therapy have a profound effect on Alzheimer's and dementia patient's physical, social, psychological and mental status. Healthcare settings that offer social support, sense of control, physical activity and exercise, as well as a positive distraction from nature was shown to provide restoration from anxiety and improve health outcomes [118,119]. Recent studies suggest that multimodal non-pharmacological interventions can enhance the cognitive function prime diagnosis of dementia in adults by dealing with multiple modifiable risk factors that contribute to cognitive decline [120]. Recent evidence suggests that a more ecologically valid cognitive-motor VR setting that simulates multifaceted daily activities may enhance the transfer of trained skills as well as help define a prophylactic regimen for AD, though its benefits in asymptomatic high-risk individuals is yet unknown [104]. Technological advancements in healthcare application such as virtual reality (VR), 3D simulation technologies and intelligent environments have shown substantial effect on health outcomes, especially in terms of cognitive rehabilitation [43,107 – 109]. Additionally, VR may be applied to simulate or recreate a boundless range of environments that comprised of nature scenes, patient's place of living, as well as a positive setting for recuperation. Tables 5, summaries the findings derived from the literature review that could guide future research in the clinical contexts.

Table 5

Summary of the findings adapted from existing literature

Design intervention	Design parameters	Sub-design parameters	Health benefits for improved user experience
Healing environments	Gardens	<p>Therapeutic and Healing gardens. Horticulture therapy.</p> <p>Colors.</p> <p>Views, Positive distraction and Nature scenes.</p> <p>Sunlight.</p> <p>Sound.</p> <p>Social support.</p> <p>Sense of control.</p> <p>Art work.</p> <p>Art therapy.</p>	<ul style="list-style-type: none"> • Credible evidence in literatures suggest that the health impact of therapeutic, healing gardens and horticulture therapy on Alzheimer's and dementia patients generally cuts across their physical, social, psychological and cognitive status. • Therapeutic and healing gardens are a non-pharmacological intervention that can reduce pain, agitation and anxiety, increase cognitive functioning in elderly patients, facilitate emotional recovery and heighten physical activity for patients in the healthcare settings. • Integrating interactive, appealing colors for signage on floors and pathways can improve better wayfinding within the garden spaces. • Colors and well-chosen hues on furniture and floors in a garden may have a positive or negative effect on a health and wellbeing. • Overdosing spaces with too much or ominous colors such as black can increase anxiety levels and depression. • Properly designed gardens in the healthcare physical environment provide pleasant nature views and calming effects on users. • Nature scenes provide pleasant distractions that may reduce worrisome and stressful thoughts. It also serves as a tool for reminiscing past environments which may improve memory loss. • Visibility of garden spaces from inside by both staff and residents is critical to its use. • Adequate light exposure to sunlight is required for vitamin D synthesis and calcium metabolism especially for the elderly group in nursing homes. • Introducing pleasant sound including sounds from water fountains, nature sounds and bird sounds may be included as a positive distraction in gardens to improve memory gain, postoperative patient sleep and physiological recovery, as well as reduces stressful pain and reduces psychological. • Gardens that promote social support for patient's family members and close friends accelerates psychological rehabilitation and emotional healing. • Respite spaces for care givers can reduce anxiety of family members, improve staff-patients communication and promote better care in clinical environments. • Gardens provide environments for patients and family members that increase the sense of control and intimacy through features including flexible seating arrangements that can reduce frustration and promote a sense of togetherness among families. • Incorporating nature themed murals and art works on wall surfaces in gardens to evoke positive response, provides positive distraction and elicits positive feelings which sustains attention and interest. • Art therapy programs should provide positive distractions, increase cognitive functioning and promotes comfort level.

	Architectural design factor.	
Non-invasive technologies	VR and intelligent environments.	<ul style="list-style-type: none">• It also helps to reduce ambient environmental stressors that could impede patients and staff health outcomes.• Phenomenological considerations in the design of gardens can improve the sensory experience of space and considers the mutual influence of emotions and the environment.• The design of garden spaces can enhance life and wellbeing if it addresses all the senses simultaneously and combines our image of self with our experience of the world.• Architectural designs of gardens should consider the different activities and spaces that can accommodate and meet the aimed atmospheres and experiences of the target patient group.• An optimal design of garden environment should integrate a mix of both architecture that is not alienating and domesticity that is practical to its users.• VR provides a visual and auditory experience through high-tech gadgets such as 3D headsets which incorporate simulated nature environments including nostalgic beach scene, forest full of animals and underwater experience of coral reef and dolphins to improve memory loss in dementia patients.• VR creates an environment where users become immersed in a futuristic world which has been shown to leave long lasting calming effects sometimes hours after the experience and improve patients' moods.• VR technologies have been applied with 3D simulation in the hospital environment as mock-up tools to evaluate patient responses in a real-world design.• The application of nature elements including photographic sky compositions as an alternative to supplement other forms of nature stimulus have been shown to create intelligent environments in dementia care facilities.• 3D interactive walls create intelligent environments in geriatric homes that provides activities including playing familiar music and images which improves emotional responses, reduces wandering and walking in circles, as well as restless and agitation in dementia patients.

3.5.2. Suggestions for the designs of garden in healthcare

The design of healthcare environments that incorporates environmental design factors such as therapeutic and healing gardens may have the potential to reduce stress related outcomes within the healthcare landscape. This proposes that the healthcare ecosystem should consider design features such as ease of access; signage, and automatic doors [121], movement and orientation; sensory stimulus, positive distraction and mental mapping; shelter and shade; as well as safety considerations and maintenance to create a patient-centered environment can help patients, family and healthcare providers cope with the stress and other health related issues that accompanies illness (Table 6). For example, studies comment that each garden is unique, each client is unique and various elements, (such as foliage, flowers, water and pleasant nature sounds (see [122])) can influence the relationship with the client, designer and the site [123].

Medical practitioners and planners, as well as landscape designers, architects and their associates should utilize possible improvement strategies to enhance patients and healthcare workers' experience in a positive way. However, when designing a garden for healthcare facilities, factors such as age, abilities and health conditions of targeted users should be put into consideration at all phases. The design suggestions for garden design presented in this review may be appropriate in a certain context, however not all may be generally required to attain a healing design. Thus, these suggestions are not meant to be applied unconditionally, but should suit the design briefs for a specific healthcare healing garden and to serve as a basis to kick start the design process. Using evidence-based approaches, architects, designers, landscape architects and healthcare professionals can show concrete data that illustrated how cost effective, successful and essential therapeutic gardens and green space can be.

Table 6

Summary of the suggestions for the designs of garden in the healthcare settings.

References	Design consideration(s)	Garden design feature	Recommendations for healthcare garden designs
[23,37,64, 68,]	Ease of Access, Movement & Orientation.	<ul style="list-style-type: none"> ▪ Visibility and Views. ▪ Routes and entrances. ▪ Footpaths. ▪ Signage. 	<ul style="list-style-type: none"> • Integrate views into the gardens to provide visible outdoor spaces which help to maximize staff comfort levels about residents being outside. • Provide clear, legible routes and entrances. • Provide level plane access to garden areas from communal rooms or private patios. • Introduce ‘circular’ walking routes which return the resident to their starting point. • Footpaths around the garden must be immediately obvious and clearly signposted. • Seats should have adequate space around them so wheelchairs can fit alongside.
[11,19,23,37,49, 51,66,68,70,71, 85,122 –126]	Sensory Stimulus, positive distraction and Mental Mapping.	<ul style="list-style-type: none"> ▪ Phenomenology. ▪ Haptic interaction. ▪ Colors. ▪ Fragrant verdant. Foliage and seasonal plants. ▪ Texture. ▪ Floor finish. ▪ Pictures, art works and wall mural. ▪ Positive sounds such as bird songs and sounds from water features. ▪ Sunlight. ▪ Spaces for meditation and reflection. ▪ Spaces for physical activities. 	<ul style="list-style-type: none"> • Garden designs for Alzheimer’s patients and their caregivers should transcend the five physical senses into the emotional senses including, but not limited to: (Sense of self ; Sense of place; Sense of being; Sense of belonging; Sense of purpose; Sense of imagination; Sense of humor; Sense of discovery and Sense of spiritual connectedness). • Introduce haptic elements in gardens to evoke the senses of touch and proprioception. • Gardens should be designed to moderately expose users to sunlight which is required for vitamin D synthesis and calcium metabolism. • Use patterns and floor texture to changes the dynamics larger surface area. • Incorporate variation in shades of brown (wooden elements) to reduce monotony. • During planning, considerations should be given to colors of both person-made objects (benches, stone walls and fences) and also to planting schemes. • Incorporate reminisce plants into the sensory garden and allow the residents/clients an opportunity to identify and suggest plant types for the garden. • Plantings should be organized to provide fragrant places, colorful verdant foliage and texture that stimulate all five senses. • Use pictures of real, live plants to initiate plant selection response. • Avoid abstract sculptures or art works that can evoke a negative response, such as increased stress and anxiety.

[24,37,64]	Shelter and Shade.	<ul style="list-style-type: none"> ▪ Pergola, climbing plants and trees. ▪ Seats and arm rests. ▪ Summer houses, huts and screened porches. 	<ul style="list-style-type: none"> • Include nectar-producing plants that lure birds into your garden. A garden ‘singing’ with birds is an inviting place to visit. • Introduce plants that have significant spring or fall coloration that is quite different from other seasons to stimulate reminiscing. • Incorporate wall murals of nature scenes to evoke positive stimuli to the senses and stimulate a calming effect. • Select textured paths that make sounds as you walk on them, such as crushed gravel to aid people with sight impairment. • Install a water feature in gardens where possible to provide a cooling effect, positive distraction, visual appeal and to drown unwanted noise. • Integrate spaces for gardening experiences which offers the opportunity to reminisce and engage in familiar activities such as picking flowers, growing herbs and vegetables. • Create spaces for meditation and physical activities with the garden. • Introduce a pergola, climbing plants and trees to create light shade. • Provide appropriate seating in the garden such as arm rests for elderly users.
[23,121,127,128]	Safety Considerations and Maintenance.	<ul style="list-style-type: none"> ▪ Fences. ▪ Consistency in floor levels. ▪ Smooth edged planters. ▪ Physical support features: hand rails and covered metal grills. ▪ Non-toxic or thorny plants. ▪ Surveillance measures. ▪ Education. 	<ul style="list-style-type: none"> • Provide heated summer houses or winter gardens containing indoor plants to enable access to the garden environment all-round the year. • Perimeter fences or other physical boundaries should be adopted in garden designs to help people avoid accidentally leaving safe areas and being exposed to risks. • The goal is to provide secured spaces that encourage a variety of activities without causing a sense of feeling “fenced in.” • Good design techniques can successfully disguise or even hide fencing, making more interesting garden spaces that focus attention on a variety of activities in the garden rather than focusing on how to get out. • Avoid steps or sudden changes in level. • Use circular planters rather than square ones with sharp corners. • Gardens should have adequate handrails for support and metal grills should be covered. • Stones in planting beds should be fixed firmly so that patients cannot move or throw them. • Avoid toxic, thorny plants or species with serrated leaves. • Install a mesh screen below the surface of the water to protect children and to discourage birds and cats from feeding on the fish. • Consider defensive planting screened with a combination of physical barrier to secure site boundaries.

- Consider observation and surveillance of the space from the building.
 - Educate staff and volunteers about the gardens and how to access them, to maximize garden use.
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4. Conclusion

The purpose of this paper was to throw light on the role of therapeutic gardens in the healing environments as an intervention for improving the physical and mental health care with an extension of specific patient groups. The findings of this paper suggest that therapeutic gardens are designed mainly to serve specific patient populations such as Alzheimer's and dementia. It also discloses that while there are limited literatures that outline the design criteria for therapeutic gardens, there is also a dearth of literature linking these standards to other physical, psychological and mental diseases such as psychiatric patients and cases of drug dependence.

Therapeutic gardens and horticultural therapy was shown to have a profound impact on the physical, social, psychological and cognitive health of Alzheimer's and dementia patients. However, the effectiveness of horticulture therapy is dependent on the patients' ability to be adequately engaged and motivated enough to begin a rehabilitation program and remain involved in the intervention until a therapeutic dosage is attained. This review suggests that therapeutic gardens should be applied as a non-pharmacological intervention or positive distraction in the routine care of Alzheimer's and dementia patients for stress reduction, pain management and positive cognitive gains. Additionally, it should be extended to provide speedier recovery for other patient populations as well.

Technological innovation for treatment with nature, such as virtual reality (VR) showed possible improvement in cognitive gains of Alzheimer's and dementia patients, suggesting that VR may be used to simulate or recreate a boundless range of environments, including positive setting for patient's recuperation. This also established that the VR technological application in clinical environment may create supplementary multi-sensory and self-relevant situations than typical laboratory conditions. As the knowledge of neuroscience become increasingly linked to environmental design, the impacts of technological based intervention with nature becomes more evident, suggesting that designers are challenged with the responsibilities to interpret how people living with Alzheimer's and dementia patients experience the world and to apply their design skills to make sure this knowledge is transformed into creating a therapeutic environment. Through evidence-based design practices and collaborative effort, architects, designers, landscape architects and healthcare professionals can present strong data that illustrate how cost effective, successful and essential therapeutic gardens and green space can be. Thus, it is worthwhile that future studies should inquire into the positive aspects of non-invasive applications of VR technologies to create a greater understanding of this new application in healthcare.

Conflict of interest

None declared.

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Authors' contributions

PCU was responsible for the study conception and design. PCU and TOI performed the data collection. PCU, TOI and MP were responsible for drafting and editing the manuscript. TOI, and MP reviewed, edited, and approved the final manuscript.

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