

**A Framework for Improving Healthcare  
Environments of Alzheimer's and Dementia Patients  
using Therapeutic Gardens**

**Patrick Chukwuemeke Uwajeh**

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Approval of the Institute of Graduate Studies and Research

---

Prof. Dr. Ali Hakan Ulusoy  
Acting Director

I certify that this thesis all the requirements as a thesis for the degree of Doctor Philosophy in Architecture.

---

Prof. Dr. Resmiye Alpar Atun  
Chair, Department of Architecture

We certify that we have read this thesis and that our opinion it is fully adequate in scope and quality as a thesis for the degree of Doctor of Philosophy in Architecture.

---

Prof. Dr. Mukaddes Polay  
Supervisor

---

Examining Committee

1. Prof. Dr. Sebahat Açıksöz

2. Prof. Dr. Mükerrer Arslan

3. Prof. Dr. Mukaddes Polay

4. Assoc. Prof. Dr. Payam Mahasti Shotorbani

5. Asst. Prof. Dr. Nevter Zafer Cömert

## **ABSTRACT**

The design of healthcare buildings for individuals with Alzheimer's disease (AD) and dementia, using nature can create a therapeutic environment that positively affects architectural quality and health outcomes. Clinically, AD is known to progress in three stages, including mild (early stage), moderate (middle stage), and severe (late stage). This present study focuses on the middle and severe stages of AD and dementia based on the therapeutic advantages of nature for improving their quality of life. Therapeutic gardens, which have been shown to be the most successful nature-based complementary treatment option applied in the form of therapeutic gardens (TG), and Horticultural Therapy (HT) for individuals with AD and dementia was explored in this research. Prominent theories by Roger Ulrich, and Wilson Edward, which cut across architecture, landscape design, environmental psychology, and hospital management was used to underpin this study. A critical and systematic review method was adopted for this study. A qualitative content and thematic analysis was used in the critical review section. Literatures were retrieved from four (4) database, including Elsevier Science Direct, Sage Journal Online, Taylor and Francis ProQuest dissertation and thesis global in the systematic review section. The findings of this dissertation established that TG and HT should be integrated as an Evidence-Based Design (EBD) intervention in the design of AD and dementia care facilities. These approaches have yielded positive outcomes, including reduced agitation, stress, anxiety, negative mood, improved cognition and general wellness in patients. Virtual reality (VR) was found to simulate a range of nature-based environments that enhances cognition and overall experience of AD and dementia patients. Factors synthesized from the literature were used to develop a conceptual framework for utilizing the health benefits of TG in the

design of spaces. This study likewise closes the gap between research and practice through EBD recommendations to guide architects, health care practitioners and policy makers.

**Keywords:** Therapeutic Garden, Nature-based Intervention, Landscape, Architecture, Alzheimer's disease, Dementia.

## ÖZ

Alzaymır ve demans hastaları için, sađlık binalarının tasarımında, dođanın kullanılması, mimari kaliteyi ve sađlık sonunlarını olumlu yönde etkileyen, tedavi edici bir yöntemdir. Klinik olarak, Alzaymır hastalığının, hafif (erken evre), orta (orta evre) ve şiddetli (geç evre) olmak üzere üç aşamada ilerleme gösterdiği bilinmektedir. Bu çalışma, Alzaymır ve demans hastalıklarının orta ve ciddi evrelerinde, hastaların yaşam kalitelerini artırmak adına, dođanın tedavi edici avantajlarına odaklanmaktadır. Terapi bahçeleri ve bahçecilik terapisi, Alzaymır hastalığı ve demans tedavisinde en başarılı tamamlayıcı yöntem olarak uygulanmaktadır ve bu çalışmada bahsi geçen konu irdelenmektedir. Bu araştırmada, Roger Ulrich ve Wilson Edward'ın mimarlık, hotikültür peyzaj tasarımı, çevre psikolojisi ve hastahane yönetimini ile ilgili ana teorileri kullanılmıştır. Çalışma kapsamında, eleştirel ve sistematik inceleme yöntemi kullanılmıştır. Araştırmanın eleştirel inceleme bölümü için, nitel içerik ve tematik analiz yöntemi kullanılırken, sistematik inceleme bölümü için de, Elsevier Science Direct, Sage Journal Online, Taylor ve Francis ProQuest Tezi Global dahil olmak üzere, dört veri tabanından kaynaklar alınmıştır. Bu çalışma, Alzaymır ve demans hastalarının tedavi mekânlarında, terapi bahçeleri ve bahçecilik terapisinin, Kanıta Dayalı Tasarım stratejilerine entekre edilmisinin önemini ortaya koymakta. Buna bađlı olarak, hastalarda ajitasyon, kaygı, olumsuz düşünme hallerinde azalma ve bilme yetisinde de ilerleme görölmektedir. Ayrıca, sanal gerçeklik ile de dođal ortamlar yaratılarak, hastaların algılama ve iyileşmeleri sađlanmaktadır. Literatür taramasından elde edilen bulgular ışığında, bir kavramsal çerçeve oluşturulmuş ve terapi bahçelerinin Alzaymır ve demans hastalarının tedavi mekânlarının tasarımındaki önemi ortaya konmuştur. Bu çalışma, ayrıca, araştırma ile uygulama arasındaki

boşluğu Kanıta Dayalı Tasarım önerileri ile doldurmuş, mimarlar, sağlıkçılar ve sağlık otoritelerine de kılavuz oluşturmuştur.

**Anahtar Kelimeler:** Terapi Bahçeleri, Doğaya Dayalı Müdahale, Peyzaj, Mimarlık, Alzaymır hastalığı, Demans.

## **DEDICATION**

I dedicate this work to God Almighty, the supreme source of my life, wisdom, grace and patience to excel.

To my loving parents, Mr. and Mrs. A.N. Uwajeh, who have been a constant source of emotional, spiritual, psychological and financial support, without whom I would not be where I am today.

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## LIST OF ABBREVIATIONS

AD	Alzheimer's disease
AGT I	Angiotensinogen I
ANGII	Angiotensin II
BDNF	Brain-Derived Neurotrophic Factor
BNP	Brain Natriuretic Peptide
CHD	Centre for Health and Design
CRP	C-Reactive Protein
CHF	Chronic Heart Failure
DHEA	Dehydroepiandrosterone
EBD	Evidence-Based Design
EBM	Evidence-Based Medicine
ET-1	Endothelin-1
ESCAPE	Effects of Stress on Cognitive Aging, Physiology, and Emotion
GM-CSF	Granulocyte Macrophage Colony-Stimulating Factor
HG	Healing Garden
HT	Horticultural Therapy
IL	Interleukin
IFN- $\gamma$	Interferon- $\gamma$
TG	Therapeutic Garden
TNF- $\alpha$	Tumor Necrosis Factor- $\alpha$
NK	Natural Killer
RAS	Renin-Angiotensin System
URT	Unconstructive Repetitive Thought

VR	Virtual Reality
VOCs	Volatile Organic Compounds
WHO	The World Health Organization

# Chapter 1

## INTRODUCTION

As the population of older adult continues to increase, the need to become better informed about various ways to understand and prevent cognitive decline and ultimately promote wellness becomes a global priority. With the global increase in health crisis, physical inactivity, obesity and mental illness, there has been an upsurge in the awareness that interacting with natural environments plays an important role in improving health and possibly prevents illness. This has led to a greater acceptance of the need for improved human wellbeing. The presence of an expanse of land, often covered in grass or sparsely planted floras, has been the case in the healthcare environment for several decades. Therapeutic gardens are important architectural design factors that offer substantial benefits on human health and overall wellness. Therapeutic gardens have been applied for many centuries for therapeutic purposes in healthcare environments and its benefit to human health has been well documented in research. However, it is yet to gain adequate usage as an architectural design strategy and a non-invasive therapeutic option for specific patient user groups.

Against this backdrop, studies have associated a strong link between landscape, gardens and nature-based interventions on health and well-being (Stigsdotter et al., 2018; Poulsen et al., 2018; Corazon et al., 2018; Sidenius et al., 2017; Vujcic et al., 2017; Poulsen et al., 2016; Gillis & Gatersleben, 2015; Aghaie et al., 2014; Ray & Jakubec, 2014; Corazon et al., 2012; Corazon et al., 2011).

Research evidence shows that almost every country in the world will experience a growth in the population of older adults and people of 85 years and above is globally projected to grow at an alarming rate between the year 2000 and 2050 (World Population Ageing, 2017). It has been estimated that 6% of individuals aged 65 and above, will likely suffer from dementia, with those in their 80's having more than a 30% chance. Also, investigators suggest that developing countries with large population, will show a greater increase in disease burden (Peters, 2001; Prince, 2000). As a result, the World Health Organization (WHO) Global Network of Age-friendly Cities and Communities recommended that creating age-friendly environments that is accessible, supportive, inclusive, and secure, should be designed to ensure that everyone has the opportunity to fully participate, promote health and prevent or delay the onset of disease and functional decline in older persons as they age (The World Health Organization, 2018).

Generally, older adults with age-related disabilities such as Alzheimer's disease (AD) and dementia often experience a decline in psychological functioning which leads to difficulty in adjusting to their physical environments. This greatly impacts on their quality of life. Unfortunately, research findings posit that clinical trials and monotherapeutic treatment options for this patient group have not yielded a permanent cure till date (Singh et al., 2016; Kurakin & Bredesen, 2015). For example, 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 (Siemers et al., 2016; Doody et al., 2014; Salloway et al., 2014; Doody et al., 2013).

This has led to studies adopting a more holistic medicine that integrates natural environments which provides psychophysiological and therapeutic advantages for optimizing healing experience through a variety of alternative interventions (Kaufman, 2018; Chang et al., 2008). Earlier studies affirm that gardens, play a vital role in the design of AD and dementia care facilities because that can be infused seamlessly with cultural traditions, fond memories and images that can evoke lost memories to create a dynamic contrast of a clinical feel in long-term care settings (Brawley, 1997). Thus, a healing environment that incorporates design factors such as therapeutic gardens may prove to be an approach towards optimizing the healing environment of AD and dementia patients. To buttress the relevance of landscape and garden design and its wellness impacts in healthcare settings, three key theories were selected, including the evidence-based design theory; the biophilia theory and the theory of supportive design.

Prior studies pointed out that documenting more research on gardens in the health care settings is important to harness the potential and therapeutic benefits of well-designed gardens that can increase exercise and mobility, minimize feelings of isolation, vulnerability, loss of capabilities, improve depression and enhance self-esteem of individuals with AD and dementia (Brawley, 2004; 2002). Brawley (2004) suggests that architectural planning should ensure that gardens and outdoor spaces preserve health and maximize the abilities of individuals with cognitive impairment. Gonzalez & Kirkevold (2014) noted that despite considerable attention paid to the utilization of sensory garden and other horticultural or nature-based therapeutic programs, only few specific investigations have been conducted within dementia care, with research mainly focusing on the United States.

Kurakin and Bredesen, (2015) suggest that although, there is no accurately effective therapy for the treatment of AD, it may be vital to consider the successful therapeutic developments from other chronic illnesses such as cancer and human immunodeficiency virus. Chaudhury et al. (2017) also 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 designing physical environments appropriate and responsive to residents' cognitive abilities and functioning. This call has stimulated research into integrative medicine that involve patient centered and healing oriented approach, which embraces conventional and complementary rehabilitations (Maizes et al., 2009; Clark et al., 2019). As the population of older adults rapidly grows, the need to reconsider the care and design of AD facilities remains a global concern until a cure is found.

Based on these views, this dissertation investigates the impact of Therapeutic Gardens as an evidence-based design factor for improving the architectural quality of space for individuals with AD and dementia as well as their health outcomes. It further stimulates research into the extent to which studies have postulated the positive health impacts of other nature-based interventions such as horticultural therapy (HT) therapeutic gardens (TG) and nature-based virtual reality (VR) technologies as a non-invasive intervention for AD and dementia rehabilitation.

## **1.1 Problem statement**

Global projections estimate that 6% of individuals aged 65 and above, will likely suffer from dementia. Individuals in their 80's have a higher chance of this disease burden.

It is therefore inevitable that individuals with AD and dementia are subjected to special care facilities that often confines them indoors. Against this backdrop, the motivation for this study stems from the following problems:

1. Research evidence asserts that clinical trials and monotherapeutic treatment options for AD and dementia patients have not yielded a permanent cure till date. Thus, the onus to find alternative treatment options have been placed on the shoulders of other disciplines including architecture and environmental psychology

2. People with AD and dementia are often confined in nursing homes, or special care units due to their tendencies of exhibiting behavioral issues ranging from agitation to delusional mental health problems. This restriction to indoor spaces deprives them the opportunity of connecting and engaging with the outdoor natural environments. Thus, natural environments should be brought to them through architectural designs that consider nature-based interventions.

3. The application of Therapeutic Gardens in healthcare environments are often considered an outdoor dressing rather than a therapeutic factor, integrated purposefully to provide positive distractions on stressful experiences and improve the architectural design quality of spaces.

4. More emphasis has been laid on the design of interior spaces in AD care facilities, with little emphasis on exterior spaces and their health impacts on AD and dementia patients.

5. Although, research provides evidences of the use of nature-based interventions such as therapeutic gardens as a treatment option for AD and dementia patients, empirical



findings have not been adequately integrated in architectural design of spaces for AD and dementia patients. As such, the positive outcomes and results from scientific studies is yet to have a global impact on the design of these healthcare facilities.

6. Furthermore, factors including, government policies, cost, technology, and heterogeneity in research findings possess a great challenge in optimizing care facilities for this patient group.

The medical profession remains one of the respected disciplines to incorporate and embrace the use of scholarly information, methodical record keeping, and progress monitoring, into its practice. Consequently, designers can intelligently adopt these approaches in the design of healthcare facilities through EBD concepts and theories that support healing by design to optimize the environment of patients with AD and dementia. The above concerns have stimulated the need to develop a conceptual framework in which this present study attempts. Through a critical review of literature (narrative and systematic), this study documents best practices, clinical findings from empirical studies on the therapeutic benefits of using nature-based interventions and design recommendations for improving AD and dementia facilities using therapeutic gardens.

## **1.2 Research Aim**

The main aim of this study is to investigate the potentials of using therapeutic therapeutic gardensto improve care facilities and wellbeing of AD and dementia patients. Using selected theories such as Evidence-Based Design (Ulrich, 1984), theory of supportive design for healthcare (Ulrich, 1991) and the biophilia hypothesis (Wilson, 1984), this study dissertates that incorporating credible evidences from

empirical research into design, providing access to social support, access to nature and other positive distraction as well as encourage a sense of control and access to privacy can optimize patient health outcomes and architectural design quality of AD and dementia care facilities.

### **1.3 Research Objectives**

The quality of the physical environment of care has a substantial impact on the comfort and health outcomes of AD and dementia patients. As such, it should be designed to ameliorate stress and enhance wellness. More so, a well-designed healthcare space should not only provide medical care as the basic health requirements for its users, but should also provide quality shelter, spatial experience, social and emotional gratification. In this regard, this research broadly intends to explore the healing attributes of therapeutic gardens as a non-pharmacological, physiological and psychological supportive design factors for improving the health status of AD and dementia patients as well as optimize the architectural quality of care facilities.

The key objective of this investigation is to improve the healthcare environment of AD and dementia patients through the development of a conceptual framework for utilizing the benefits of therapeutic gardens as well as other nature-based interventions. Through a multi-disciplinary approach, it will explain how and why nature can heal and the need to incorporate research finding of nature-based interventions into architectural design. This research curiosity will be approached from both a theoretical standpoint and a critical review of literature to identify the gap in which this dissertation queries as follows:

I. To explore the scientific applications of therapeutic gardens for improving health outcomes in AD and dementia care.

II. To develop a conceptual framework through a critical review of existing literature on the therapeutic benefits of gardens in healthcare settings.

III. To incorporate the research findings (objective II) into the framework and document recommendations for the design of AD and dementia care buildings.

## **1.4 Research Questions**

The main researched question of this study is:

How can therapeutic gardens be used to improve the design of care facilities and wellbeing of AD and dementia patients?

Six sub-questions were pertinent to achieve an in-depth investigation on the study.

Questions 1 and 2 were answered in the first section of the critical review of literature.

1. What are the health benefits of nature in healthcare environments?

2. What are the health benefits of therapeutic gardens for cognitive rehabilitation of AD and dementia patients?

Questions 3-6 were answered with the systematic review.

3. How has research on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities evolved between 1984 –2019?

4. What is the country or regional distribution of studies on the use of therapeutic gardens as design factors in AD and dementia care facilities?

5. What is the most common method used in research on therapeutic garden as an architectural design factor in AD and dementia care facilities?

6. What are the architectural parameters to consider in the design of therapeutic gardens in AD and dementia care buildings?

## 1.5 Research Methodology

This study adopts a qualitative method using a critical review of literature and a follow up systematic review.

### 1.5.1 Critical review of literature

A critical review was used to effectively present, analyses and synthesizes literature from diverse sources. As suggested by previous studies, this method is most suitable for studies that aim to develop a hypothesis or model which may comprise of a synthesis of existing models, schools of thought or it may be a completely new interpretation of the existing data (Grant & Booth, 2009). The same study documents the key attributes of a critical review mapped against a Search, Appraisal, Synthesis and Analysis (SALSA) framework (See Table 1.1).

Table 1.1. Attributes of a Critical Review Based on the Search, Appraisal, Synthesis and Analysis (SALSA) Framework Adapted from (Grant & Booth, 2009)

Method	Description	Search objective	Appraisal	Synthesis	Analysis
Critical review	Presents an extensive research literature and critically evaluates its quality. Extends beyond ordinary description to include degree of analysis and conceptual schemes.	To identify the most significant issues in the field under investigation	Evaluates data according to their contribution to the topic	Typically narrative, conceptual or chronological	Aims to identify conceptual contribution to embody existing or derive new frameworks.

### **1.5.2 Systematic Review**

A follow up systematic review of literature was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (Moher et al., 2009). This five-step guidelines on conducting Systematic Review of Denyer and Tranfield (2009) including (i) Research Question, (ii) Database search, (iii) Study Selection and Evaluation, (iv) Analysis and Synthesis, (v) Reporting and Using the Results, was adapted.

The review is systematic because the selection criteria for included and excluded papers are explicit and reproducible. Additionally, prior studies which support the adoption of this method in natural and social sciences suggest that it can be used to review both quantitative and qualitative literature, thus, is predominantly appropriate for interdisciplinary research (Lee & Kamler, 2008; Kamler, 2008). This validates the choice of this method because this study cuts across medical, psychology and environmental disciplines. The systematic review improved the quality and strength of the critical review by answering the research questions of this study, while retaining transparency of inclusion and exclusion criteria.

The benefits of using a systematic review method for doctoral dissertation have been documented in several studies (Daigneault et al., 2014; Mallett et al., 2012; Waddington et al., 2012). Based on these views, the author deemed a systematic review appropriate to synthesize key studies in a structured and comprehensive process

to answer the research questions 3 and 4 (see section 1.4). The findings enabled the author to produce a baseline for future research and architectural recommendations for the design of AD and dementia care facilities. This also provides a useful platform for evaluating the knowledge contribution of this present research.

### **1.5.3 General Key Words and Review Search Phrase for this Study**

A wide range of search terms was used singularly as key words or in combination with “AND”. For example, therapeutic garden AND dementia facility or therapeutic garden AND Alzheimer’s healthcare. The major search terms and phrases identified in this study include but not limited to: “biophilia theory”, “evidence-based design”, “supportive design theory”, “healthcare”, “innovative design practice and healthcare”, “hospital environment”, “sensory gardens”, “multisensory gardens”, “children’s garden”, “Alzheimer’s gardens”, “dementia gardens”, “cancer gardens”, “patient experience”, “trauma gardens”, “horticultural therapy”, “emotional comfort”, “healthcare experience”, “landscape and health”, “landscape and healing”, “landscape and wellbeing”, “therapeutic garden and mental health”, “therapeutic garden and mental stress”, “therapeutic garden and psychology”, “therapeutic garden and physiology”, “therapeutic garden and cognition”, “health care occupants,” “gardens and non-invasive interventions,” “nature-based interventions,” “therapeutic garden and geriatric homes,” “therapeutic gardens and physical activities,” “garden and wellbeing,” “healing garden and mental health,” “therapeutic garden and mental wellbeing,” “gardens and physical health,” “garden and technology,” and other relevant key words derived from materials retrieved.

### **1.5.4 Analysis**

Qualitative Content and Thematic Analysis: This research combines both a qualitative content analysis and a thematic analysis. It is deemed most suitable for this study due

to the multidisciplinary dimension of this research and its notable results in nursing studies and healthcare research (Elo & Kyngäs, 2008). The qualitative content analysis is a widely used data analysis technique which falls within a broad family of analysis methods often called framework method.

This thematic analysis was considered appropriate for this research because it identifies the differences and similarities in qualitative data, before concentrating on the interactions between different parts of the data, thereby mining descriptive and/or explanatory conclusions grouped around themes (Gale et al., 2013). Studies have suggested that thematic analysis, is a flexible research tool, which offers a complex, yet detailed account of the data (Vaismoradi et al., 2013; Braun & Clarke, 2006). Evidently, this study conducts a thematic approach to analyze data from a rigorous systematic review of existing literature, and identifies common threads that extend across the data set (DeSantis & Ugarriza, 2000). Although, content analysis brings to the fore, the intersections between concepts, including textual matter, symbols, messages, information, mass-media content, and technology supported social interactions (Krippendorff, 2018; Hsieh & Shannon, 2005; Krippendorff, 2004), thematic analysis on the other hand, offers the systematic characteristic of content analysis, and also permits the researcher to combine the analysis of their meaning within their particular context (Vaismoradi et al., 2013; Loffe & Yardley, 2004).

## **1.6 Significance of the Study**

The ability to draw upon the healing qualities inherent in nature has been shown to improve the health status of individuals with AD and dementia. The health benefits include reduced stress, pain and agitation, improved cognition, physical, social psychological and emotional wellbeing. Although there is a substantial amount of

literature on the health benefits of therapeutic garden within the healthcare setting, there is not enough evidence to support the use of therapeutic gardens as a non-invasive intervention or architectural design feature for optimizing the healing environments of patients with AD and dementia. This study is significant to the body of knowledge for the following reasons:

1. The findings of this study show that the integration of gardens as a therapeutic factor in the design of AD and dementia care facilities has only gained global attention in the United States (US) and most parts of Europe and Asia. It is yet to gain recognition Africa and other developing regions. This emphasizes the need for this study within this region.

2. Previous studies have investigated design guidelines and recommendations for AD and dementia care facilities only from an architectural point of view. This study foregrounds its recommendations on credible evidences from both clinical and architectural standpoints. The current study suggests that the design of healthcare spaces for this patient group should not only offer special comfort, but should integrate the knowledge of their health conditions into design to achieve an optimized healing environment.

3. Based on academic literature and to the best of the authors' knowledge, this study will be one of the first attempt to document a consolidated empirical approach via a conceptual framework for the design of AD and dementia care facilities and the treatment of this patient group within this region. Thus, this study serves as a launch pad to guide researchers and landscape architects in further case-based studies in future.



## **1.7 The Structure of the Dissertation**

This is a theoretical study combined with a critical and systematic review of literature as shown in figure 1.1. It is structured into six chapters. Chapter 1 introduces the problem and the need for the study, the aim, objectives and research methodology. Chapter 2 includes the theoretical framework used to support the topic under investigation. Through a critical review of literature, Chapter 3 narratively discusses the healing environment, therapeutic garden from a general perspective in healthcare settings. Furthermore, it documents an understanding of the healing environment and the use of therapeutic gardens as well as nature-based interventions, including HT, TG and VR technologies for the rehabilitation of patients with AD and dementia. It concludes with a systematic review of the design impact of therapeutic garden in AD and dementia care facilities and presents the findings towards the design of the conceptual framework of this study. Chapter 4 explains the framework developed for the use of therapeutic Gardens in healthcare settings, and in AD and dementia care settings, describes the themes and sections of the frameworks as well as suggestions for garden design and application of the framework in the healthcare ecosystem. Chapter 5 summaries and concludes the findings of the research.

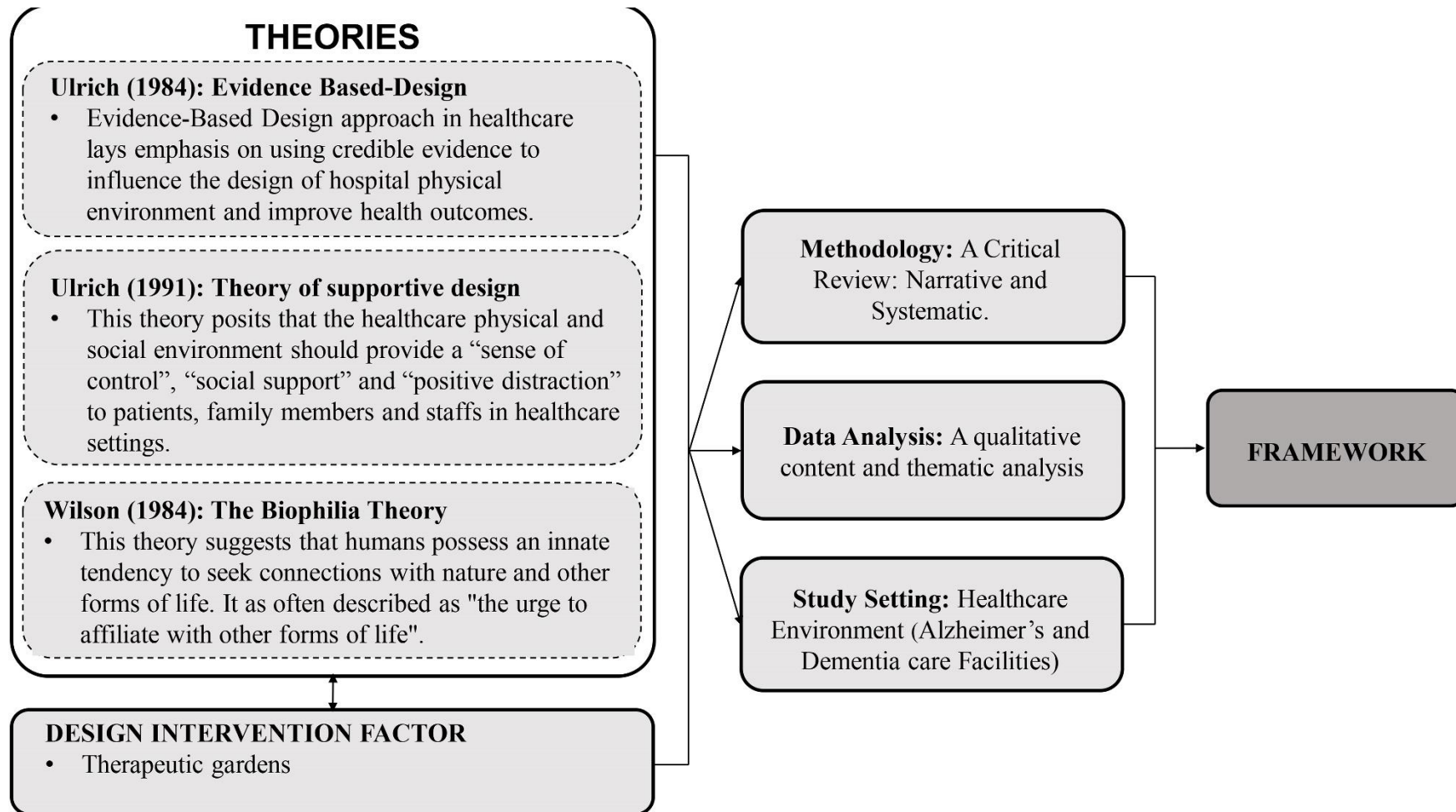


Figure 1.1. Schematic Structure towards developing the study Framework (Authors compilation)

## **1.8 Scope, Limitation and delimitation of the Study**

### **1.8.1 Scope**

1. This study captures the physical, social and psychological dimensions of space for the treatment of AD and dementia patients in healthcare environments. The application of therapeutic gardens for therapeutic gains documented in this current study spans through the broad spectrum of healthcare facilities that cater to senior citizens and older adults predisposed to AD and dementia.

2. This study focuses on nature-based interventions that currently have the most evidence of effectiveness of AD and dementia care including TG and HT and VR technologies. These nature-based interventions were chosen for the following reasons:

I. They all use a common approach involving active interaction of participants with nature.

II. They are the most used among all other nature-based interventions for AD and dementia rehabilitation on a global scale.

III. They can be easily integrated into interior and exterior spaces through design.

3. This study synthesizes the findings from existing literature and case studies to develop a conceptual framework for gardens design in AD and dementia healthcare facilities.

### **1.8.2 Limitation**

The limitations of this study will be discussed in two segments. First, from a broad perspective of the challenges faced when carrying out research within the healthcare domain. Secondly, the challenges that are specific to this study:

**Broad perspective:**

1. Empirical studies in health care are both expensive and complex. Likewise, case-based studies for sensitive patient groups such as AD and dementia presents several challenges due to the lack of control subjects and the progressive nature of the disease.
2. Rigid protocols, and inability to access first-hand information from patients, nursing staff and healthcare facility management due to government policies.
3. Lack of funding or research grant.

**Specific to this study:**

1. Limited sample size of the study
2. Limited access to database.

However, given the above limitations and the inability to conduct an experimental phase of this study after synthesizing evidences from literature a conceptual framework is considered useful as a starting point to guide future research on AD and dementia facility design especially in developing regions.

**1.8.3 Delimitation**

This present study does not intend to provide a medical treatment for the selected patient group, but seeks to improve their environment of care from an architectural point of view. To achieve this, it was necessary for the author to have a basic understanding of the health conditions of the patient population of this study from a medical stand point. As such, these key words “Alzheimer’s” and “dementia” patients significantly appeared in various sections of the dissertation. However, the objective

was to develop a framework that extends beyond a documentation of design guidelines to one that integrates an understanding of patients' health conditions and clinical outcomes of alternative treatment therapies involving therapeutic gardens into the considerations required for the design or improvement of nursing homes, and care facilities for these patient groups.

## **1.9 Definitions of Common Terms Used**

**Evidence-Based Design (EBD):** According to the Center for Health Design (CHD), Evidence-based design (EBD) is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes (Center for Health Design, 2008).

**Evidence-based Medicine (EBM):** An approach to medical practice intended to elevate decision-making by integrating individual clinical expertise with the best available external clinical evidence from systematic research (Sackett, 1997). It assesses the strength of evidence, weighing the risk and benefits of treatments or non-treatment, and diagnostic tests.

**Evidence-based Landscape Architecture (EBLA):** Is defined as the deliberate and explicit use of scholarly evidence in making decisions about the use and shaping of land (Brown, & Corry, 2011).

**Healing Environment:** A term which defines a physical setting and administrative culture that helps patients and families cope with the stresses caused by illness, the healing process, and sometimes with the demise of family and friends in healthcare environments (Stichler, 2001).

**Supportive Design Theory:** A theory designed by Ulrich (1991) that explores the various ways to utilize the built environment to minimize stress and stress causative factors, by providing a sense of control, access to social support and access to positive distractions to users in the physical surroundings.

**Biophilia Theory:** Biophilia is used to describe human's inherent love for nature and other forms of life and environments that are essential for survival (Kellert & Wilson, 1995).

**Health:** The World Health Organization (WHO) describes Health, as not just the absence of disease or infirmity, but a state of complete physical, mental and social well-being (World Health Organization, 1946).

**Mental Health:** Mental health is defined as a state of well-being in which every individual realizes his or her own potential, cope with the normal stresses of life, work productively and fruitfully, and is able to make a contribution to her or his community (WHO, 2014).

**Alzheimer's disease:** The term AD clinically refers to a medical condition that typically presents with a characteristic progressive amnesic disorder with the subsequent appearance of other cognitive, behavioral, and neuropsychiatric changes that impair social function and activities of daily living (Cummings et al., 2014). AD was first described by a neuropathologist Alois Alzheimer in 1906 and was named after him (Zeisel and Tyson, 1999).

**Dementia:** This refers to the loss of cognitive functioning and behavioral abilities to an extent that it interferes with a person's daily life and activities. These functions include memory, language skills, visual perception, problem solving, self-management, and the ability to focus and pay attention (National Institute on Aging, 2019).

**Nature-Based Interventions:** These are part of solutions to support mental health care or to specifically aid treatment alongside drug treatments and psychological therapies (Bragg & Atkins, 2016).

**Horticultural Therapy:** This is the participation in horticultural activities facilitated by a registered horticultural therapist to achieve specific goals within an established treatment, rehabilitation, or vocational plan (American Horticultural Therapy Association, 2019).

**Gardens:** This generally refers to a wide range of spaces ranging from small space with a collection of potted plants, to large areas with richly planted flowers and vegetables, in private outdoor sanctuaries, and in urban green spaces (Dixon, 2002).

**Wander Garden:** A wander garden is a type of the classical hospital garden designed to provide dementia patients with safe outdoor environment for daily activities (Detweiler et al., 2002).

**Landscape:** According to the European Landscape Convention, "Landscape" means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors (European Landscape Convention, 2000).

Additionally, the term “landscape” was used as a compound term word in this dissertation to represent natural elements such as flora and fauna as well as geographic forms and hardscapes (materials in the built environment structures that are incorporated into a landscape including fountains, benches, or gazebos, paved areas, driveways, retaining walls, sleeper walls, walkways, wood, stone, and concrete), within the landscape in healthcare environments.



## Chapter 2

### THEORETICAL UNDERPINNINGS OF THE STUDY

In order to develop a proper understanding of the study under investigation, three (3) theories were selected for investigation as shown in Fig. 1 above. The theories include the Evidence-based design concept (Ulrich, 1984), The Biophilia theory Wilson, (1984), and the Theory of supportive design (Ulrich, 1991). Three main factors were considered for selecting the theories. These include:

- a. They all present a common goal of transforming the built environment through environmental design factors to generally enhance positive outcomes in the health and wellbeing of users.
- b. They all incorporated physical, social, and psychological factors as well as technological advancements which promote innovations in healthcare designs.
- c. The application and utilization of nature as a positive distraction and mediator between the healthcare physical environment and wellness enhancement is peculiar to the three theories selected for this present study.

Mining the salient themes, and keywords associated with these theories with respect to the selected patient group in this research, aided the development of the conceptual framework in which this study proposes (See figure 2.1).

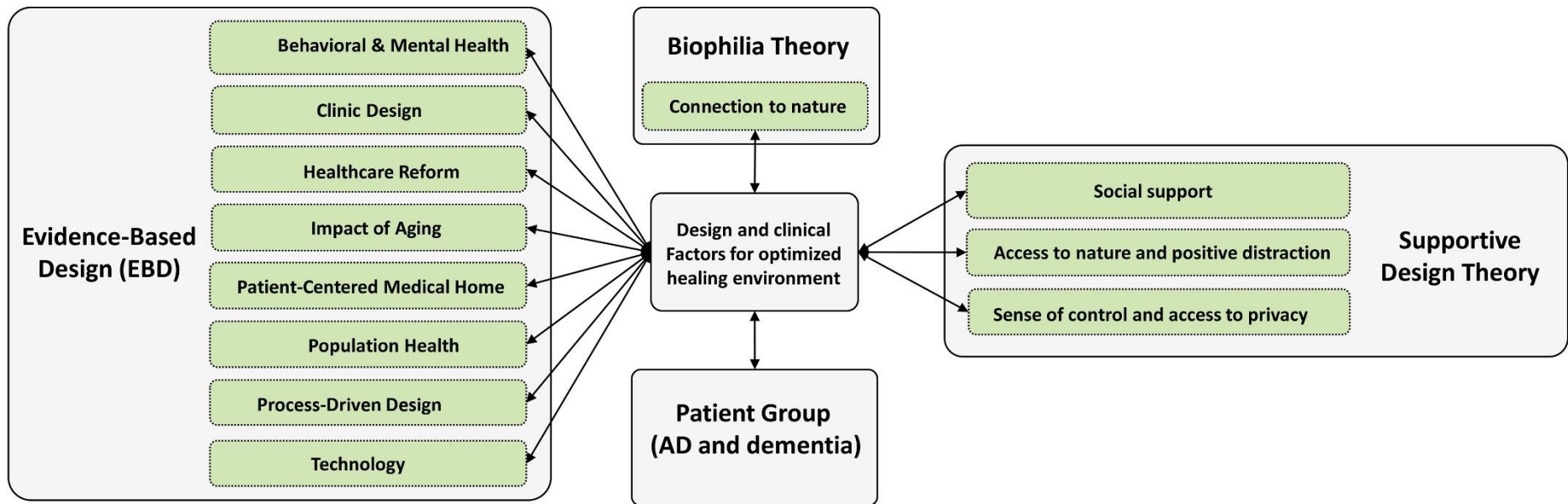


Figure 2.1. Relationship between the Selected Theories (Adapted from the Center for Health Design, 2008).

## **2.1 Evidence Based Design Theory in Healthcare Settings**

### **2.1.1 Describing the Evidence-Based Design (EBD) Concept**

The evidence-based design (EBD) concept was adopted from evidence-based medicine (EBM) which is an approach to medical practice intended to elevate decision-making by stressing the use of evidence from well designed and conducted research. As described by Sackett et al. (1996) EBM is “the conscientious, explicit, and judicious use of current evidence in making decisions for clinical treatments and outcomes of patients.” This involves gathering reliable imperial evidences from research and using these evidences to develop the bases for clinical procedures and treatment programs (Molzahn, 2007; Sackett, 1997; Sackett et al., 1996).

However, the roots of evidence-based design (EBD) could be traced back to the 1860s, when the provision of fresh air was placed as the very first canon for linking the healthcare physical environment with improvement of patients and staff safety, wellness, and satisfaction. This concept extends to include the importance of quiet, proper lighting, warmth, and fresh water. With the advances made in EBD and technology development in the 1970s, there was a gradual shift, which transformed the healthcare setting into a “medical machine” that promoted social, physical, and psychological wellness. The EBD approach 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 health care workers under stress (Smith, 2007), as well as for improving the design of healthcare facilities, health care management, and policymaking (McCullough, 2010).

Studies supporting the EBD concept, found that patients experience less pain when exposed to a view of nature from their hospital rooms (Malenbaum et al., 2008), suffered fewer complications, used less pain medication and were discharged sooner than those who looked out on a brick wall (Ulrich, 1984). Consistent with this, Mackrill et al. (2017) 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 healthcare environment (Tagharrobi et al., 2016). For example, therapeutic gardens and healing gardens (HG) as a non-pharmacological intervention has been shown to improve wellness, reduce the level of pain, agitation, and anxiety of patient in the healthcare settings (Gillis & Gatersleben, 2015; Jiang, 2014; Ulrich, 2002).

The evidence-based design (EBD) concept has been shown to promote stress-free environments and based its focus on strategic opportunities to influence the design of health care facilities. EBD as a tool for healthcare planning is a method that began with the general aim of providing evidence-based medicine (Huisman et al., 2012), and has now extended to become the theoretical concept of what are called healing environments. Therapeutic environments create a shared atmosphere that strengthens the self-healing capacity of both patients and care providers. In other words, the healing environment should reflect the values, beliefs, and philosophies of the patients served. The integration of EBD strategies in the healthcare environment has created a sustainable and ecological healthcare ecosystem (Anåker, 2017) which improves clinical outcomes (Iyendo, 2016; Ulrich et al., 2008), economic performance and job satisfaction (Pati et al., 2008).

Healthcare designs have experienced significant transformation in recent times. This includes the application of innovative design approaches in the design of healthcare facilities that have created new domains within the health care milieu, such as user-centered design, and evidence-based design (Reay et al., 2017; Djukic & Marić, 2017; Quan et al., 2011). These design approaches take into consideration the needs of users and introduce novel ways for improving the health care landscape. According to the Center for Health Design (CHD), EBD is described as “the deliberate attempt to base design decisions on credible evidences from research to improve design outcomes and critically evaluate post-occupancy results” (Zimring et al., 2004). Generally, the CHD, categorises health and design strategies for improving healthcare environments under fourteen (14) main topics including behavioral and mental health, clinical design, communication, emergency department throughput, healthcare reform, impact on aging, infection control, noise, patient-centered medical home, perception of cleanliness, population health, process-driven design, safety and technology as shown in Figure 2.2.

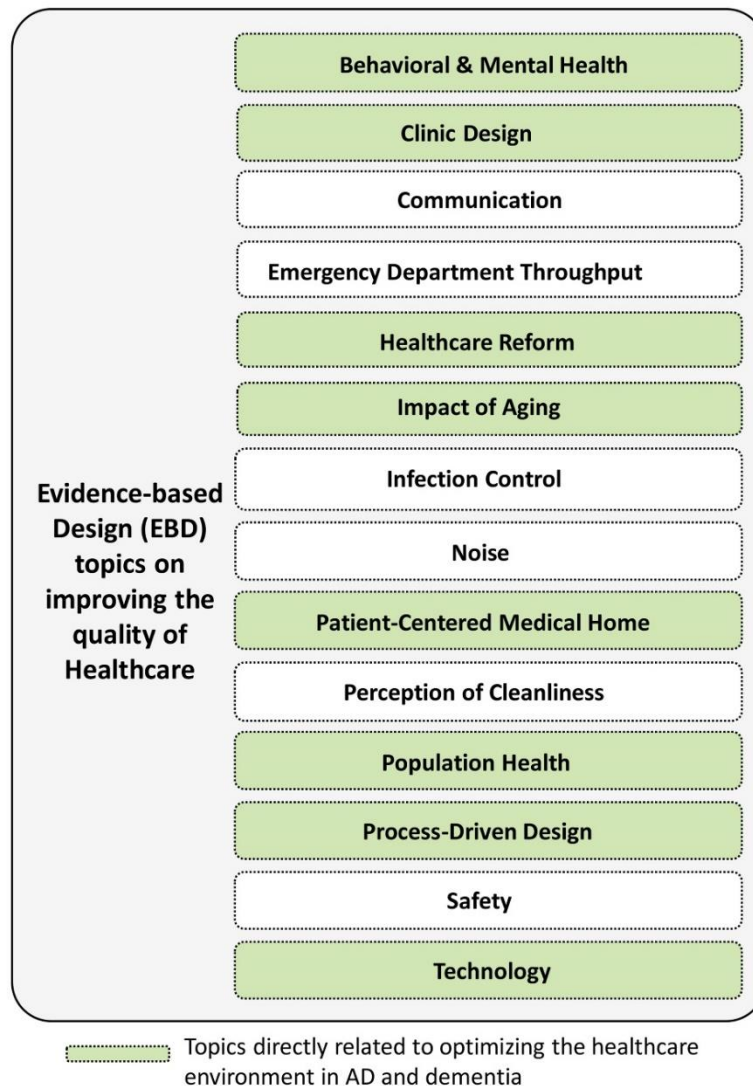


Figure 2.2. Main EBD topics on Healthcare Improvement (Adapted from the Center for Health Design, 2008).

One of the tenets of EBD is to integrate strategies and evidences into various stages of design. To achieve this, the EBD process needs to be stratified into steps that would correspond with the conventional design stages. The CHD documents EBD process into eight steps namely: Define evidence-based goals and objectives; find sources for relevant evidence; critically interpret relevant evidence; create and innovate evidence-based design concepts; develop a hypothesis; collect baseline performance measures; monitor implementation of design and construction as well as measure post-occupancy performance results (Rashid, 2013; CHD 2012).

Integrating these steps into practice necessitates the collaboration between healthcare organizations, research, and expert design firms. The EBD process requires an understanding of the design, construction process, research and healthcare delivery industry collectively. Figure 2.3 represents a schematic wheel showing the stages; (organizational readiness, pre-design, design Phase, construction and occupancy/post occupancy) of integrating the eight-evidence based design process in different phase of projects from start to finish. Consequently, designers should realize that adopting EBD approach is not a rejection of creativity, but a means to improve their design solutions (Martin, 2009). As stated by the Center for Health Design (2008), Table 2.1 highlights the integration of EBD steps as it relates to various project designs phase.

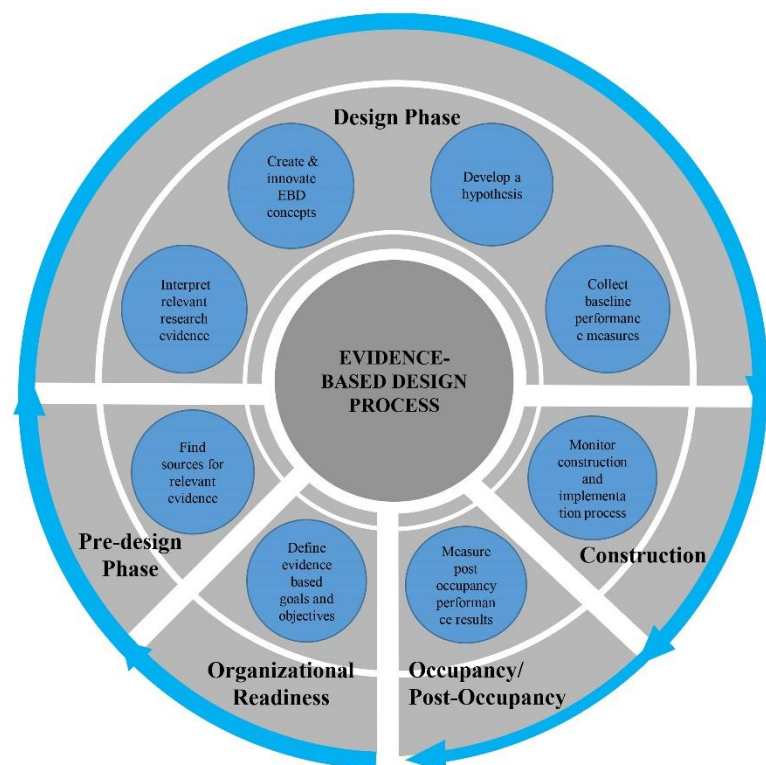


Figure 2.3. The Evidence-Based Design Process Integration in Stages of Projects (Adapted from Rashid, 2013; Martin, 2009; CHD 2008)

Table 2.1. EBD Process and their Integration in Design Stages

Pre-Design Stage in EBD			
Reference	Design Task	EBD Steps	EBD Tasks
[Rashid, 2013; Martin, 2009; CHD 2008]	<ul style="list-style-type: none"> <li>• Institute interdisciplinary teams.</li> <li>• Visualize anticipated goal.</li> <li>• Develop functional and space programs.</li> </ul>	<ul style="list-style-type: none"> <li>• Define EBD goals and objectives.</li> <li>• Research and discover relevant evidences.</li> <li>• Interpret evidences critically.</li> <li>• Create EBD concepts/themes.</li> </ul>	<ul style="list-style-type: none"> <li>• Document project vision.</li> <li>• Define desired outcomes.</li> <li>• Establish goals that link design to desired outcomes.</li> <li>• Evaluate the evidence.</li> <li>• Create design concepts.</li> <li>• Translate project goals to research hypothesis.</li> <li>• Collect baseline data.</li> </ul>
Design Stage			
	Design Task	EBD Steps	EBD Tasks
	<ul style="list-style-type: none"> <li>• Conceptual Design development.</li> <li>• Schematic Design development.</li> <li>• Full Design Development.</li> <li>• Construction Documents.</li> </ul>	<ul style="list-style-type: none"> <li>• Develop a hypothesis.</li> <li>• Collect baseline performance measures.</li> </ul>	<ul style="list-style-type: none"> <li>• Create and innovate design concepts.</li> <li>• Test conceptual diagrams.</li> <li>• Construct a mock-up environment.</li> <li>• Integrate EBD features into design strategy.</li> </ul>
Construction and Occupancy stage			
	Design Task	EBD Steps	EBD Tasks
	<ul style="list-style-type: none"> <li>• Bidding/ Negotiation.</li> <li>• Construction/Project execution.</li> <li>• Move-in.</li> <li>• Post Occupancy Evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>• Monitor the implementation of design and construction.</li> <li>• Measure Post-Occupancy results.</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure that the design intent is directly linked to EBD goals.</li> <li>• Ensure that the selected design interventions and hypothesis are maintained during bidding and negotiation.</li> <li>• Monitor the implementation of design and construction.</li> <li>• Communicate the interface between construction and research plan to the construction team.</li> <li>• Prepare for Post-occupancy.</li> <li>• Ensure the building complies with the intended research plan, design, interventions and business plan during the commissioning phase of project.</li> </ul>



## **2.2 The Biophilia Theory**

A spatial organization, interpreted subconsciously, but quickly, into an instinctive evaluation of one's present location can be appraised personally, directly with the use of some or all of one's senses. As such, the human perceptual system is the most suitable and dependable means of judging our immediate surroundings, positively or negatively. In recent times, the term "biophilia" has become a prominent buzz word in the environmental studies. Biophilia is used to describe human's inherent love for nature and other forms of life and environments that are essential for survival (Kellert & Wilson, 1995). The theory is similar to the attention restoration theory (ART) which asserts that people can concentrate better after spending time in nature, or looking at nature scenes (Kaplan & Kaplan, 1989; Kaplan, 1995). This notion was supported by (Wilson, 1984, p. 33) with his assertion that man's inclination to nature is genetic. Biophilic features include natural shapes and forms; natural patterns and characteristics of the natural world such as color, water, sunlight, animals and natural materials, as well as landscapes and geology (Grinde & Patil 2009; Colley, 2015) (See figure 2.4).



Figure 2.4. Biophilic Design of Indoor Spaces: The Henry Ford West Bloomfield Hospital. (Source: <http://tiny.cc/1djq8y>)

Although, the theory of biophilia also includes “biophobia”, or negative emotional responses to certain habitats, activities and objects that are potentially hazardous, such as barren landscapes (ice, desert) or predators and dangerous animals (snakes, lions, spiders). Stokes (2006) suggested that the expression of biophilia must be triggered through contact with nature, possibly at a young age. Thus, biophobia, which is defined as the fear of living things, aversion, and estrangement from nature, may occur (Zhang et al., 2014; Simaika & Samways, 2010). Biophobia is also evident in the tendency to regard nature as nothing more than a disposable resource (White & Stoecklin, 1998).

Biophilic spaces are generally designed for the purpose of connecting humans to nature in order to improve or trigger healing and general well-being. As such, humans need contact with plants and water bodies, both natural and artificial. However, a growing body of scientific evidence have reveals that most of our natural inclinations to connect

with nature continue to show substantial effects on people's physical, and mental health (Frumkin et al., 2017; Frumkin, 2003).

Human interaction with natural environments have been recognized for the contributions they add to social wellness. A research conducted at the University of Illinois, Urbana-Champaign, by the Landscape and Human Health Laboratory (LHHL) revealed that the more trees and grasses in green spaces within cities, the more the usage by residents, advantage to social activity, sense of belonging and well-being (Sander-Regier & Etowa, 2014; Sullivan et al., 2004). Similarly, studies have reported the benefits of physical activities in natural outdoor spaces with adequate greenery when compared to only physical exercise in other places to have more positive health benefits such as improved physical and mental health (Pretty et al., 2005). Consequently, the impact of nature and green spaces in which physical activities offers to human health include reduced stress-associated and life style related disorders such as the burnout syndrome, obesity, and cardiovascular diseases (Barton, 2009; Stigsdotter & Grahn, 2011; Stigsdotter et al., 2010). Thus, Montgomery (2015) suggests that the understanding of human ecosystem and how biophilic design correlates with well-being to impact contemporary and future, users through adaptation and positive human interaction with the natural environment, ecology and social processes will improve the understanding of the relationship between humans and the spaces they inhabit as shown in Figure 2.5.

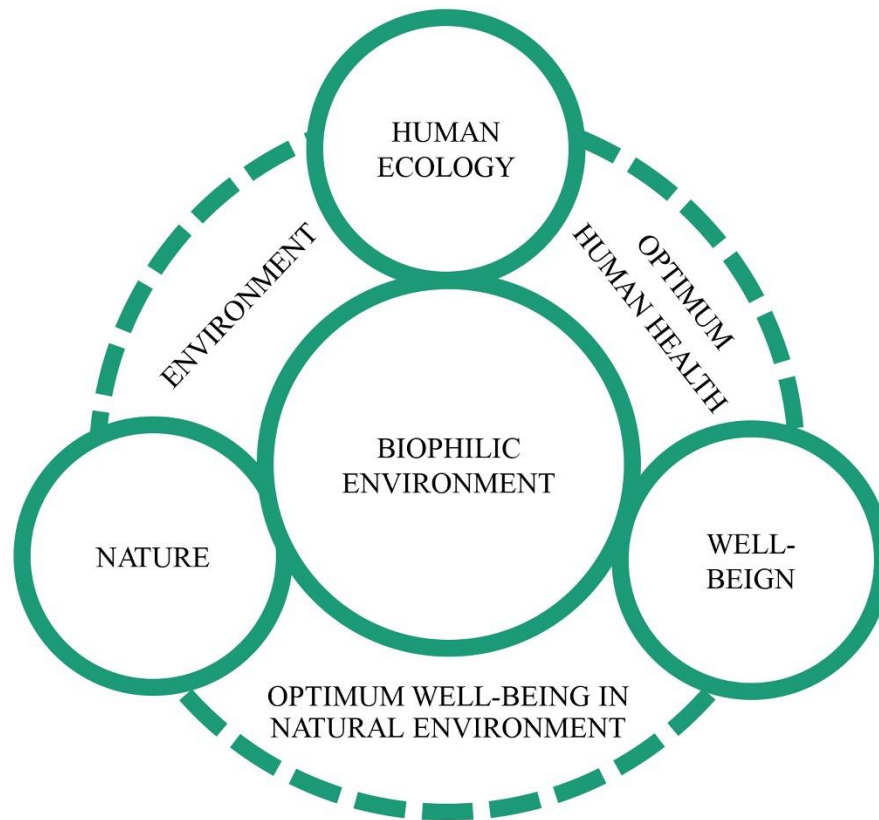


Figure 2.5. Biophilia Theory (Adapted from Montgomery, 2015)

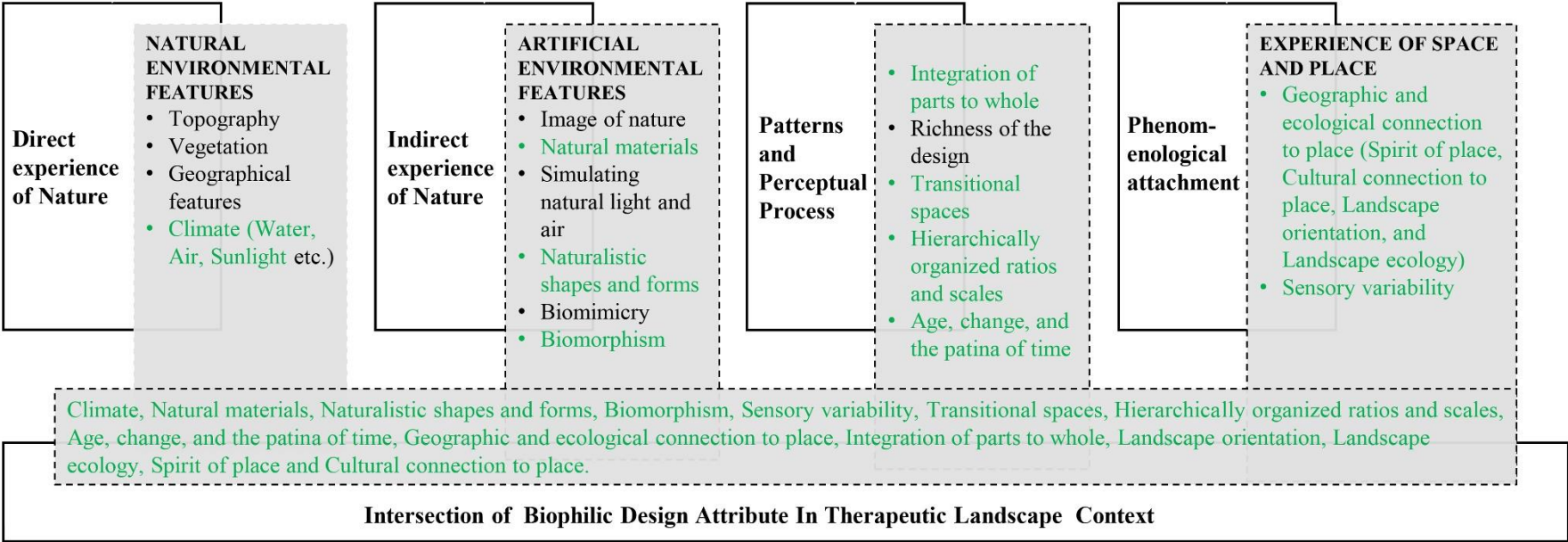
### 2.2.1 The Principles and Benefits of Biophilic Design

Biophilic design faces a major challenge of solving the pitfalls born out of modern buildings and landscape practices by creating a new structure for the gratifying experience of nature in the built environment (Ryan et al., 2014). It seeks to create habitable environments for people as a biological organism in the modern built environment that enhances human health and wellbeing. Indeed, Kellert & Calabrese demonstrates that the successful application of biophilic design requires constant adherence to certain basic principles which include: (a) sustained interaction with nature; (b) promotes positive interactions between people and nature as well as encourage a sense of relationship and communal responsibility; (c) encourage mutually reinforcing, organized, and integrated architectural solutions; and (d)

encourage an emotional attachment to particular settings and places (Kellert & Calabrese, 2015).

Contemporary designs have neglected the consideration and integration of nature over the past few decades. However, recent studies have shown that Biophilia suggests more than a random placement of flower pots and introducing plants within our environment. It should be understood as the incorporation of a pure sense of natural beauty into the indoor and outdoor built environment that consequently creates a greener experience. This is noticed in the direct and indirect experience of nature, natural Patterns and Process, and the phenomenological attachment of space and place that make up the attributes of biophilic design and human experiences (See Figure 2.6).

**Elements, Attributes and Dimensions of Biophilic Design**



● Intersections between elements, attributes and dimensions

Figure 2.6. Elements, Attributes and Dimensions of Biophilic Design (Adapted from Kellert & Calabrese, 2015; Kellert et al., 2011; Kellert & Heerwagen, 2008; Kellert & Wilson, 1995)

Additionally, landscape architects need to develop innovative and up to date scholarly information that will inform both decision-making and transfer it to practitioners in a readily applicable model. These models should encapsulate landscape aspects and dimensions such as “social and cultural components”, “aesthetics”, and concepts like “phenomenology” and “genius loci [spirit of place]” (Fisher, 2004).

### **2.3 Supportive Design Theory**

The Supportive design theory presents a probable paradigm for general health promotion by design within the physical environment and in particular within healthcare facilities. This theory emphasizes on the view that the physical environment has the ability to promote improved health outcomes efficiently by eliminating stress causative factors, which often have negative impacts on health outcomes (Ulrich, 1999; 1991). The core of this theory posits that the qualities of the physical environment require both functional efficiency and psychosocially supportive design factors to achieve an improved and conducive conditions to improve healing process. This is consistent with a study which suggests that the healthcare physical and social environment can promote wellness if they are properly design to provide access to social support, access to nature and other positive distraction as well as encourage a sense of control and access to privacy (Andrade & Devlin, 2015) (See Figure 2.7).

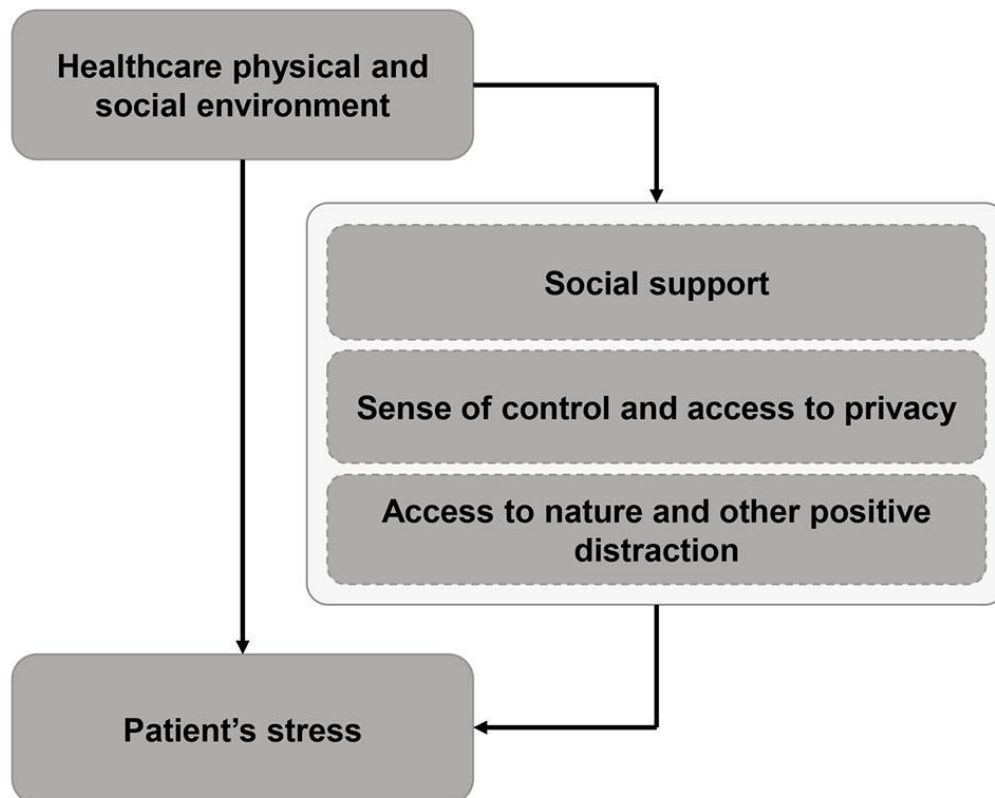


Figure 2.7. Supportive Design Theory (Adapted from Ulrich, 1991)

These are the three main overarching precepts of the theory which further explains the attributes that provides the psychological needs of the patient's, family members, and caregivers such as, reduced stress and increase coping abilities in healthcare facilities (Ulrich, 2000; 1999; 1991).

**Social Support:** A large number of research indicates that people who receive maximum social support, experience less stress and have better health than those who are isolated socially (Cohen et al., 2000; Czajkowski, & Shumaker 1994; Ulrich, 2000; 1999; 1991). Social support can therefore be regarded as the emotional help and care rendered to a person or that which is received from others as shown in figure 2.8.





Figure 2.8. Social Support in Sapphire Elderly Care Residences.  
(Source: <http://tiny.cc/u2nq8y>)

Possible examples of approaches, adopting social support for patients include, the provision of the following for the family and visitors: pleasant and comfortable waiting areas, socially enhancing sitting areas, access to views of nature, effective work environment that enhances staff access and social support to patients' (Chalfont, 2006; Purves, 2002; Marcus & Barnes 1991) (See figure 2.9).



Figure 2.9. Socially Enhancing Sitting Areas and Access to Views of Nature in Sapphire Elderly Care Residences (Source: <http://tiny.cc/u2nq8y>).

**Sense of Control and Access to Privacy:** Carver et al., (2000), defines control as someone's real or perceived ability to know what they do, to control their situation, and determine the impact of other people's actions and perception towards them. Several research has shown that the results in the stress coping abilities of people who feel they have some control over their situation is far greater than that of those who feel a lack of control (Schwarzer, 2014; Ulrich, 1999; Lazarus, & Folkman, 1984). In order to reduce lack of control in healthcare facilities, which results in medical and psychological conditions such as depression, high blood pressure and reduced immune system functioning, the need to implement this key supportive design strategy to create a more controlled environment.

It should be noted that an addition factor indicated by various studies, for the loss of control, is caused by architectural designs that do not enhance or provide access to privacy. For example, design of rooms that deprive a view out of the window, force bedridden patients to stare at a glaring ceiling light, or rooms that are difficult to locate

without the guide of proper signage for directions (Shraiky, 2011; Schwartz, & Solove, 2011; Winkel & Holman, 1986). As such, the consideration of incorporating architectural designs that facilitate wayfinding and access to privacy, for patients and staff include; providing bedside dimmers for private control, access to television control by individual patients, easy access to nurses work station from wards through mobile services, providing adjustable workstations for staff and comfortable relaxation areas during their break periods that provides a temporal sense of escape from the stress of work place (Ulrich, 2000; O'Neill, 2010) (See figure 2.10).



Figure 2.10. Easy Access to Nurses and Temporal Sense of Escape from the Stress of Work Place. (Source: <http://tiny.cc/tkmq8y>; <http://tiny.cc/5imq8y>)

**Access to Nature and other Positive Distraction:** Positive distractions are a sub sections of environmental-social phenomena that are well-known by their ability to promote wellness and reduce stress levels adequately and on time. They include distractions such as music, art, comedy, pet animals, and nature views within and outside buildings. Ulrich (1999) study reveals that people suffering from anxiety or stress related illness are positively affected by certain nature scenes and recover faster. However, a limited number of research in healthcare suggests that stressed patients can experience substantial reduction in stress levels after a few minutes of viewing nature settings with greenery, flowers or aquatic bodies as shown in figure 2.11.





Figure 2.11. Healing Gardens: Dell Medical Center. (Source: <http://tiny.cc/7hlq8y>)

Nevertheless studies related to the use of nature as a positive distraction, though small, have shown substantial results enough to validate its propositions with outcomes, one of the most important, being the recovery rate of patient from post operations. This is evident in the study of patients recovering from abdominal surgery, which established that patients had better postoperative health status if their bedside windows afforded them a view trees or greenery instead of a mure wall (Ulrich, 1991; Ulrich, 1984; Kaplan, & Kaplan, 1989). It is worth noting that a controversial type of positive distraction in healthcare settings is the use of abstract art. Although designers, artists and most healthcare staff react positively to abstract images, or artworks that tend to challenge one mentally, a number of evidences in research affirm the possibility of such artworks to have negative impact on patient outcomes (Ulrich, 1991, 1992, 1999), therefore, healthcare managements should carefully select artworks displayed with the intention of a positive impact, to avoid an opposite negative outcome. The

Psychosocially Supportive Design approach is offered as a useful theory and framework to guide healthcare designers and planners who consider how the physical environment impacts wellness factors in order to promote health. It has also been shown to benefit both patients, staff and visitors in healthcare settings (Uwajeh & Ezennia, 2019).

## **2.4 Describing the Therapeutic Environment**

Healthcare environments are often perceived as stressful places for patients, their relatives and staff; however, they can be therapeutic if they are designed to foster positive physiological, psychological, social and behavioral outcomes (Uwajeh, et al., 2019; Iyendo, et al., 2016; Van der Linden et al., 2016). (See Figure 2.12). This idea is supported by previous studies that documented the need to design of healing environments that improve user experience (Ghazali & Abbas, 2017; Iyendo, 2017; Altimier, 2004), especially through interventions including art therapy (Kometiani, 2017; Uwajeh & Iyendo, 2016), music therapy (Hansen, 2017; Goldstein, 2016), music medicine (Iyendo, 2016), and horticultural therapy (Detweiler et al., 2012). While the benefits of healing environments have been discussed, there is a need to explore the specific aspects of these environments in greater depth.

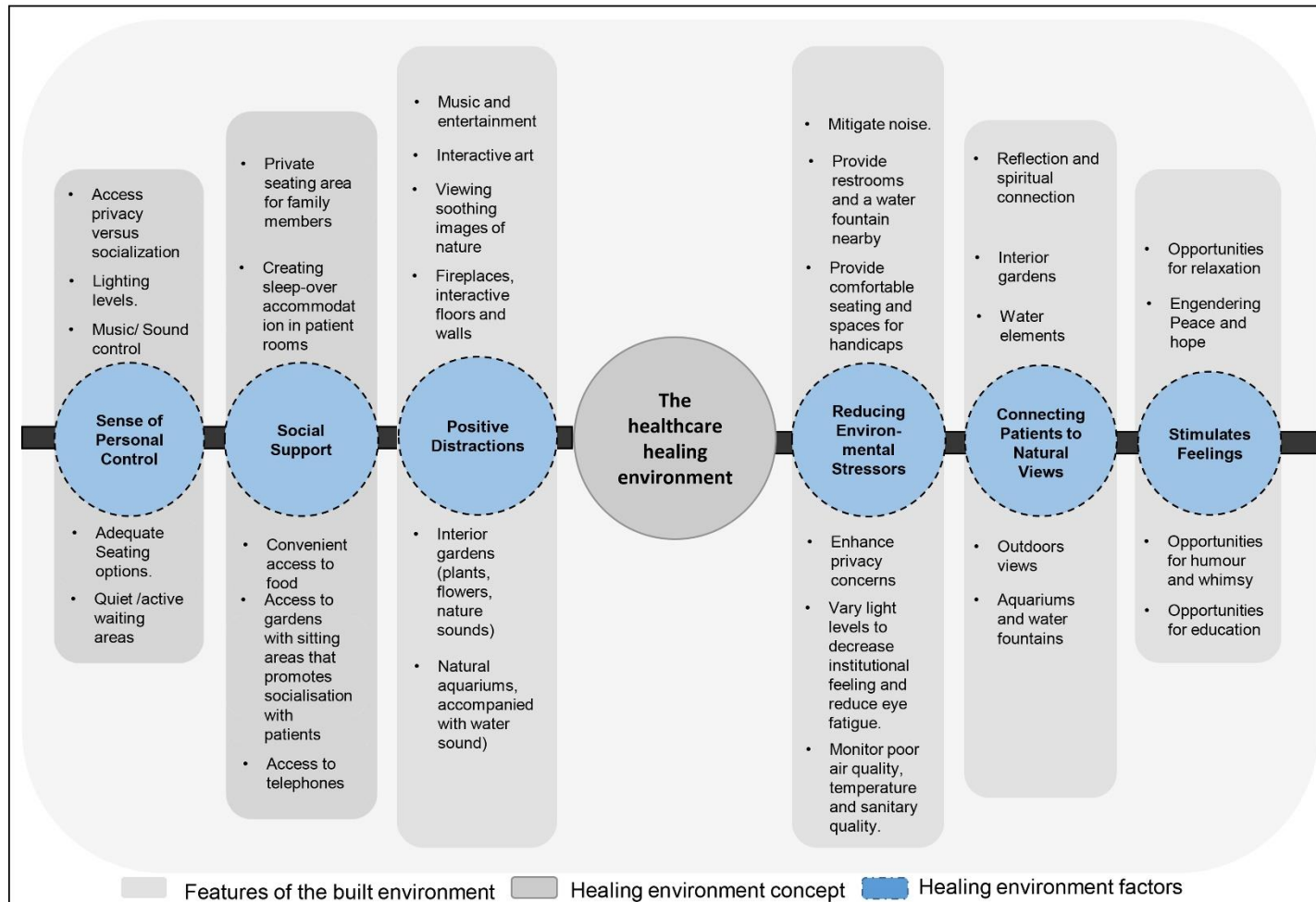


Figure 2.12. A Model for Understanding the Therapeutic Environment (Adapted from Uwajeh, et al., 2019; Iyendo, et al., 2016; Van der Linden et al., 2016).

## **2.5 Summary of Chapter**

This chapter describes the selected theories used to underpin this current study. The theories include EBD, the biophilia theory and the supportive design theory. The justification for selecting these three theories is foregrounded on the premise that fact that they are all geared towards transforming the built environment through environmental design factors, they all attempt to improve wellness for users in healthcare environment, they all incorporate environmental, social, technological and psychological factors to improve the quality of healthcare facility designs. Lastly, they all employ the construct of connecting healthcare with nature to provide positive distraction for patients. Understanding the relationship between these three theories and how they contribute to the improvement of wellness and the architectural design quality of care facilities for AD and dementia patients, provided a theoretical standpoint to critically investigate how well these theories have aided research and design on the topic under investigation in chapter 3. A schematic diagram highlighting these theoretical correlation was used to clarify the authors' justification as shown in figure 2 above.

## **Chapter 3**

### **CRITICAL REVIEW OF LITERATURE**

#### **3.1 Therapeutic Garden as Nature-based Interventions in Healthcare settings**

##### **3.1.1 Describing landscape**

Landscape has been holistically defined in human geography as a term, which seeks to unite the material and visible environment as well as the immaterial and invisible mental structures of the environment (Lindström, 2010). However, studies have focused on the visual aspects of landscape, and have described it as a cultural image, a visual representation, structuring or symbolizing of our environments (Daniels & Cosgrove, 2007). Photographs has been traditionally used as a surrogate of the real landscape in landscape perception research (Daniel, 2001; Lange, 2001). The subjective experience of the landscape aesthetic values in city parks has also been used to evaluate landscape perception (Liu et al., 2013). Other approaches to understanding landscape perception have included the effects of soundscape perception on landscape, focusing on spatial patterns and features that link the concept of landscape and soundscape (Hong & Jeon, 2015; Hong & Jeon, 2014; Liu et al., 2014). Concretizing this view, Liu et al. (2013) suggests that natural elements including trees, bushes, grasses, flowers and water, present in visual landscape, introduces natural sounds that are congruent to landscapes (see figure 3.1). However, contrary to a common misconception, landscape is not limited to the visual aspects of the surrounding environment, neither can it be equated to physical environment or nature alone



(Lindström, 2010). Therefore, viewing landscape involves a rhythmic movement of the eyes, which is also a code to reconstitute oneself, such that, a person who beholds a landscape does not leave it as the same person.



Figure 3.1. Landscape in Perception in Healthcare Environments (Source: Front Yard Landscape Fence, 2019).

Additionally, the significant effects of vegetation in landscape differs based on both the location and the vegetation density factors when compared with other vegetation densities. For example, studies have shown that, an increase in vegetation density from 1.7% to 24%, consequently causes an increases in stress recovery. However, with a continuous increase in vegetation density beyond 24%, the effect on stress stops (Jiang et al., 2014). Similarly, a study on three locations and three density conditions: forest interior, forest edge, forest exterior, high density, medium density, and low density by Chiang et al. (2017) revealed that high-density vegetation best restored attention and evoked the most positive mood in individuals, when compared to medium-density vegetation, but the participants preferred medium-density vegetation the most (See figure 3.2). These findings are consistent with the recent studies of Jiang et al., (2016) which demonstrated that a medium-high level of vegetation is associated with optimal results. Thus, considering the health implications of location and vegetation density,

designer can make efficient decisions to enhance the ecological and human health of spaces.



Figure 3.2. Samples of Location (Left) and Vegetation Density (Right)  
(Source: Chiang et al., 2017)

In recent times, studies have reveal a links between landscape and soundscape in terms of health and wellbeing are increasingly recognized as important in research (Cerwén

et al., 2016) and at the policy level (Adams et al., 2006). Landscapes influence health and well-being, through our experiences and physical activities (Menatti & Casado da Rocha, 2016; Hartig et al., 2014; Abraham et al., 2010; Velarde et al., 2007), and are also valued as objects of aesthetic beauty in the physical environment (Tieskens et al., 2018; Benovsky, 2016). Conversely, soundscape refers to the totality of the sounds emanating from a specific landscape with an emphasis on the relationship between an individual or society's interaction, perception, and understanding of the sonic environment (Schafer, 1994; Truax, 1999). This suggests that soundscapes are perpetual and dynamic attribute of a landscape (Slabbekoorn & Ripmeester, 2008), as soundscapes are a direct connection between natural systems and humans (Gobster et al., 2007). Indeed, sounds of vocalizing and stridulating animals and the non-biological sounds of running water and rustling wind all emanate from the natural landscapes (Pijanowski et al., 2011). There are growing evidences to show that certain natural sounds such as bird song has been found to have a positive effect on recuperation from stress (Iyendo, 2017; Aghaie et al., 2014; Annerstedt et al., 2013; Saadatmand et al., 2013).

### **3.1.2 Landscape Perception, Health and Well-Being**

The benefits of landscapes to nature and well-being can be traced far back to two centuries ago. However, the benefits of landscape perception and assessment research in the 1960s were considered too subjective to measure (Jorgensen & Gobster, 2010). This has stimulated several curiosities about the specific correlations between landscape environment, green outdoor spaces and health, as they relate to the dimensions of physical, mental, and social well-being and their perspectives on health promotion. For instance, studies suggest that child spaces should be considered as part of a viable strategy for health promotion by designing outdoor environments with

natural landscape characteristics that promote physical activity and health (Özdemir, 2013). Landscapes have been shown to promote physical well-being through physical activities and leisure time in green environments; mental well-being through the evocation of positive distraction, positive emotions and stress reduction; social well-being through social integration, engagement and participation, as well as through social support and security (Abraham et al., 2010).

Özdemir & Yilmaz (2008), posits that landscape features including large trees provide shadows and comfortable seating elements will provide more use of outdoors which defines the natural habitat in cities. There is evidence to show that the spatial factor and component that make up green areas in cities are significant, and has been demonstrated in terms of visual quality assessment (Sakici, 2015; Liu et al., 2013; Lindström, 2010). Sakici (2015), further emphasized that utilizing the visual, auditory and therapeutic effects of waterscapes in urban open green areas, contributes functionally as much as aesthetically to the space. For example, urban green and blue areas offer spaces for social interactions and physical activity which improves stress recovery (Tyrväinen et al., 2014), social cohesion and promotes general well-being (Van den Bosch, 2017). Freshwater blue spaces have been shown to have both social and psychological benefits on health (De Bell et al., 2017; Finlay et al., 2015). A study revealed that residing in greener environments was associated with sustained mental health improvement (Alcock et al., 2014). Indeed, there is recent evidence to show the positive impacts of human contact with green urban areas on mental health and well-being (Van den Bosch, 2017; Dadvand et al., 2016; Ward et al., 2016; Gidlow et al., 2016).



The positive health outcomes of the relationship between humans and nature have been documented in the early studies of (Ulrich, 1999; Marcus & Barnes, 1999; Kaplan, 1995; Ulrich, 1984), to include a substantial improvement in stress recovery and mental health outcomes. Similarly, as shown in figure 3.3, living near green spaces or viewing nature through a window can promote positive health benefits (Keniger et al., 2013). This is congruent with studies which suggest that patients experience less pain when exposed to a view of nature from their hospital rooms (Williams & Gardiner, 2015; Malenbaum et al., 2008).



Figure 3.3. Therapeutic Effect of Viewing Nature through a Window  
(Source: <http://tiny.cc/2yiq8y>)

Other green options to foster well-being have included the practice of vertical gardens also known as bio walls or green wall technologies in the built environment. These systems integrate the traditional plants and substrates process with new technologies to improve their performance and expected health benefits (Pérez-Urrestarazu et al., 2015). Butkovich et al. (2008) concurs, with this view, as they suggest that vertical

gardens may have certain health impact on people who spent time around them. For example, Bringslimark et al. (2009), revealed distinct positive health outcomes including 20% reduction in headaches. As shown in the interior spaces A and B in figure 3.4, investigators have also suggested that vertical gardens can stabilize humidity levels, reduce indoor levels of volatile organic compounds (VOCs) such as benzene, toluene and other toxic fumes (Darlington et al., 2001), noise (Huang, 2011), as well as sick building syndromes (Başdoğan & Çığ, 2016). From an ecological and sustainability stand point, phytoremediation, a process of eradicating indoor environmental airborne toxicants with the aid of plants have shown to improve wellbeing. For example, research has shown that indoor plant placement decreased the concentrations of volatile organic compounds (VOCs) and improved the health condition of asthmatics (Kim et al., 2014). A study conducted by Wolverton on 50 most effective houseplants for indoor air purification, considering four (4) criteria including removal of chemical vapors; ease of growth and maintenance; resistance to insect infestation; and transpiration rates found that houseplants are most effective in removing VOCs in energy-efficient non-ventilated buildings (Wolverton, 1997). Similarly, 86 species of house plants from five general classes for their ability to remove formaldehyde were tested by Kim et al. (2010) and the result showed that ferns had the highest formaldehyde removal efficiency of all the plants tested especially *Osmunda japonica*, commonly known as Japanese royal ferns, or *zenmai*. However, Pegas et al. (2012) remarked that the rate at which plants absorb air pollutants depends on their growing conditions as well as the plant species.



Figure 3.4. Therapeutic Effect of Indoor Vertical Gardens or Green Walls  
(Source: <http://tiny.cc/x0gq8y>)

Studies on psychological perspective of place, reveals the potential benefits of using nature as a venue to facilitate self-regulation of physiological, psychological and social needs (Adevi & Mårtensson, 2013). For instances, indoor spaces without windows that allow a view to nature and landscape sceneries can be virtually or artificially simulated to foster a natural ambience as seen in the interior spaces A and B in figure 3.5.

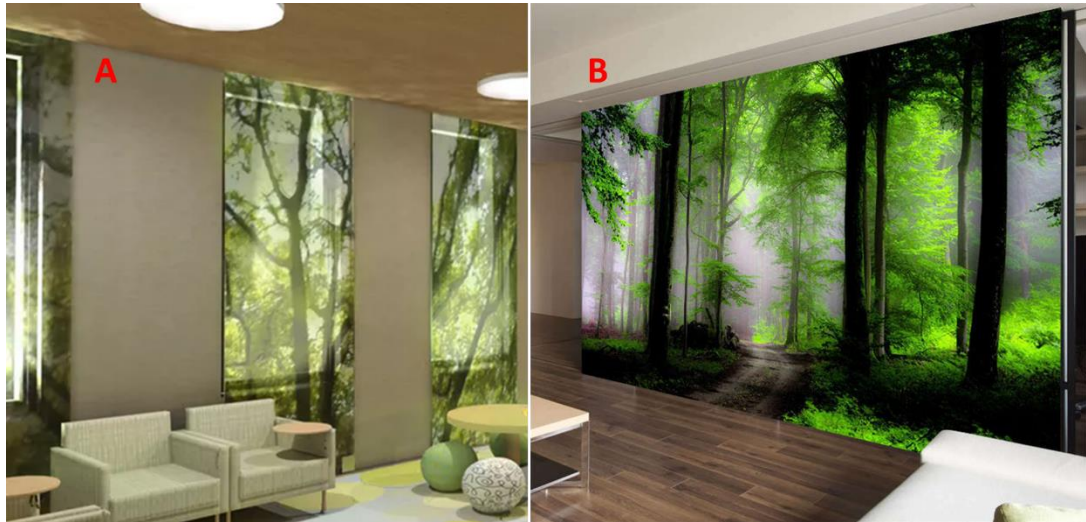


Figure 3.5. Virtual or Simulated Walls.  
(Source: <https://urlzs.com/7gKPJ>; <https://urlzs.com/EhwMJ>)

Similarly, studies have documented claims that indoor plants may offer psychological benefits on individuals through passive interactions with indoor plants (Haluza et al., 2014; Bringslimark et al., 2009; Chang & Chen, 2005). However, it is not often considered challenging to introduce indoor potted plants, mostly in AD and dementia care facilities due to the challenges of memory loss and other cognitive impairments associated with the disease, because residents may ingest plants that could be harmful to their health (Rappe & Linden, 2002).

### **3.2 Brief History of HG and TG**

HG and TG have had similar historical tradition in healthcare over time. This can be traced far back to the Asclepieia of ancient Greece regarded as first healthcare facilities of Europe, the healing powers of pharmacopeia plants found in ancient China and the Ayurvedic traditions of India (Gesler, 1992; Van den Berg, 2005) (See figure 3.6).





Figure 3.6. Asclepieia the Ancient City of Greece.  
(Source: <https://urlzs.com/LW7um>)

During the middle Ages religious institutions were in charge of the medical care and the caregivers were nuns and monks. Two important features including “monastic infirmaries” and the “doctrine of signatures” facilitated the promotion of HG and therapeutic landscapes (Potterton, 1983). The design of the monastic infirmaries laid emphasis on patient rooms facing the south, adjacent to a central courtyard or garden, monastic life activities in gardens and growing of medicinal plants. While the “doctrine of signatures” was based on the belief that objects in nature which looked similar to human organs were thought to be divinely given, thus have the potential to cure ailments (Gesler, 1992, Potterton, 1983). Around the 17th and 18th century, the monastic tradition hospitals gave rise to the pavilion style in France and included design features similar to monastic infirmaries, adapting the use of natural environmental features including sunlight, fresh air and peaceful green surroundings as a therapeutic mechanism for patient healing (Cooper-Marcus & Barnes, 1999). After the first and second World Wars, the 20th century experienced a substantial use of gardens in hospitals designed for rehabilitation and therapeutic purpose for the combatants and survivors who returned from the wars with physical disabilities (Simon & Straus, 2003). Till date, HG and TG designers and researchers base their conceptual framework on the work of (Ulrich, 1999; 1984).

### 3.2.1 Gardens as a Multisensory Design Factor

Frequent encounter and experience with a natural environment evokes all our senses, thereby reducing stress, anxiety and pain (Ulrich, 1999). Subjectively, all gardens can stimulate the senses, however, sensory gardens do this to a greater degree, when compared to others. For instance, Osei (2014) posits that gardens should provide 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 (See figure 3.7). Similarly, the study of Koura et al. (2009) revealed that horticultural activities including herbal soap making, soil sifting were found to stimulate the sense of touch, while herbal tea drinking stimulated the sense of taste.



Figure 3.7. Multi-Sensory Experience through Incorporating Nature  
(Source: <http://tiny.cc/93oq8y>)

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 (Gonzalez & Kirkevold, 2014) (See figure 3.8).



Figure 3.8. Sensory Dementia Garden, Westcliff-on-Sea Essex  
(Source: <https://urlzs.com/kPpsh>)

Exposure to sensory gardens in the clinical environment has been shown to have a positive impact on health outcomes. For instance, in dementia facilities, wonder gardens have been employed to increase sensory stimulation by providing frequent access to nature for high elopement risk residents (Detweiler et al., 2008). An earlier study suggests that in the presence of a visually dominant sensory garden environments, 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 (Rawlings, 1998). This implies that, of all the senses, sight has been regarded as the most dominant (Pallasmaa, 2012). 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 (Williams & Gardiner, 2015). Similarly, studies have demonstrated that listening to soothing nature sounds such as birdsong can reduce patient anxiety and agitation (Ghezeljeh et al., 2017; Rejeh et al., 2016). 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 treatment rooms (Hill et al., 2013; Dijkstra et al., 2008; Dijkstra et al., 2006) (See figure 3.9).



Figure 3.9. Nature-Based Interior Environment that Provide Calming effect and Positive Distraction for patients. (Source: <http://tiny.cc/gjxq8y>; <http://tiny.cc/hfxq8y>)

Against these backdrop, the healthcare environment 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 (Scott et al., 2014; Stigsdotter et al., 2011).

### **3.2.2 The Distinction between HG and TG**

The phrase HG or therapeutic gardens have often been used interchangeably. Nonetheless, few studies have documented clarification regarding the use of these terms (Marcus & Barnes, 1999). A HG has been described as a space designed with the intention of providing certain therapeutic benefits for most of its users (Ulrich,

1999). The distinction between HG and TG is that, the design of a HG is aimed at achieving a general set of goals, while the design of a TG is chiefly dictated by the demands of one or more specific patient group (Bergeman, 2012). However, horticultural therapists often refer to HG or TG as environments that offer places for gardening activities and encourage physical movements (Jiang, 2014).

### **3.2.3 Therapeutic Gardens in Healthcare**

Several studies in western countries, have documented the impacts of therapeutic gardens, revealing the healing attributes of natural views and landscape sceneries from different perspectives. These including horticultural therapy (Detweiler et al., 2012; Söderback et al., 2004), medical geography (Gesler, 2003), ecological psychology (Cosco et al., 2010), Socio-cultural and ecological perspectives (Uwajeh & Ezennia, 2018) as well as environmental psychology (Ulrich, 1999; Kaplan, 1992; Kaplan & Kaplan, 1989; Ulrich, 1984). Regardless of these prominent theories surrounding the therapeutic use of gardens, very limited research have developed a comprehensive model for understanding the use of Therapeutic Gardens as evidence-based design factors for improving wellness and the architectural design quality of healthcare facilities.

The study of the relationship between health, healing and place has manifested itself in the topic of “therapeutic landscape”, which is a fairly new research area (Kearns & Moon, 2002). Gesler (1996) was the first to describe therapeutic landscape as a place of healing that includes natural and man-made environments, historical events, cultural beliefs, social relations and personal experiences. However, this definition is such that accommodates different geographic environments. The common connection is the fact that they are specific places that lay emphasis on healing, as opposed to simply relaxation, recreation and restoration. Other activities that take place in the therapeutic

garden can range from sitting outside, to dozing, napping, or being engaged in meditation, prayer, exercise, walking to a preferred spot, eating, reading, working outside, viewing children playing in the garden, self-involvement in raised bed gardening, and light sports activities (Verderber, 2010; Hartig & Cooper-Marcus, 2006). Previous research has designated that garden-users reported significant positive mood change resulting from garden use, and that time spent in observing nature establishes a restorative experience (Whitehouse et al., 2001). Research evaluations indicates that incorporating gardens in the healthcare settings can improve quality of life for patients, and afford an opportunity for them to exercise without becoming agitated, and lighten the burden of care for nurses (Hartig & Cooper-Marcus, 2006).

#### **3.2.4 Nature Views and Access to Gardens in Healthcare**

Evidence exists that living near green spaces or viewing nature through a window can promote positive health benefits (Keniger et al., 2013), reduce health care costs (Hansen-Ketchum et al., 2009) and help in recovering from mental stress (Kaplan, 1995). Thus, healthcare designers should lay emphasis on the relationship between the building and the landscape to integrate the interior and exterior environments (Verderber & Fine, 2000) (See figure 3.10).

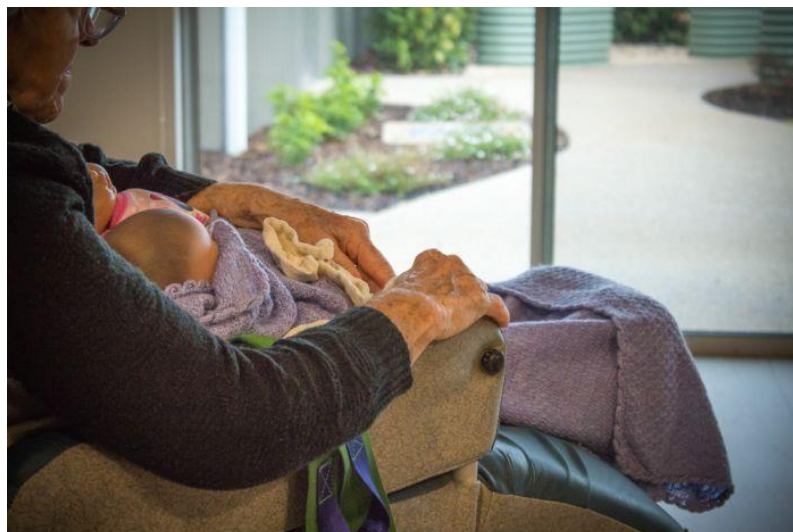


Figure 3.10. Access to Viewing Nature View through a Window  
(Source: <http://tiny.cc/6wgr8y>)

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 (Jiang, 2015; Reeve et al., 2017) (See figure 3.11).



Figure 3.11. Spatial Continuity of Indoor and Outdoor Healthcare Spaces  
(Source: <http://tiny.cc/ygfr8y>)

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 (Gillis & Gatersleben, 2015), as well as improve physical and mental health (Iyendo et al., 2016). Therapeutic landscapes and HG with a variety of features have

the tendency to stimulate restoration and other positive influences on healthcare occupants (Marcus & Barnes, 1995; 1999). Research evidence found that garden users reported positive mood change and experience from time spent in observing nature (Williams & Gardiner, 2015).

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 (Van der Riet et al., 2017). A research conducted on access to gardens and activities, revealed perceived restoration and increased consumer satisfaction (Whitehouse et al., 2001). 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 (Van der Riet et al., 2017; Pasha & Shepley, 2013). Similarly, Davis (2011) 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. These evidences from literature suggested that patients may experience substantial positive responses to specifically designed environments in the health care facilities using design interventions such as gardens (see table 3.1).



Table 3.1. Highlights the Impact of Natural Views, Access to Healing and TG in Healthcare Settings

Selected reference(s)/medical specialty	Study Design	Participant size	Design Intervention type	Results/Reports on health outcome(s)
(Memari et al., 2017); Restorative natural environments in care settings.	Photo-questionnaire.	<ul style="list-style-type: none"> <li>• A total number of 124 participants were involved in the analyses.</li> <li>• The participants comprised 43 males and 81 females.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Therapeutic natural environment.</li> </ul>	<ul style="list-style-type: none"> <li>• This study determined that perceived sensory dimensions (PSDs) affect restoration in natural care settings.</li> <li>• The PSDs influencing restoration are described as; Serene, Nature, Refuge (positively) and Rich in species and Social (negatively).</li> <li>• The combination of Serene, Nature and Refuge with the absence of Rich in species and Social, were recognized as qualities of restorative environments.</li> </ul>
(Reeve et al., 2017); LCCH Children’s Hospital	The use of comments left in visitors’ books	<ul style="list-style-type: none"> <li>• The number of participants included was N/A in the study.</li> </ul>	<ul style="list-style-type: none"> <li>▪ HG.</li> <li>• Bench Diaries were left in four types of the garden:               <ol style="list-style-type: none"> <li>1. <i>Secret garden [SG].</i></li> <li>2. <i>Adventure garden [AG].</i></li> <li>3. <i>Staff garden [StG].</i></li> <li>4. <i>Babies garden [BG].</i></li> </ol> </li> </ul>	<ul style="list-style-type: none"> <li>• 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 HG in a dense urban environment.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> </ul>
(Van der Riet et al., 2017; Riet et al., 2014): Pediatric ward.	Narrative inquiry (NI) design.	<ul style="list-style-type: none"> <li>• A total of 16 participants were interviewed involving 4 focus group interviews</li> </ul>	<ul style="list-style-type: none"> <li>▪ Access to a garden environment. <i>“Fairy Garden” (FG).</i></li> <li>• Semi-structured interviews centered upon</li> </ul>	<ul style="list-style-type: none"> <li>• The study revealed that the Fairy Garden (FG) was a non-clinical environment for play and relaxation.</li> <li>• Family members reported enhanced physical and social engagement on the children.</li> </ul>

Selected reference(s)/medical specialty	Study Design	Participant size	Design Intervention type	Results/Reports on health outcome(s)
		<p>with family members.</p> <ul style="list-style-type: none"> <li>• Mothers (N=4), Fathers (N=3) and grandparent (N=1) who spent, or had spent, considerable time at the bedside of the children.</li> <li>• Head nurses (N=2)</li> <li>• Ward nurses (N=3)</li> <li>• Administrative nurse (N=3).</li> </ul>	<p>the things users liked about the FG, such as:</p> <ul style="list-style-type: none"> <li>• What benefits were observed for the children who used the garden?</li> <li>• Positive attributes noticed or experienced in the fairy garden.</li> <li>• Negative attributes noticed or experienced in the fairy garden.</li> <li>• Had the FG changed the behaviors of the children?</li> <li>• How was the garden used and who used it?</li> <li>• What were the things they did not like about the fairy garden?</li> <li>• Difficulties or barriers encountered in the garden</li> <li>• In their opinion, what was missing from the garden?</li> </ul>	<ul style="list-style-type: none"> <li>• The Fairy garden promoted interaction amongst the children, parents and caregivers.</li> <li>• 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.</li> <li>• 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.</li> <li>• Both studies also deduced that he 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.</li> <li>• 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.</li> </ul>
<p>(Pasha &amp; Shepley, 2013): Pediatric Hospital.</p>	<p>Exploratory data analysis</p>	<ul style="list-style-type: none"> <li>• A total of 184 participants was involved in the survey.</li> <li>• 82 staff, 53 children and 49 adult family members.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Physical activity in gardens</li> </ul>	<ul style="list-style-type: none"> <li>• The study reports that the quality of design can influence levels of physical activity in pediatric hospital gardens.</li> <li>• The behavioral culture of most gardens is related to their design characteristics.</li> <li>• Results demonstrated that gardens with higher substantial planting, properly designed layout and pathways and amenities for children generally had more active behavior cultures.</li> <li>• It emphasizes that less physical activity does not necessarily translate into less therapeutic benefits, as the passive use of HG such as; introducing sounds and</li> </ul>

Selected reference(s)/medical specialty	Study Design	Participant size	Design Intervention type	Results/Reports on health outcome(s)
(Davis, 2011): Surgery center	Post-Occupancy Evaluation (POE)	<ul style="list-style-type: none"> <li>• A total of 20 participants were involved in the survey.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Access to a garden environment.</li> </ul>	<p>views into the interior spaces, can also have valuable therapeutic benefits for hospital visitors, patients and staff.</p> <ul style="list-style-type: none"> <li>• 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 design.</li> <li>• The evaluation suggested the need for multiple perspectives to be considered in facility and garden master planning.</li> <li>• The study recommends that horticultural therapists be consulted in garden management to preserve and enhance garden functionality.</li> </ul>
(Detweiler et al., 2009): dementia unit.	Observational study	<ul style="list-style-type: none"> <li>• (N = 28) participated out of the original 34.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Wander Garden</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• Dementia residents reported a decrease in agitation with access to a wander garden.</li> <li>• Wander garden can be used to improve the quality of life for residents with dementia by using appropriate designs based on existing guidelines.</li> </ul>
(Naderi & Shin, 2008); Health Care Center	<p>Traditional landscape architecture data-base design method.</p> <ul style="list-style-type: none"> <li>▪ <i>This can be synonymous to Evidence-Based Landscape Architecture (EBLA).</i></li> </ul>	<ul style="list-style-type: none"> <li>• A total of 61 participants was involved.</li> </ul>	<ul style="list-style-type: none"> <li>▪ HG</li> </ul>	<ul style="list-style-type: none"> <li>• The study reports that nursing staffs preferred significant contact with nature and privacy.</li> <li>• 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.</li> </ul>

<b>Selected reference(s)/medical specialty</b>	<b>Study Design</b>	<b>Participant size</b>	<b>Design Intervention type</b>	<b>Results/Reports on health outcome(s)</b>
(Hernandez, 2007); Dementia Special Care Units.	Multi-method qualitative research and Post-Occupancy Evaluation (POE).	<ul style="list-style-type: none"> <li>• A total of 45 participants was involved.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Therapeutic Garden</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• Staff and family members reported that the garden spaces provide three main types of relief activities:</li> <li>• Low-level activity (Sitting Indoors and Looking Out to the Garden).</li> <li>• Mid-level activity for Redirection and Relief from Stress and Agitation (Sitting Outdoors and places to smoke).</li> <li>• High-level activity (Picking Flowers, Planting and Physically Gardening).</li> <li>• 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 with dementia to their past, to provide the therapeutic goal of retaining old memories and familial ties.</li> </ul>
(Ottooson & Grahn, 2005): Geriatric Home.	An intervention study	<ul style="list-style-type: none"> <li>• A total of 15 participants were involved.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Exposure to gardens.</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• The intervention deduced that exposure to gardens nor resting in a room, had no effects on blood pressure or heart rate.</li> <li>• Both the outdoor environment and the indoor environment at the home were highly valued by participants.</li> </ul>
(Sherman et al., 2005); Pediatric cancer centers.	Behavioral observations and Post-Occupancy Evaluation (POE).	<ul style="list-style-type: none"> <li>• A total number of 1400 people were observed.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Exposure to HG.</li> <li>• A group of three HG called Carley’s Magical Gardens:</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> </ul>

Selected reference(s)/medical specialty	Study Design	Participant size	Design Intervention type	Results/Reports on health outcome(s)
			<ol style="list-style-type: none"> <li>1. <i>Garden of Dreams.</i></li> <li>2. <i>Friendship Garden.</i></li> <li>3. <i>Buggy Garden.</i></li> </ol>	<ul style="list-style-type: none"> <li>• Design features like structural elements will encourage children to engage in interactive activities in the garden.</li> <li>• 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.</li> <li>• Private relaxation and restoration spaces, separate from patients and visitor spaces should be designed for of staff use on their break.</li> <li>• 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.</li> <li>• The study suggests that the use of plant screens may maximize both privacy and window views for patients.</li> </ul>
(Whitehouse et al., 2001): Children's Hospital Garden	Post-Occupancy Evaluation (POE)	<ul style="list-style-type: none"> <li>• A total of 105 participants were involved.</li> <li>• Adults (N=83)</li> <li>• Children and adolescent (N=22)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Garden use and activity.</li> </ul>	<ul style="list-style-type: none"> <li>• The findings of the study suggested that chronically ill and handicapped children may have very different requirements for a hospital garden environment.</li> <li>• It documented that very few severely or chronically ill children were found using the garden.</li> <li>• 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.</li> <li>• The study reports that there is evidence that gardens can increase consumer and staff satisfaction within the hospital.</li> <li>• 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.</li> </ul>

### **3.3 Nature-Based Interventions for Optimizing the Healing Environment of Patients with Alzheimer's disease and Other Dementias**

#### **3.3.1 The Pathology of AD and Dementia**

AD is the most common cause of dementia and a leading cause of mortality in the aging population (Staekenborg et al., 2016). It is a neurodegenerative disease with a clinical characteristic of progressive memory loss, pathologically by two major features for the diagnosis, namely; extracellular aggregation of amyloid-beta ( $A\beta$ ) peptides forming senile plaques (SP) and the deposits of intracellular neurofibrillary tangles (NFT) of hyperphosphorylated tau in the brain (Liu et al., 2017; Singh et al., 2016; Dong et al., 2012). It is often difficult to categorize AD patients in specific stages due to overlapping of symptoms. However, AD gradually progresses in three general stages including mild (early stage), moderate (middle stage), and severe (late stage). The timing and severity of dementia symptoms varies according to individuals in different ways through the stages of Alzheimer's (Alzheimer's Association, 2019).

#### **3.3.2 The Brain, Stress Physiology and Nature Interaction**

The behavioral and physiological responses to stressful experiences are executed by the brain, which interprets it either as acute or chronic through autonomic, and neuroendocrine responses in the hypothalamus, as well as cognitive areas responsible for memory, anxiety, and decision-making (McEwen, 2007). Stress has been associated with the biological reactions of corticosterone, a hormone with multiple effects on memory, including emotional long-term memory, fear, memory, and cognitive abilities (Albrecht et al., 2013). Corticosterone is released in a diurnal rhythm after an experience of stress, and appears to have a wide range of effects on

the hippocampus, a brain area that plays a central role in memory formation (Kalsbeek et al., 2012; Schaaf et al., 2000).

It has been well established that inadequate control of stress responses can present a severe threat on health and well-being especially for the elderly. This supports the assertion that the loss of hippocampal cells is associated with normative aging in most cases (Detweiler et al., 2012). Physiologic and psychological dysfunctions associated with excessive secretion of glucocorticoids has been implicated in the pathogenesis of systemic disease (Herman & Cullinan, 1997) including depression, post-traumatic stress disorder (Charney et al., 1993), and neurodegenerative disease such as AD (Landfield et al., 2007). A hallmark of the pathology of stress response is the activation of the hypothalamo pituitary adrenocortical (HPA) axis, which mobilizes energy required by organism to respond to psychological stressors (Herman et al., 2016). For instance, McEwen (2007) posits that stress induced alterations in neuroendocrine control may be associated with limbic dysfunction, involving the hippocampal formation regions, medial prefrontal cortex or the amygdaloid body.

Given that, stress responses can present a deleterious effect on a variety of physiologic functions, including behavior and brain function. Access to natural environments has been linked with mental restoration in children (Mygind et al., 2018; Huynh et al., 2013; Faber Taylor & Kuo, 2009; Mårtensson et al., 2009), and among older adults (Pun et al., 2018; Wu et al., 2015; Ottosson & Grahn, 2008). It has been reported that HT may be effective in accelerating an improvement of activities in the brain region (Kamioka et al., 2014). Yasukawa (2009) suggested that HT using a periodic and effective method might improve cognitive and psychosocial functioning, especially of elderly people with dementia. Mizuno-Matsumoto et al. (2008) studied the

effectiveness of HT on the improvement of functional activities in the brains of brain-damaged patients. They found that HT can accelerate an improvement of activities in the visual and color processing areas and the association areas as well as the sensory-motor areas of the brain in the patients with cerebrovascular diseases. A study by Söderback et al. (2004) investigated the rehabilitative value of HT in participants with brain damage and found that HT improved emotion, cognitive or sensory motor functional improvement, alleviated stress, increased well-being, promoted participation in social life and re-employment in individuals with mental and physical illness. Verra et al. (2012) highlighted that the addition of HT to a pain management program improved participants' physical and mental health and their coping ability with respect to chronic musculoskeletal pain.

### **3.3.4 Therapeutic Dimensions of Nature Views and Access to Gardens in AD and Dementia Care**

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 (Detweiler et al., 2012). Studies have shown that therapeutic gardens can assist dementia patients to reduce behavior problems caused by fear and anxiety during post-stroke rehabilitation procedures (Detweiler et al., 2008; Detweiler & Warf, 2005). A post-occupancy evaluation found there is a need for incorporating therapeutic gardens as a complementary element for dementia patients in assisted living facilities (Hernandez, 2007).

Visitors and family members have often referred to the beauty of gardens in healthcare settings as a peaceful place that provides a sense of time out (Reeve et al., 2017). This suggests that the combination of serene and refuge offers a solitary experience that



promotes a restorative healthcare environment (Memari et al., 2017; Sherman et al., 2005) as well as symbolic creek and sacred springs (Naderi & Shin, 2008). 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) (Hernandez, 2007). Indeed, therapeutic gardens that allow relaxation, stimulate activities and memories, provides a normalizing context for interactions within the healthcare ecosystem (Whear et al., 2014).

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 (Gowans et al., 2007; Cohen-Mansfield, 2001). 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 (Detweiler et al., 2008). 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 (Detweiler et al., 2009).

### **3.4 The Health Effects of TG and HT on AD and Dementia Patients**

#### **3.4.1 Effects of TG on AD and Dementia Patients**

In the specialized healthcare setting, therapeutic gardens have been found to have a positive impact on AD and dementia patients. This suggests that a therapeutic garden within a healthcare environment can induce a profound effect on agitation and

behavior of AD patients (Sloane et al., 2002). Additionally, it has been reported that older adults with 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 (Cohen-Mansfield, 2001; Ottosson & Grahn, 2005; Cohen-Mansfield et al., 1995). Several studies reveal 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 (Goto et al., 2017; Goto et al., 2014; Goto et al., 2013).

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 HT programs may improve the stress levels and physical functional abilities of elderly patients with mental health problems (Han et al., 2018). Furthermore, the effects of gardens in populations with dementia includes outcomes such as decreased agitation (Detweiler et al., 2012; Cohen-Mansfield, 2001). A similar study based on ambulation criteria in a therapeutic wander garden revealed lower levels of agitation in dementia patients (Murphy et al., 2010; Detweiler et al., 2002). 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 (Edwards et al., 2013). Gardening may be a way of facilitating reminiscence (Wang & MacMillan, 2013) and increasing activity participation for patients with dementia (D'Andrea et al., 2007). Having discussed the effect of therapeutic gardens on AD and dementia, it is likewise reasonable to highlight the health effects of HT, which has been a prominent gardening practice for promoting the wellbeing and health care experience of older adults in the healthcare environment.

### 3.4.2 Effects of Gardening and HT on AD 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 (Detweiler et al., 2008). 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 (Cohen-Mansfield et al., 1995), inappropriate or aggressive behaviors (Cohen-Mansfield, 2001) and increased mental status (Ottoosson & Grahn, 2005). Additionally, gardening activity may likewise promote general health and quality of life, cognitive function (Frith & Loprinzi, 2018; Fu et al., 2018), as well as physical strength and socialization (Wang & MacMillan, 2013; Ashton-Shaeffer & Constant, 2006) (See figure 3.12).



Figure 3.12. Gardening and HT in AD and Dementia Care Facilities  
(Source: <https://urlzs.com/RQRHt>)

Research evidence supports the reduction of stress through active or passive experience with nature through HT, by modulation of the central nervous, endocrine and immune systems (Lehmann et al., 2018). 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 (Joyce & Warren, 2016). For example, HT 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 (Kamioka et al., 2014). As shown in figure 13, 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 (Gonzalez et al., 2010), including actual gardening, imagining and viewing nature, as well as visiting a HG to improve their well-being (Söderback et al., 2004).



Figure 3.13. Passive and Active Physical Activities in Gardens  
(Source: <http://Tiny.Cc/Zykr8y>)

Studies reporting the practice of HT for rehabilitation recommend the incorporation of HT 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 (D’Andrea et al., 2007). In addition, the findings of a recent study on the psychopathological effects of participation in a 10-session HT program revealed a significant improvement in the clinical symptoms of patients with schizophrenia (Oh et al., 2018).

Several studies have reported that HT and active participation in gardening by older adults has health effects on anxiety, depression and improved self-identity in middle-aged women (Kim & Park, 2018; Gonzalez et al., 2010), as well as improved hand and body strength and flexibility (Wang & MacMillan, 2013; Park & Shoemaker, 2009). This is consistent with Brown et al. (2011) who comment that HT 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 3.2).

Table 3.2. Selected Studies that Summarize the Health Effects of Therapeutic Gardens and HT on AD and Dementia Patients

<b>Theme</b>	<b>Selected references</b>	<b>Measured outcome</b>	<b>Result on health outcome(s)</b>
Therapeutic gardens impact on AD and Dementia patients	(Goto et al., 2017; Goto et al., 2014; Goto et al., 2013; Edwards et al., 2013; Wang & MacMillan, 2013; Detweiler et al., 2012; Murphy et al., 2010; Detweiler et al., 2008; D’Andrea et al., 2007; Ottosson & Grahn, 2005; Sloane et al., 2002; Cohen-Mansfield, 2001; Cohen-Mansfield et al., 1995)	<ul style="list-style-type: none"> <li>• Physical, Social, Psychological and Cognitive effects</li> </ul>	<ul style="list-style-type: none"> <li>• Therapeutic gardens reduced agitation, isolation and vulnerability, provided opportunity for walking and socialization, improved depression, aggressive behaviors and self-esteem.</li> <li>• Promoted physical activities, ambulation, positive reminiscences, stabilized sleep-wake cycles and reduced stress.</li> <li>• Reduced heart rate, improved short-term and long-term memories and improved behavioral symptoms.</li> <li>• Overall improvement in quality of life.</li> </ul>
HT impact on AD and dementia patients	(Wang & MacMillan, 2013; Brown et al., 2011; Gonzalez et al., 2010; Park &	<ul style="list-style-type: none"> <li>• Physical, Social, Psychological and Cognitive effects</li> </ul>	<ul style="list-style-type: none"> <li>• HT improved strength and stamina, mobility, flexibility and endurance.</li> <li>• Enhanced coordination and social interaction, improved coping skills and motivation.</li> </ul>

Theme	Selected references	Measured outcome	Result on health outcome(s)
	Shoemaker, 2009; D'Andrea et al., 2007; Ashton-Shaeffer & Constant, 2006; Söderback et al., 2004).		<ul style="list-style-type: none"> <li>• Reduced depression and anxiety, increased confidence and hope, rewards nurturing behavior and stimulates the sense through touching, tasting and smelling of plants.</li> <li>• Improved concentration and focus, problem-solving and planning skills and promotes positive thinking.</li> </ul>

### **3.5 The Failure of Monotherapeutic Treatment Option for AD and Dementia Patients**

This absence of an effective prevention and treatment option by numerous clinical trials on the treatment of AD, thus far, has raised concerns of potential bankruptcy of the Medicare system in the future, with 13 million Americans and 160 million globally projected in 2050 (Bredesen, 2014). 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 (Jia et al., 2014).

### **3.6 Future Directions in the Treatment of AD and Dementia Patients**

It has been emphatically stated that there is no cure for AD (Singh et al., 2016; Kurakin & Bredesen, 2015). However, promising research and development for early detection and treatment is in progress (Garnier-Crussard et al., 2019; Dubois et al., 2016). This has led to a series of progressive studies by Dr. Dale Bredesen and his associates at the University of California, Los Angeles (UCLA), in collaboration with the Buck Institute for Research on Aging, on a novel, comprehensive, and personalized therapeutic program that is based on the underlying pathogenesis of AD which

involves multiple modalities to achieve metabolic enhancement for neurodegeneration (MEND). Results from the first 10 patients using this program presented with memory loss associated with AD, amnesic mild cognitive impairment (aMCI), or subjective cognitive impairment (SCI). Participants (N=9) displayed subjective or objective improvement in cognition beginning within 3-6 months, participant (N=1) was reported as a failure due to very late stage AD. Six of the patients (N=6) who had stopped working or were struggling with their jobs returned to work with improved performance (Bredesen, 2014). Similarly, applying the MEND program to test the reversal of cognitive decline in patients with early AD, mild cognitive impairment (MCI) and subjective cognitive impairment (SCI), quantitative MRI and neuropsychological testing in 10 patients (N=9) ApoE4+ (five homozygous and four heterozygous) and patients (N=1) ApoE4- treated for 5-24 months reported significant improvements (Bredesen et al., 2016). These results suggest that early detection of cognitive decline may be potentially treated by metabolic processes. Due to the failure of monotherapeutics in AD to date, these results offer a possible platform for a successful treatment therapy for AD and dementia (Bredesen et al., 2016; Bredesen, 2014).

### **3.6.1 Non-Invasive Technological Interventions for Improving Clinical Outcomes of AD and Dementia Patients**

A recent study has suggested that the utilization of preclinical treatment, which involves non-pharmacological trials for AD patients, such as VR-based cognitive-motor training during prevention, may offer better health outcomes (Doniger et al., 2018). This is consistent with Riley-Doucet and Dunn's (2013) assertion 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.

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 (Boggio et al., 2011). These improvements have involved various non-invasive, or non-pharmacological interventions which have increasingly gained attention in recent years (Zanetti, 2014; Cotelli et al., 2012), such as in VR, 3D simulation technologies and intelligent environments (Cifter & Cifter, 2017; Black, 2015). 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 (Williams et al., 2008).

VR 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 VR headset as shown in Figure 3.14, that provides a visual and auditory experience that 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 (Haworth, 2018).





Figure 3.14. A VR Headset for Dementia Patients at St Peter's Hospital, Ashford and St Peter's Hospitals NHS Foundation (Haworth, 2018)

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 (Davis, 2015). 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 (Cifter & Cifter, 2017; García-Betances et al., 2015). For instance, the Lantern assisted living facilities of Madison for Alzheimers and dementia in the United States integrates both technology and innovation to provide an indoor living environment that connects residents with the outside world, such as sky compositions in illuminated stretched ceilings, landscape and garden, as well as sensory elements (smells and sound) to bring back old memories (Engineering et al., 2016). See Figure 3.15 and 3.16.



Figure 3.15. Sky Compositions and Greeneries in Hall Ways in the Lantern Assisted Living Facilities of Madison (Engineering et al., 2016)



Figure 3.16. Nature themed wall, Garden, and Synthetic Grass Floor Finish in the Lantern Assisted Living Facilities of Madison (Engineering et al., 2016)

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 (Manera et al., 2016). 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 (Plancher et al., 2012). 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 (Man et al., 2012). 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. A summary of selected studies that highlight the application of VR technology as a non-invasive rehabilitative intervention for AD and dementia patients is shown in Table 3.3.

Table 3.3. Selected Studies on the Use of VR Technology as a Non-Invasive Rehabilitative Intervention for AD 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	Doniger et al., (2018)	Randomized controlled trial	<ul style="list-style-type: none"> <li>• A total of 55 participants were involved.</li> <li>• Active participants (N=35) and Passive participants (N=20)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Primary and secondary cognitive outcome.</li> <li>▪ Primary and secondary neurobiological outcome.</li> </ul>	<ul style="list-style-type: none"> <li>• VR-based cognitive-motor training improves cognitive function.</li> <li>• A more ecologically valid cognitive-motor VR setting may augment transfer of trained skills.</li> <li>• VR training has benefited clinical cohorts, but benefit in asymptomatic high-risk individuals is unknown.</li> </ul>
	Manera et al., (2016)	Self-report questionnaire	<ul style="list-style-type: none"> <li>• A total of 57 participants were involved.</li> <li>• (N=13) Female and (N=15) male with Mild Cognitive Impairment (MCI).</li> <li>• (N=12) Female and (N=17) male patients with dementia.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Cognitive and behavior impairment</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
	García-Betances et al., (2015)	A Review and analysis of the literature	<ul style="list-style-type: none"> <li>• Not specified.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Not specified.</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
	Jia et al., (2014)	Review of literature	<ul style="list-style-type: none"> <li>• Not specified.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Not specified.</li> </ul>	<ul style="list-style-type: none"> <li>• AD is a disorder that is too intricate and factor-driven to be entirely understood from its pathogenesis.</li> <li>• The conventional “one protein, one drug, one disease” hypothesis would not work for AD.</li> <li>• 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.</li> </ul>
	Riley-Doucet & Dunn, (2013)	Quantitative pilot study	<ul style="list-style-type: none"> <li>• A total of 12 participants were involved.</li> <li>• Older adults (N=8) caregivers (N=4) with behavioral and</li> </ul>	<ul style="list-style-type: none"> <li>▪ Participant’s reaction to Agitation.</li> <li>▪ Participant’s multisensory environment (MSE),</li> </ul>	<ul style="list-style-type: none"> <li>• Results indicated that most participants enjoyed the MSE and improvements in some BPSD were observed after using the MSE.</li> <li>• Caregivers’ reported that the MSE was a useful nonpharmacological therapy for reducing anxiety and agitation among participants who exhibited BPSD.</li> </ul>

Theme	Selected references	Study Design	Participant size	Measured outcome	Result on health outcome(s)
			psychological symptoms of dementia (BPSD).	<ul style="list-style-type: none"> <li>▪ Caregiver satisfaction with MSE as a management strategy for older adults with BPSD</li> </ul>	
	Man et al., (2012)	A pre-test and post-test design	A total of 24 older adults' participants.	<ul style="list-style-type: none"> <li>▪ Multifactorial Memory Questionnaire and Fuld Object Memory Evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
	Plancher et al., (2012)	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"> <li>▪ Neuropsychological assessment. VR episodic memory assessment</li> </ul>	<ul style="list-style-type: none"> <li>• 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).</li> <li>• The study highlights specific cognitive differences additional insight into the early diagnosis and rehabilitation of pathological aging.</li> <li>• 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.</li> </ul>

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

### **3.7 Architectural Considerations for Garden Designs in AD and Dementia Care Facilities: A Systematic Review**

One of the curiosities of this research is that the practice of integrating Therapeutic Gardens as a design factor for improving the healing environment in AD and dementia care facilities has not been globally applied. Relatively little attention has been paid to ensure that research findings are implemented in practice. Also, the geospatial distribution, research methods and application of these design factors through empirical evidence needs to be brought to the fore to increase awareness and its effectiveness. The findings of this review answer the research questions 3, 4, 5 and 6 previously stated in section 1.4. The keywords “landscape” and “garden design,” was used in combination with “Alzheimer’s” or “Dementia” “nursing units” and “elderly care facility”. This five-step guidelines on conducting Systematic Review of Denyer and Tranfield (2009) including (i) Research Question, (ii) Database search, (iii) Study Selection and Evaluation, (iv) Analysis and Synthesis, (v) Reporting and Using the Results was adapted.

#### **3.7.1 Research Questions**

3. How has research on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities evolved between 1984 –2019?
  
4. What is the country or regional distribution of studies on the use of therapeutic gardens as design factors in AD and dementia care facilities?
  
5. What is the most common method used in research on therapeutic garden as an architectural design factor in AD and dementia care facilities?

6. What are the architectural parameters to consider in the design of therapeutic gardens in AD and dementia care buildings?

### **3.7.2 Database Search**

Four databases were searched with the Eastern Mediterranean University online full text database for relevant studies. These include Elsevier Science Direct, Sage Journal Online, Taylor and Francis, ProQuest dissertation and thesis global. The basis for selected database in this study is a single publication. Based on the selected theories for this study which includes Evidence-based design (Ulrich, 1984), theory of Supportive Design for healthcare (Ulrich, 1991) and the Biophilia hypothesis (Wilson, 1984), the systematic review considered article publication dates ranging from 1984 to 2019. The year 1984 was selected as a starting point due to the emergence of the two theories included in the study.

### **3.7.3 Study Selection and Evaluation (Inclusion and Exclusion Criteria)**

The transparency of the review process was upheld through clear selection criteria to evaluate the relevance of studies selected (Pickering et al., 2015; Pickering & Byrne, 2014). Table 3.4 highlights a list of inclusion and exclusion criteria used for the study selection.

Table 3.4. Systematic Review Design Criteria for Selection and Eligibility of Studies

Inclusion criteria	Rational	Exclusion criteria
Selected studies must be Published in peer-reviewed journals. Books, thesis and dissertations on case-based landscape and garden design in AD and dementia care facilities	<ul style="list-style-type: none"> <li>• Peer-reviewed journals are considered to be of higher quality than non-peer-reviewed</li> <li>• Credible evidences, design based results and recommendations can be extracted from these studies.</li> </ul>	<ul style="list-style-type: none"> <li>• Irrelevance to the topic</li> <li>• Inability to obtain full document due to access restrictions.</li> <li>• Studies that do not discuss actual design of gardens.</li> <li>• Studies that only presented garden design recommendations without case studies.</li> </ul>
Selected studies should be published within 1984-2019	The year 1984 was selected as a starting point due to the emergence of the two theories Ulrich 1984 and Wilson 1984, included in the study.	<ul style="list-style-type: none"> <li>• Non English publications and studies that do not report geographic location, study design, design intervention, study population and participant size were excluded.</li> </ul>
Selected studies must be Published in the English language.	English is the dominant language for publications in academia, thus, provides a wider coverage of research.	<ul style="list-style-type: none"> <li>• Publications earlier than 1984.</li> </ul>
Selected studies had case study, research method, Primary measured design factor, geographic setting, Study Setting, design / recommendation(s).	This allows for an evaluation of original studies on the topic under investigation and enables the synthesis of design recommendation for developing a conceptual framework.	

### 3.7.4 Analysis and Synthesis

Study screening involved reading of titles abstracts and conclusion of each paper. This process was repeated for each database to arrive at 2 articles in Elsevier Science Direct, 6 in Sage Journal Online, 7 in Taylor and Francis, 8 in ProQuest dissertation and thesis global and retrieved a total of 23 studies for the review (See table 3.5; Appendix C). The coding was performed by two researches in the field of architecture and healthcare design.

As shown in Figure 3.17, this review was performed using a pre-specified protocol based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (Moher et al., 2009).



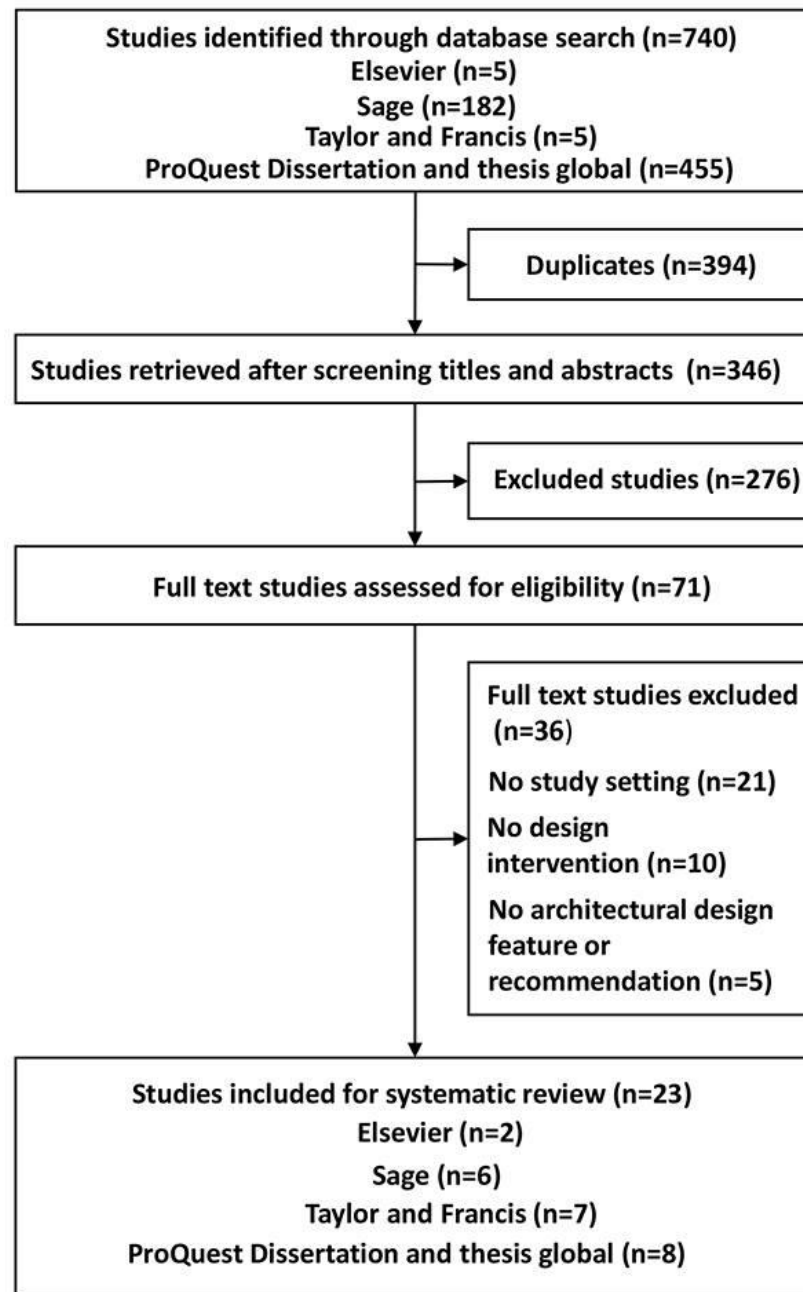


Figure. 3.17. Flow of Studies through the Review Process for the Systematic Review

### 3.7.5 Reporting and Using the Results

To answer the research questions foregrounding this study, the findings from the four database used for this study were evaluated. Table 3.5 shows the frequency distribution of databases that explored studies on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities.

Table 3.5. Database Frequency Distribution

		<b>DATABASES</b>			
		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
<b>Valid</b>	Elsevier Science Direct	2	9.1 %	9.1%	9.1%
	Sage Journal Online	5	22.7%	22.7%	31.8%
	Taylor and Francis	7	31.8%	31.8%	63.6%
	ProQuest dissertation and thesis global	8	36.4%	36.4%	100%
	Total	22	100%	100%	

The result shows that the preponderance of academic resources (thesis and dissertations) on the architectural design factor in AD and dementia care facilities was published in ProQuest dissertation and thesis global (36.4%; n=8). 31.8% (n=7) of the articles were published in Taylor and Francis, while Sage Journal Online published 22.7%; (in=5) peer reviewed articles. Elsevier Science Direct published the lowest number of peer articles, resources in Architectural considerations for garden designs in AD and dementia care facilities (9.1%; n=2).

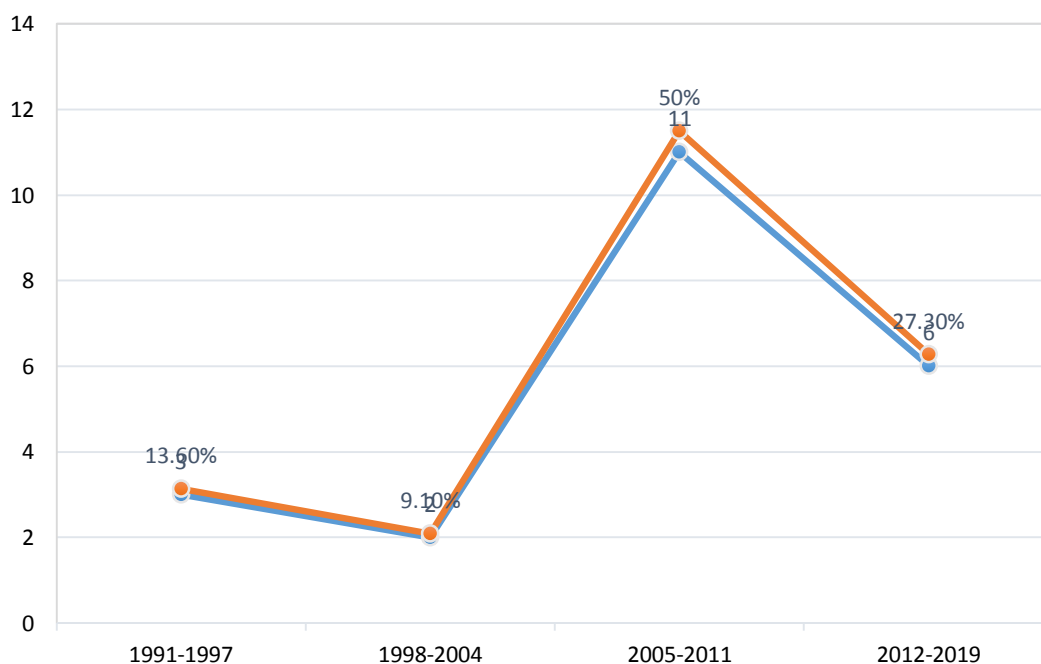
These results indicate that there is more awareness on the use of therapeutic gardens as design factors in the academic domain (pedagogy) than in scientific research. This implies that more emphasis is laid on clinical treatment and health outcome in scientific research than the environmental and architectural design considerations for improving healthcare facilities of this patient group.

**To answer the research question (3):** How has research on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities evolved between 1984 –2019?

An analysis of the frequency distribution and yearly progression of studies that explored the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities was done as shown in Table 3.6.

Table 3.6. Yearly progression of studies on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities

		YEAR			
		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Valid</b>	1991-1997	3	13.6%	13.6%	13.6%
	1998-2004	2	9.1%	9.1%	22.7%
	2005-2011	11	50%	50%	72.7%
	2012-2019	6	27.3%	27.3%	100%
	Total	22	100%	100%	



Grouped into six years intervals, the result shows that there was no publications between 1984 -1991. The majority of studies were published between the years 2005-2011 (n=11) and 2012-2019 (n=6), representing a total of 77% in twelve years. Although there has been a reasonable level of globally sensitization and awareness on AD projections due to aging, the figures revealed in this study suggest a slow rate in knowledge building and research development on topics relating to the design of care

facilities for this patient group. This decline in research publications between 2011 till date also suggests that more studies and research should be conducted, giving the progressive rate of the disease as projected by WHO.

**To answer the research question (4):** What is the country or regional distribution of studies on the use of therapeutic gardens as design factors in AD and dementia care facilities?

A frequency distribution showing the cross tabulation of facility type versus country or region shows that Europe has recorded the highest number of studies on the use of landscape and garden as an architectural design factor in AD and dementia care facilities. Most of the studies were in the United States of America (USA) (n=12; 100%), for the design of elderly care homes (n=4; 66.6%). AD and dementia facilities revealed to be the most consistent healthcare building that has applied the use of therapeutic gardens across Europe as shown in Table 3.7. This concretizes the curiosity to find out the reason for less studies in developing countries and other regions.

Table 3.7. Facility Type, Country and Regional Distribution Frequency Distribution Cross Tabulation

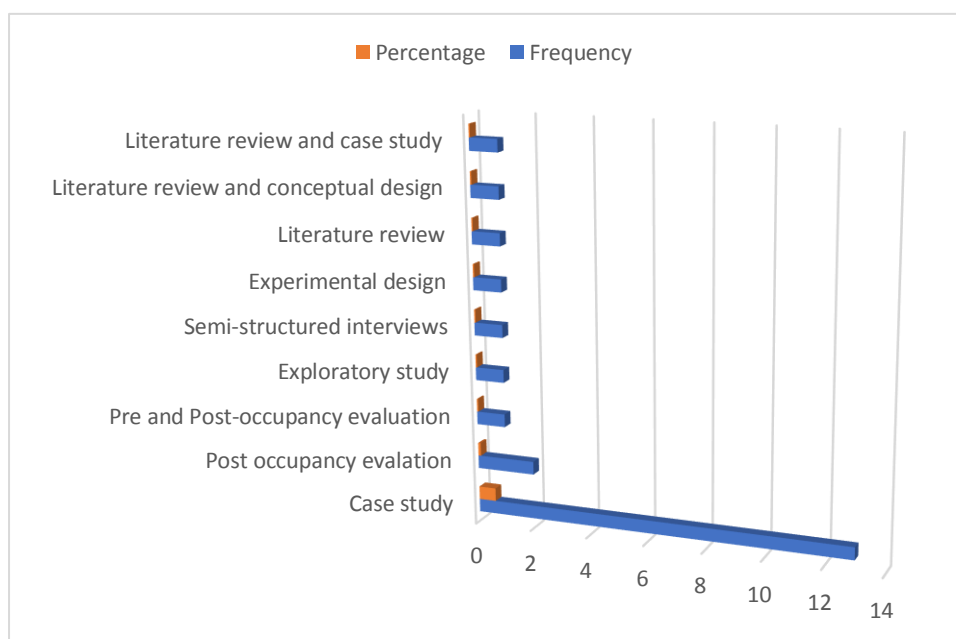
Country/Region		USA (Europe)	Canada (Europe)	London (Europe)	France (Europe)	UK (Europe)	Japan (Asia)	N/A	Total
<b>Facility Type</b>	Elderly Care home	4 (66.6%)	0	0	1(16.6%)	0	0	1(16.6%)	6
	Multi-level care facility	0	1(100%)	0	0	0	0	0	1
	Long-Term care facility	1(100%)	0	0	0	0	0	0	1
	Special Care dementia units	2(100%)	0	0	0	0	0	0	2
	University Hospital	0	0	0	1(100%)	0	0	0	1
	Experimental Space	0	0	0	0	0	1(100%)	0	1
	Park	0	0	0	0	1(100%)	0	0	1
	AD and dementia care facility	1(25%)	1(25%)	1(25%)	0	0	0	1(25%)	4
	AD and dementia care home	4(80%)	1(25%)	0	0	0	0	0	5
	<b>Total</b>	12(100%)	3(100%)	1(100%)	2(100%)	1(100%)	1(100%)	2(100%)	22

**To answer the research question (5):** What is the most common method used in research on therapeutic garden as an architectural design factor in AD and dementia care facilities?

An analysis of the frequency distribution of methodologies in studies that focused on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities was evaluated. 59%; (n=13) of studies utilized the case study method, and 9.1%; (n=2) used post-occupancy evaluation method, while 31.5%; (n=7) of studies used Pre and Post-occupancy evaluation, exploratory study, semi-structured interviews, experimental design, literature review, literature review and conceptual design, literature review and case study as shown in Table 3.8. This implies that the case study approach has been the most used method in research focused on the use on landscape and garden as a design factor in AD and dementia care facilities. Although, this method may yield more result, it is however more expensive to conduct and requires funding or grants and access to sensitive clinical information of patients from healthcare teams. The occupancy evaluation method (pre and post) was shown to be the second most employed approach to research.

Table 3.8. Frequency Distribution Table of Research Methods

		<b>METHODS</b>			
		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
<b>Valid</b>	Case study	13	59.1%	59.1%	59.1%
	Post-occupancy evaluation	2	9.1%	9.1%	68.2%
	Pre and Post-occupancy evaluation	1	4.5%	4.5%	72.7%
	Exploratory study	1	4.5%	4.5%	77.3%
	Semi-structured interviews	1	4.5%	4.5%	81.8%
	Experimental Design	1	4.5%	4.5%	86.4%
	Literature review	1	4.5%	4.5%	90.9%
	Literature review and conceptual design	1	4.5%	4.5%	95.5%
	Literature review and case study	1	4.5%	4.5%	100%
	<b>Total</b>	<b>22</b>	<b>100%</b>	<b>100%</b>	



**To answer the research question (6):** What are the architectural parameters to consider in the design of therapeutic gardens in AD and dementia care buildings?

A frequency distribution table showing the analysis of studies that highlighted architectural design parameters discussed under themes including socio-cultural and emotional, visual and physical, psychological and emotional, sensory factors, cost implication and design objectives of garden, architectural design approach to garden for therapeutic outcomes, gardens as an integral part of architectural design as well as design guideline and recommendation in AD and dementia care facilities is presented in Table 3.9. More studies (2005-2011; 100%) revealed the need to consider architectural design approach to garden for therapeutic outcomes, sensory factors in gardens and to integrate gardens as part of the overall design. Design guidelines and recommendation was revealed to be a consistent prerequisite, adhered to, as it was recorded at least once between the years 1991-2019. The frequency is thus distributed as 12.5%; (n=2) in (1991-1997; 1998-2004) and 75%; (n=6) in (2005-2011; 2012-2019). Between the years 2005-2011, all themes were discussed in the studies reviewed (n=11) except for cost implication and design objectives. This validates the importance of the eight themes highlighted and discussed as architectural design parameters in section 4.3.1.

Table 3.9. Theme and Year Cross Tabulation

THEMES (Design Parameters)	YEAR				Total
	1991-1997	1998-2004	2005-2011	2012-2019	
Socio-cultural and emotional	0	0	1(50%)	1(50%)	2(100%)
Visual and Physical	1(20%)	0	3(60%)	1(20%)	5(100%)
Psychological and emotional	1(33.3%)	0	2(66.6%)	0	3(100%)
Sensory factors	0	0	1(100%)	0	1(100%)
Cost implication and design objectives of garden	0	1(100%)	0	0	1(100%)
Architectural design approach to garden for therapeutic outcomes	0	0	1(100%)	0	1(100%)



	YEAR				Total
	1991-1997	1998-2004	2005-2011	2012-2019	
Gardens as an integral part of architectural design	0	0	1(100%)	0	1(100%)
Design guideline and recommendation	1(12.5%)	1(12.5%)	2(25%)	4(50%)	8(100%)
<b>Total</b>	<b>3</b>	<b>2</b>	<b>11</b>	<b>6</b>	<b>22</b>

### 3.8 Summary of Chapter

This section presents a scientific evaluation of the role of natural environments as they contribute to positive outcomes in healthcare through. It further highlights the causes of AD and dementia, its psychological and physiological perspectives on mental health, the role of HG, and evidences on the impacts of TG, HT and nature-based VR technologies for improving clinical outcomes of AD and dementia patients. Research findings suggest that healthcare environment for AD and dementia patients should be designed to include nature-based interventions that promote socialization, cognition, rehabilitation and overall wellness. These therapeutic practices were shown to cut across the psychological, physiological and social health status of dementia patients.

The pathology of AD and dementia was discussed to understand the health conditions AD, the various stages of the disease, symptoms and health challenges in patients. These clinical evidences gathered from empirical studies enabled the author develop design criteria for AD and dementia care homes. Research findings assert that clinical trials and monotherapeutic treatment options for this patient group have not yielded a permanent cure till date. Thus, research investigators suggest the need to develop better options through alternative treatment. The highlights of the critical review can be summarized as follows:

- a. Health implication of therapeutic gardens and horticultural therapy on Alzheimer's and dementia patients' spans across physical, social and cognitive effects.
- b. TG may promote positive cognitive gains, decrease depression and agitation in AD and dementia patients.
- c. Future directions in the prevention and treatment of AD and other dementias may ultimately be dependent on the precedents of successful therapeutics from other chronic illnesses.
- d. Nature-based VR technologies may create supplementary multi-sensory and self-relevant situations to AD and dementia patients.
- e. Future studies should inquire into the positive aspects of virtual reality (VR) technologies to create a greater understanding of this new application in the healthcare landscape. The findings from this section answers the research questions 1 and 2 previously stated in section 1.4.

A follow up systematic review was conducted to investigate the use of therapeutic gardens as architectural factors for designing AD and dementia care facilities. The systematic review was used to answer research questions 3-6 earlier stated in section 1.4. The results from the selected studies were evaluated and thematically analyzed. This helped the author mine design parameters and recommendations used to develop the conceptual framework proposed in chapter 4 of this study.

## Chapter 4

# A CONCEPTUAL FRAMEWORK FOR IMPROVING HEALTH, WELLBEING AND THE PHYSICAL ENVIRONMENT OF AD AND DEMENTIA CARE BUILDINGS

The conceptual framework developed in this dissertation explores both the clinical and environmental strategies in designing care spaces for AD and dementia patients. It is divided into three main sections, A (knowledge source), B (health and design strategies) and C (possible applications of the framework) (See figure 4.1).

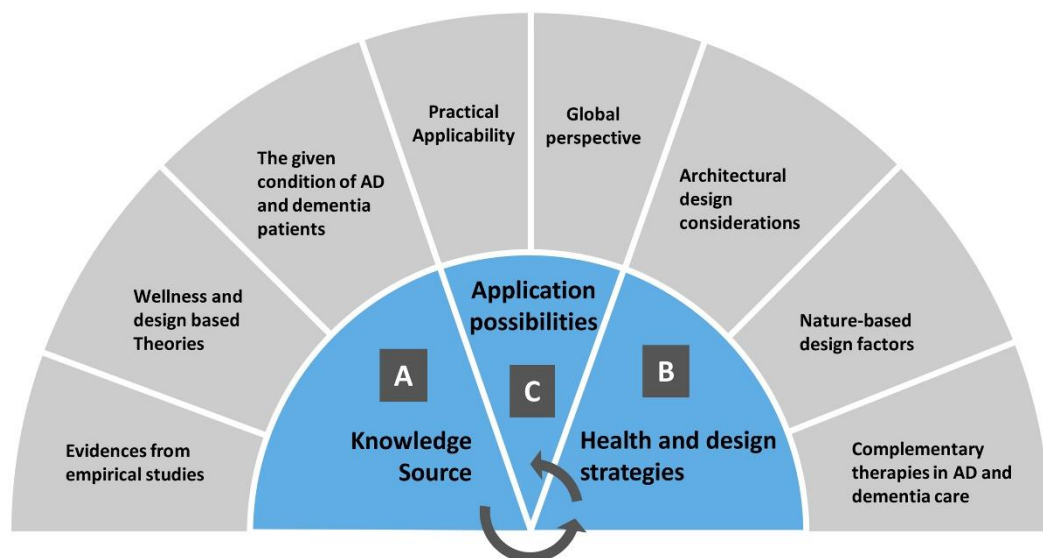


Figure 4.1. The 3 Main Sections of the Conceptual Framework for Optimizing the Healthcare Environment in AD and Dementia Care (Authors compilation)

Section A broadly highlights the given condition of AD and dementia patients, wellness and design based theories and evidences from empirical studies. Section B describes Complementary therapies in AD and dementia care, Nature-based design factors and architectural design considerations. Section C describes the global perspectives and practical applicability. The framework proposes that applying the theory of supportive design, evidence-based design construct and the biophilia theory, the wellbeing of individuals with AD and dementia can be improved. It also proposes that the architectural design quality of AD and dementia care facilities can be optimized through the integration of a well-planned therapeutic garden.

The framework is made up of 3 main overlapping sections. The sub-contents of these sections overlap each other, indicating that each section is dependent on the other to archive a therapeutic goal. The sections include, knowledge sources, architectural design considerations and global perspective (See figure 4.2).

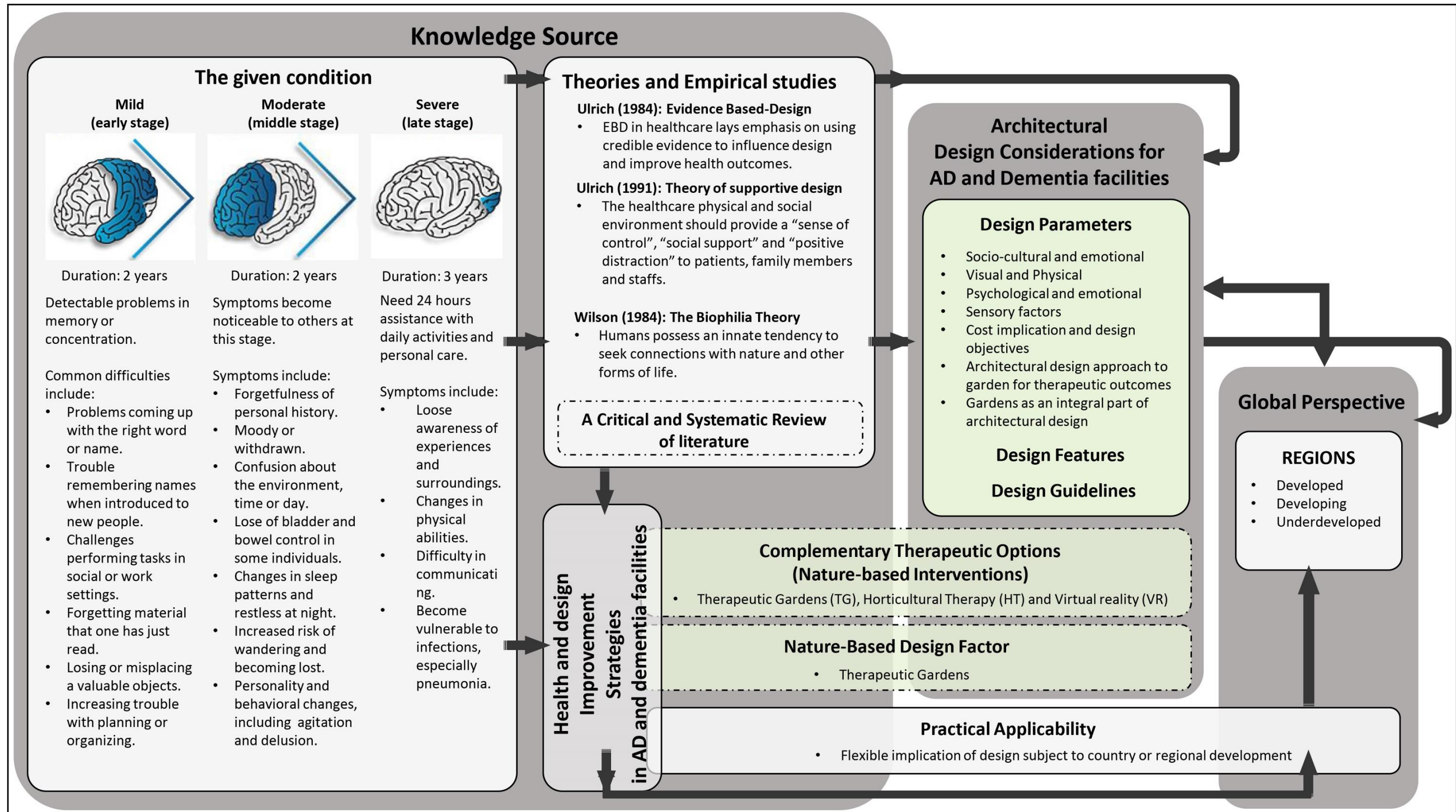


Figure 4.2. A Conceptual Framework for Optimizing the Healthcare Environment in AD and Dementia Care (Authors compilation)

To achieve the execution of an effective healing environment for AD and dementia patients, an understanding of the given conditions of the patients, the selected theories on wellness and clinical outcomes of nature-based interventions on health from empirical studies, should be synthesized with design strategies for improvement. These strategies will be implemented through architectural design parameters and features, based on country and regional prospects. The application of this framework is by no means rigid, and should be utilized as flexible as possible, based on factors including culture, cost and technological advancements.

## **4.1 The Breakdown of the Framework**

### **4.1.1 Knowledge Sources**

This section represent the theories underpinning used in this study and empirical evidences from literature reviews. The knowledge covered a wide range of interdisciplinary subjects including nursing, physical therapy, horticultural and architecture. This allowed a more comprehensive understanding of the role of therapeutic gardens for optimizing the architectural quality of healthcare facilities, as well as its health implications for individual with AD and dementia. This also helped assess the state of knowledge in the topic 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. The sections contained in this conceptual framework are described as follows.

### **4.1.2 The Given Condition**

As earlier discussed in the pathology of AD and dementia (section 3.1.1), this section of the framework further elucidates the various stages of AD and dementia disease

progression in the brain, and the subsequent behavioral characteristics associated in each stage (See figure 4.3).

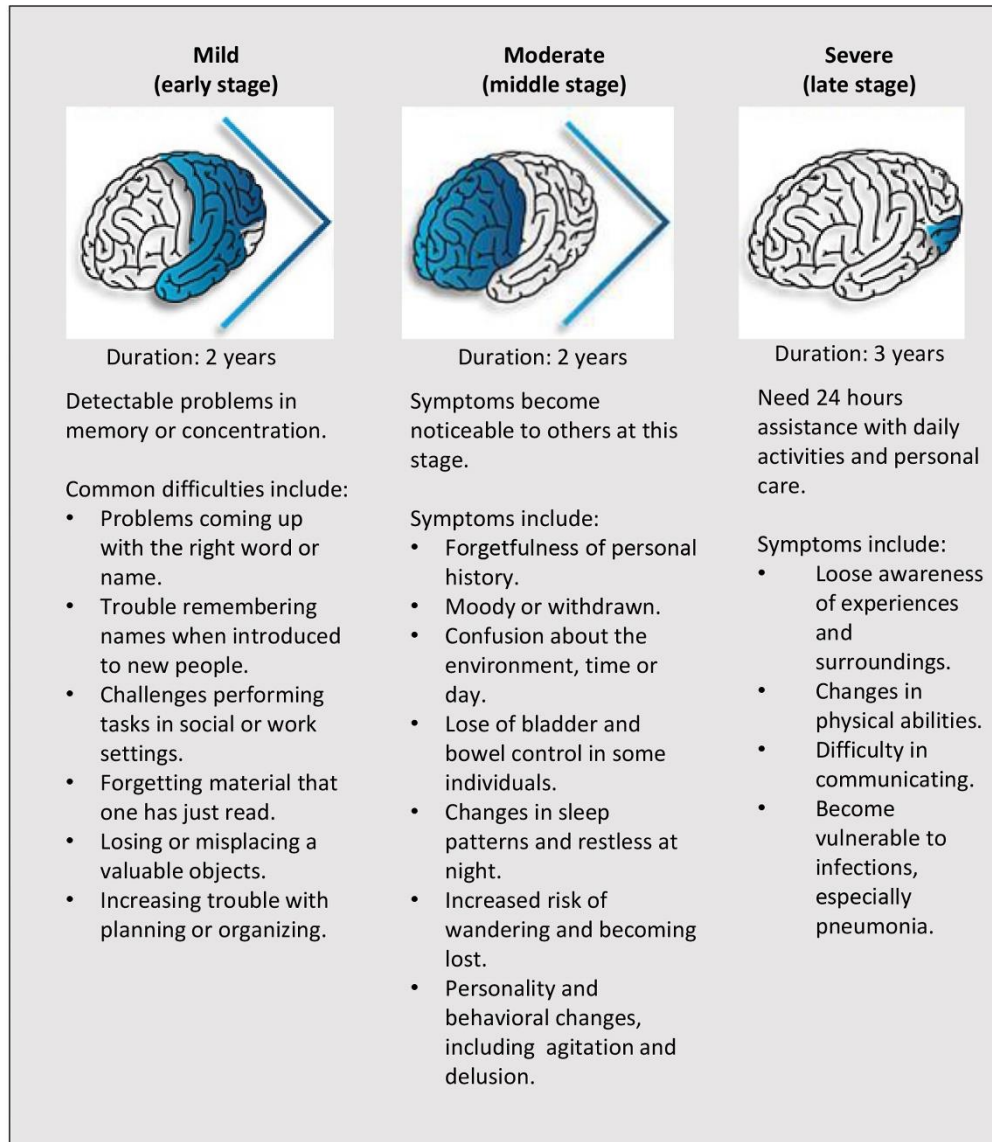


Figure 4.3. The Various Stages of AD (Authors compilation)

### 4.1.3 Theories and Empirical Evidence

As shown in Figure 4.4, the framework proposes that the integration the principles of the EBD, Biophilia and supportive design theories as well as the positive outcomes of nature-based interventions including TG, HT and VR as non-pharmacological



treatment options in AD and dementia care, can optimize the healthcare environment, cognitive gains and general wellbeing of these patient group.

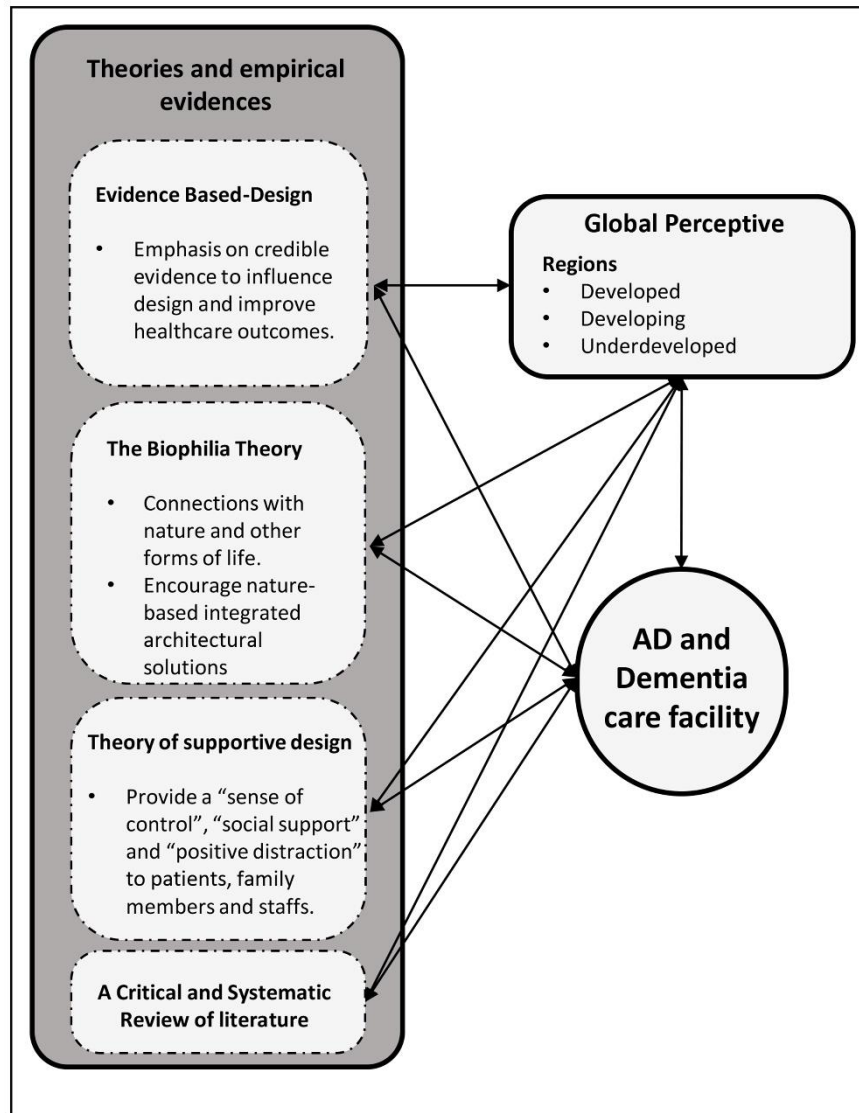


Figure 4.4. Connection between Selected Theories, Evidences Form Literature and Their Global Impact on AD and Dementia Care Facilities (Authors compilation)

## 4.2 Health and Design Improvement Strategies in AD and Dementia Facilities

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 (Alfonsi et al., 2014) as well as provides a general sense of well-being. Environments that integrates HG and HT have a profound effect on AD 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 (Marcus, & Sachs, 2013; Erickson, 2012). Table 4.1 summaries the improvement strategies that could guide future research. This section of the conceptual framework proposes that the combination of the positive outcomes from HT, TG and VR as treatment option with therapeutic gardens as design factors will substantially improve the healing environment in AD and dementia care facilities in any give region as shown in Figure 4.5.

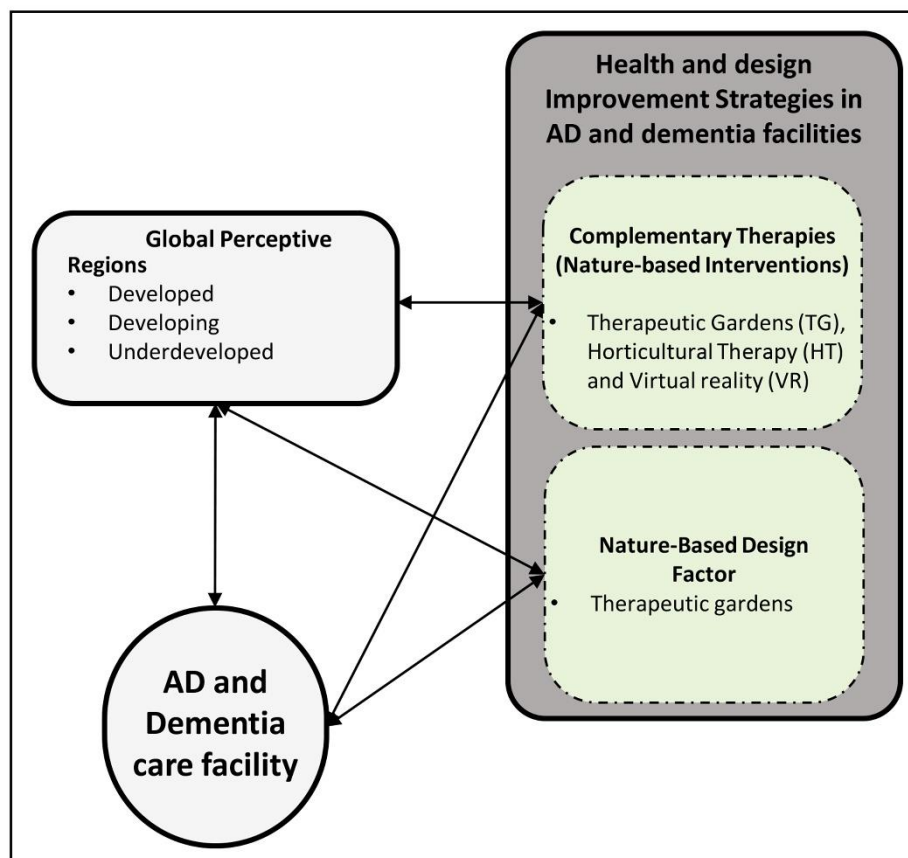


Figure 4.5. Connection between Health and Design Improvement Strategies and their Global Impact on AD and Dementia Care Facilities (Authors compilation)

Table 4.1. Summary of Improvement Strategies for Optimizing AD and Dementia Environments

Therapeutic Design intervention	Architectural Design factors	Sub-design parameters	Health benefits for improved user experience
Healing environments	Therapeutic Gardens	TG, HG and HT.	<ul style="list-style-type: none"> <li>• Advanced dementia patients are more likely to experience negative experiences in garden settings.</li> <li>• Credible evidence in literatures suggest that the health impact of TG, HG and HT on AD and dementia patients generally cuts across their physical, social, psychological and cognitive status.</li> <li>• TG and HG 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.</li> </ul>
		Colors.	<ul style="list-style-type: none"> <li>• Integrating interactive, appealing colors for signage on floors and pathways can improve better wayfinding within the garden spaces.</li> <li>• Colors and well-chosen hues on furniture and floors in a garden may have a positive or negative effect on a health and wellbeing.</li> <li>• Overdosing spaces with too much or ominous colors such as black can increase anxiety levels and depression.</li> </ul>
		Views, Positive distraction and Nature scenes.	<ul style="list-style-type: none"> <li>• Properly designed gardens in the healthcare physical environment provide pleasant nature views and calming effects on users.</li> <li>• 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.</li> <li>• Visibility of garden spaces from inside by both staff and residents is critical to its use.</li> </ul>
		Sunlight.	<ul style="list-style-type: none"> <li>• Adequate light exposure to sunlight is required for vitamin D synthesis and calcium metabolism especially for the elderly group in nursing homes.</li> </ul>
		Sound.	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
		Social support.	<ul style="list-style-type: none"> <li>• Gardens that promote social support for patient’s family members and close friends accelerates psychological rehabilitation and emotional healing.</li> <li>• Respite spaces for care givers can reduce anxiety of family members, improve staff-patients communication and promote better care in clinical environments.</li> </ul>

Therapeutic Design intervention	Architectural Design factors	Sub-design parameters	Health benefits for improved user experience
		Sense of control.	<ul style="list-style-type: none"> <li>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.</li> </ul>
		Art work.	<ul style="list-style-type: none"> <li>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.</li> </ul>
		Art therapy.	<ul style="list-style-type: none"> <li>Art therapy programs should provide positive distractions, increase cognitive functioning and promotes comfort level.</li> <li>It also helps to reduce ambient environmental stressors that could impede patients and staff health outcomes.</li> </ul>
			<ul style="list-style-type: none"> <li>Phenomenological considerations in the design of gardens can improve the sensory experience of space and considers the mutual influence of emotions and the environment.</li> <li>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.</li> <li>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.</li> <li>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.</li> </ul>
Physiological and psychological perspectives on AD	HT and therapeutic garden	Biological indices	<ul style="list-style-type: none"> <li>The physiological and behavioral reactions to any environmental setting involves bi-directional communication of the brain, with multiple systems including endocrine, cardiovascular and immune systems.</li> <li>Biological, interleukin, and immunological markers have been regarded as the Gold standard model to investigate horticultural and therapeutic garden outcome for the aging/neuro cognitively impaired.</li> <li>HT and therapeutic garden activities reduces plasma IL-6, prevents inflammatory disorders, while maintaining plasma CXCL12 (SDF-1) and hematopoietic support to the brain.</li> <li>Changes in neurobiological markers and magnetic resonance imaging (MRI) volumetric changes in brain areas including hippocampus, amygdala and caudate nucleus are current new standards in therapeutic intervention research.</li> </ul>

<b>Therapeutic Design intervention</b>	<b>Architectural Design factors</b>	<b>Sub-design parameters</b>	<b>Health benefits for improved user experience</b>
Non-invasive technologies	VR and intelligent environments.		<ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• VR technologies have been applied with 3D simulation in the healthcare environment as mock-up tools to evaluate patient responses in a real-world design.</li> <li>• 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.</li> <li>• 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.</li> </ul>

### 4.3 Architectural Design Considerations in AD and Dementia Facilities

In designing a garden for individuals with AD and dementia, factors such as age, abilities and health conditions should be put into consideration at all phases. Wander garden design for dementia patients in temperate environment with seasonal rain and snow should include adequately heated and cooled perimeter walkway with multiple entrance and exits. Shadows could be misinterpreted as frightening specters for AD and dementia patients thus should be minimized by design. This causes sundowning, a condition caused by the setting of the late afternoon sun, which increases symptoms of agitation and hallucination in late stage AD and dementia patients (Randall et al., 1990). The design considerations proposed in this framework encompasses several parameters, features and guidelines as shown in figure 4.6.

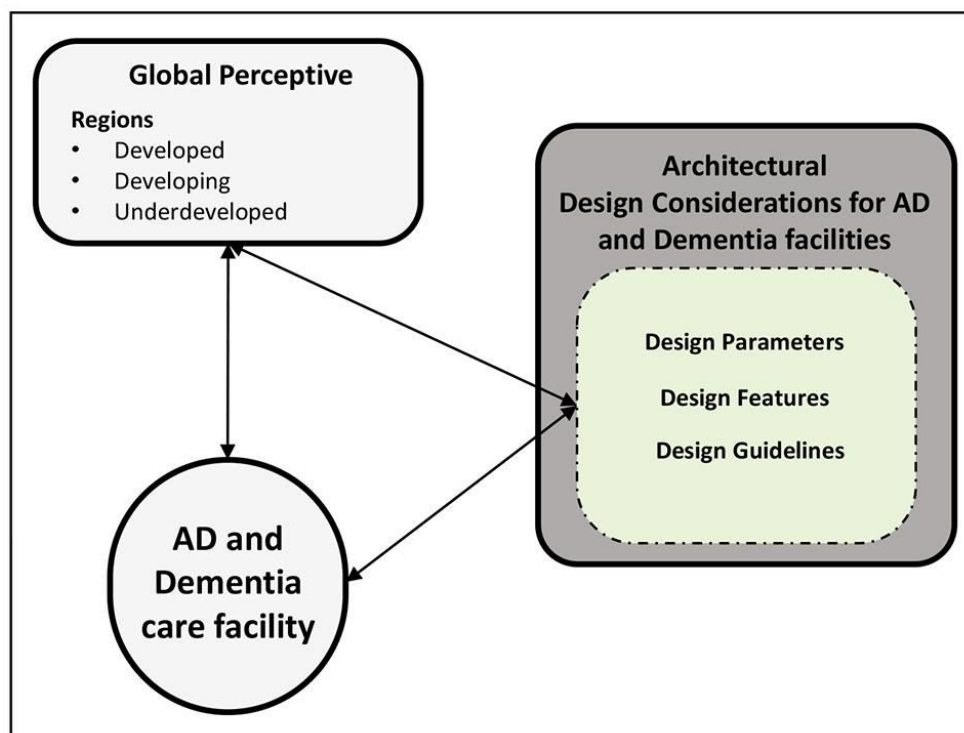


Figure 4.6. Connection between Architectural Design Considerations and Their Global Impact on AD and Dementia Care Facilities (Authors compilation)

### **4.3.1 Design Parameters**

The systematic review revealed eight parameters to be considered in the architectural design of spaces for AD and dementia, including socio-cultural and emotional, Visual and Physical, Psychological and emotional, Sensory features, Cost implication and design objectives, Architectural design approach to garden for therapeutic outcomes, and Gardens as an integral part of architectural design.

**Socio-Cultural and Emotional:** Garden elements, including vegetables, orchard and terrace familiar to users can improve their socio-cultural dimensions of gardens. Garden design consideration should include attractiveness and control of outdoor spaces; social use; design strategies that encourage curiosity; accessibility and ergonomic characteristics; structured design, composition and vegetation management strategies (Charras et al., 2018). HG that incorporate cultural and emotional factors of reminiscences improved behavioural disorders such as agitation, aggression aimless wandering de-ambulation, sleep, general health and nutritional status (Jonveaux, et al., 2011).

**Visual and Physical:** The physical and visual qualities of garden spaces have been shown to have a positive effect on the AD patients. According to an experiment by Liu et al. (2018), subjects were more engaged and relaxed in a visually pleasant garden environment. Additionally, ambient temperature was revealed to be an important factor for garden design for improved engagement. Likewise, Grant & Wineman (2007) posits that the use of the outdoor space among individuals with dementia in elderly care facilities is influenced primarily by physical access. Both physical and visual access to outdoor, garden environments were considered most important by staff and patients. Garden designs should include circular pathways and Pergolas that

provide support for climbing plants (Weatherby & Moriarty, 2006). The results of a certain study in an elderly care home suggest that architectural design should incorporate physical parameters including visibility and accessibility, covered patio or Terrace, simple returning pathways, adequate seating, outdoor space suitable to the local culture, incorporate a wide variety of perennial plants, as well as provide adequate enclosure and security within the garden (Marcus, 2007). This is consistent with the assertions of an early study which documents that designing a restorative space for AD and dementia patients requires five elements, including enclosing wall, water features, canopy (Tree or Trellis), mound or hill as well as paving (Beckwith & Gilster, 1997).

**Psychological and Emotional:** Therapeutic gardens that incorporate cultural and emotional factors of reminiscences improved behavioral disorders such as agitation, aggression aimless wandering de-ambulation, sleep, general health and nutritional status (Jonveaux et al., 2011). Similarly, a wander garden was shown to reduce agitation in dementia care facilities (Detweiler et al., 2008). AD and dementia gardens should be consciously designed to meet the needs of patients at their various stages of cognitive decline, including: the mild or forgetful stage, the moderator or confused stage and the severe or demented stage. Garden designs should incorporate the properties of restorative environments, including: being away, fascination, extent and compatibility to improve executive brain functioning and reduce fatigue in dementia patients (Moore, 2007).

**Sensory Factors:** Studies have shown that sensory factors, including improving accessibility, integrating sensory feature including water, herb wheel and raised flower beds, colour and texture of plants helps patients' sensory perception, plants, furniture

and garden features were used to improve reminiscence in the garden (Furness & Moriarty, 2006). The fields of neuroscience and architecture should be properly integrated to create physical environments that are more accustomed to human experience. Design considerations for AD homes should include lighting, color, wayfinding, and outdoor spaces that stimulates the haptic senses (McKeron, 2010). Micro design strategies such as sensory perceptions, including olfactory, auditory and plant stimulation, building materials, site features and furniture should be considered in the design of gardens in AD and dementia care facility (Dixon, 2002).

**Cost Implication and Design Objectives:** In a multi-level care facility, the cost effectiveness of the garden design features and goals had a higher satisfactory report compared to dissatisfaction. Users reported satisfactory levels of views into the garden, activities in the garden such as gardening and planting activities, safety, wheelchair-accessible, pathways, chairs, and raised garden beds (Heath & Gifford, 2001). It is imperative for designers to choose plants and vegetation that require minimal maintenance to maximize cost. Additionally, having a good knowledge of local climate and seasons will aid the choice of plant species to plant in gardens.

**Architectural Design Approach to Garden for Therapeutic Outcomes:** According to Zeisel (2007), the interior and exterior environments of AD and dementia care homes must be harmoniously designed to respond to their mental health state. This implies that the design approach to gardens for should involve 3 critical step in including: (1) Image information (Loss of complex brain function, Indoor/outdoor unity, Natural mapping, temporal support, Learning support, and Land marking); (2) Presenting (Design interior and exterior spaces together, maintain continuous visible re-entry in garden, design the entrance and exit to and fro the garden as a landmark,



safety and security considerations, maintain 90° shortcuts); and (3) Testing information (Safety and security, Walking pathways, Landmarks, Territory, Shared places, Sensory experiences, Prosthetic supports, Residential and normal).

**Gardens as an Integral Part of Architectural Design:** Therapeutic gardens can serve as a more holistic approach to treatment in AD and dementia patients, thus, they should be considered as a new design standard in nursing homes (Hernandez, 2007). To this effect, studies have suggested that the most important factors to consider in the design of AD and dementia facility are; the site, general area, safety or security, corridors and activities (Landon, 2016).

#### **4.3.2 Design Features**

Architectural design features including ease of access; movement and orientation (Landon, 2016; Brawley, 2002), sensory stimulus, positive distraction and mental mapping (Whear et al., 2014; Browning et al., 2014; Pallasmaa, 2012; Fairchild, 2011; Ulrich et al., 2008; Brawley, 2002; Dixon, 2002; Vapaa, 2002; Ulrich, 1984), shelter and shade (Gonzalez & Kirkevold, 2014; Gayna, 2013; Marcus, 2007; Grant & Wineman, 2007; Weatherby & Moriarty, 2006), safety or security, maintenance and enlightenment (Landon, 2016; Greasley-Adams et al., 2012; Cuiyan, 2012; Brawley, 2007; Brawley, 2002; Brawley, 1997) should be considered to create garden design in AD and Dementia care facilities. Adequate view into garden, unrestricted access to perimeter walkway, access to doors into garden, and spaces for activities in garden were also considered as design factors (Detweiler et al., 2008).

Ground preparation was shown to be an important factor to consider in garden design for AD (Landon, 2016). Adequate soil preparation is crucial to the success of any garden. The ground should well-nourished for planting. Areas set out for hardscape

should be well compacted. Proper drainage is important around pathways in gardens to prevent patient falls due to wet floors. Pathways should be designed with permeable surfaces that absorbs water and saves it to a holding tank through underground channels. Outdoor furniture must be firm and easily accessible as patient falls increase in long term care facilities due to cognitive decline in older adult. Hence, it is vital to ensure that furniture in garden environment are firmly installed to prevent falls and injury. Additionally, sub-design features to be generally considered include visibility and views, routes and entrances, footpaths and signage, sensory stimulus, positive distraction and mental mapping (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 as well as spaces for physical activities), shelter and shade (pergola, climbing plants and trees, seats and arm rests, summer houses, huts and screened porches), security or safety, maintenance and enlightenment (anti-elopelement strategies, 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) (See Table 5).

#### **4.3.3 Design Guidelines**

Design guidelines are general concepts or sets of recommendations put forward for good practice in design. They are chiefly intended to aid designers during the planning and design process. Unfortunately, when it comes to the design of therapeutic gardens for AD and dementia facilities, landscape architects often have little information on their health status, and evidence-based design practices needed to design these spaces. Thus, they lack the strategies to determine the appropriateness of design guideline. Although, design guidelines sometimes present conflicting responses when measured

against certain disease and patient groups, however, the recommendations presented in this current study offer design parameters and factors foregrounded by several case-based studies.

To establish the design guidelines for AD and dementia care buildings, the study reviewed current research on the health effect of AD on patients, its causes and current treatment options. Furthermore, research investigations revealed that therapeutic gardens in AD and dementia care facility do not only offer therapeutic benefits but also a sustainable environmental advantage. The same study suggests that from a sustainable perspective, trees and shrubs in the gardens provide natural shading around the east, west and south building facades as well as act as a buffer for traffic and sound especially in facilities near busy roads (Landon, 2016). The sounds of wind blowing through trees evoke a calming effect, helps patients relax and stimulate the aural senses while enriching the soundscape in the environment (Christidis, 2014). Safety and security, wayfinding and orientation, nontoxic plantings, and sensory stimulation are key design guidelines in the design for AD and dementia care facilities (Cohen & Weisman, 1991; Lovering, 1990). The design guidelines presented in this study 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, HG and to serve as a basis to kick-start the design process. (See Table 4.2).

Table 4.2. Summary of AD and Dementia Garden Designs Considerations, Features and Guidelines

Design consideration(s)	Garden design feature	Design guidelines
Ease of Access, Movement & Orientation.	<ul style="list-style-type: none"> <li>▪ Visibility and Views.</li> <li>▪ Routes and entrances.</li> <li>▪ Footpaths.</li> <li>▪ Signage.</li> </ul>	<ul style="list-style-type: none"> <li>• Integrate views into the gardens to provide visible outdoor spaces which help to maximize staff comfort levels about residents being outside.</li> <li>• Provide clear, legible routes and entrances.</li> <li>• Provide level plane access to garden areas from communal rooms or private patios.</li> <li>• Introduce “circular” walking routes which return the resident to their starting point.</li> <li>• Footpaths around the garden must be immediately obvious and clearly signposted.</li> <li>• Path width should be at least 7 feet to accommodate two wheelchairs.</li> <li>• Seats should have adequate space around them so wheelchairs can fit alongside.</li> <li>• The south-east side of building should be oriented to ensure only an immovable building shadow cast into the garden at noon.</li> <li>• In small land spaces, roof top gardens can be used as alternatives which offer similar benefits to a ground level garden.</li> </ul>
Sensory Stimulus, positive distraction and Mental Mapping.	<ul style="list-style-type: none"> <li>▪ Phenomenology.</li> <li>▪ Haptic interaction.</li> <li>▪ Colors.</li> <li>▪ Fragrant verdant. Foliage and seasonal plants.</li> <li>▪ Texture.</li> <li>▪ Floor finish.</li> <li>▪ Pictures, art works and wall mural.</li> <li>▪ Positive sounds such as bird songs and sounds from water features.</li> <li>▪ Sunlight.</li> <li>▪ Spaces for meditation and reflection.</li> <li>▪ Spaces for physical activities.</li> </ul>	<ul style="list-style-type: none"> <li>• Garden designs for AD 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).</li> <li>• Introduce haptic elements in gardens to evoke the senses of touch and proprioception.</li> <li>• Gardens should be designed to moderately expose users to sunlight which is required for vitamin D synthesis and calcium metabolism.</li> <li>• Use patterns and floor texture to changes the dynamics larger surface area.</li> <li>• Incorporate variation in shades of brown (wooden elements) to reduce monotony.</li> <li>• During planning, considerations should be given to colors of both person-made objects (benches, stone walls and fences) and also to planting schemes.</li> <li>• Incorporate reminisce plants into the sensory garden and allow the residents/clients an opportunity to identify and suggest plant types for the garden.</li> <li>• Plantings should be organized to provide fragrant places, colorful verdant foliage and texture that stimulate all five senses.</li> <li>• Locate multiple smaller wandering gardens in different areas to create a more private experience.</li> <li>• Use pictures of real, live plants to initiate plant selection response.</li> </ul>

Design consideration(s)	Garden design feature	Design guidelines
Shelter, Shade and Outdoor Furniture	<ul style="list-style-type: none"> <li>▪ Pergola, climbing plants and trees.</li> <li>▪ Seats and arm rests.</li> <li>▪ Summer houses, huts and screened porches.</li> </ul>	<ul style="list-style-type: none"> <li>• Avoid abstract sculptures or art works that can evoke a negative response, such as increased stress and anxiety.</li> <li>• Include nectar-producing plants that lure birds into your garden. A garden “singing” with birds is an inviting place to visit.</li> <li>• Introduce plants that have significant spring or fall coloration that is quite different from other seasons to stimulate reminiscing.</li> <li>• Incorporate wall murals of nature scenes to evoke positive stimuli to the senses and stimulate a calming effect.</li> <li>• Select textured paths that make sounds as you walk on them, such as crushed gravel to aid people with sight impairment.</li> <li>• Install a water feature in gardens where possible to provide a cooling effect, positive distraction, visual appeal and to drown unwanted noise.</li> <li>• Integrate spaces for gardening experiences which offers the opportunity to reminisce and engage in familiar activities such as picking flowers, growing herbs and vegetables.</li> <li>• Create spaces for meditation and physical activities with the garden.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• Introduce a pergola, climbing plants and trees to create light shade.</li> <li>• Provide appropriate seating in the garden such as arm rests for elderly users.</li> <li>• Provide heated summer houses or winter gardens containing indoor plants to enable access to the garden environment all-round the year.</li> <li>• Choose durable and weatherproof furniture to avoid fading or rot caused by weather conditions.</li> <li>• The edges of outdoor furniture should be blunt or rounded.</li> <li>• Seats should provide comfortable arm and back rest that support upright seating posture.</li> <li>• Strategically place furniture at comfortable walking distances.</li> </ul>
Ground Preparation	<ul style="list-style-type: none"> <li>▪ Soil type.</li> <li>▪ Hardscape and pavements.</li> <li>▪ Drainage.</li> </ul>	<ul style="list-style-type: none"> <li>• Adequate choice of pavement material and texture.</li> <li>• Pavers should interlock with one another.</li> <li>• Paver textures should assist garden users with wayfinding.</li> </ul>
Safety or security, Maintenance and Enlightenment	<ul style="list-style-type: none"> <li>▪ Fences.</li> <li>▪ Anti-elope ment strategies.</li> <li>▪ Consistency in floor levels.</li> <li>▪ Smooth edged planters.</li> <li>▪ Physical support features: hand rails and covered metal grills.</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• The goal is to provide secured spaces that encourage a variety of activities without causing a sense of feeling “fenced in.”</li> <li>• Design path in the shape of a loop to minimize dead end space.</li> </ul>

Design consideration(s)	Garden design feature	Design guidelines
	<ul style="list-style-type: none"> <li>▪ Non-toxic or thorny plants.</li> <li>▪ Surveillance measures.</li> <li>▪ Education.</li> </ul>	<ul style="list-style-type: none"> <li>• Use colors to disguising exits in gardens in order to guide wandering patients and strategically control their movement.</li> <li>• 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.</li> <li>• Plant trees or shrubs in front of perimeter fence to soften the institutional look.</li> <li>• Avoid steps or sudden changes in level.</li> <li>• Slopes should be gentle.</li> <li>• Use circular planters rather than square ones with sharp corners.</li> <li>• Gardens should have adequate handrails for support and metal grills should be covered.</li> <li>• Stones in planting beds should be fixed firmly so that patients cannot move or throw them.</li> <li>• Avoid toxic, thorny plants or species with serrated leaves.</li> <li>• Install a mesh screen below the surface of the water to protect children and to discourage birds and cats from feeding on the fish.</li> <li>• Consider defensive planting screened with a combination of physical barrier to secure site boundaries.</li> <li>• Consider observation and surveillance of the space from the building.</li> <li>• Educate staff and volunteers about the gardens and how to access them, to maximize garden use.</li> </ul>

#### **4.4 Practical Applicability**

A major challenge in the domain of healing environment and healthcare architecture is the lack of education on evidence-based design concepts in practice. This has led to a dearth of awareness on novel trends and approaches to design. The awareness of the EBD concept in developing countries propels the quality of design in these regions. Although this concept is still in its embryonic stage, it has gained substantial application in developed countries. The healthcare industry has made landmark achievements in the design of healthcare facilities for specific patient groups including AD and dementia. However, these developments have not gained recognition in developing countries for several reasons, including lack of research, funding, poor research to practice dynamics, government policies, and a slow rate of technological advancement.

Asides educating the public and health care teams on the global progression of AD disease, the relevant Alzheimer's Associations in each locality should extend sensitization to educational institutions and disciplines involved in the planning and design of AD nursing homes. Courses that incorporate health related discourse, EBD principles and wellness theories should be introduced in pedagogical curriculum. Additionally, Architects and designers need to understand the current approach to designing AD and dementia care homes, which involve the integration of clinical findings and architectural guidelines as shown in the framework presented in this study. The application of the design parameters and features supported by the guidelines recommended in this framework may present some challenges depending on the region. A common reason for this difficulty is that, adopting these guidelines may require legislative approval and financial aid even at the local, state and federal

government levels. However, it is interesting to know that this framework is designed to be as flexible as possible, to accommodate the economic and technological capacities of any region.

For example, to apply this framework in a developing country, the scope can be limited to the use of HT and TG practices to achieve positive health outcomes. Also, therapeutic gardens can be introduced in the design of outdoor environments in AD and dementia care facilities to maximize health outcomes. Likewise, in a developed countries, the framework can be applied to its maximum capacity, where funding, healthcare policies and technology are easily accessible. Pre and post occupancy evaluations should be done to ascertain the practical applicability of the design and the user satisfaction of the building. Figure 4.7 shows a schematic diagram of the practical connection between the various phases of the framework



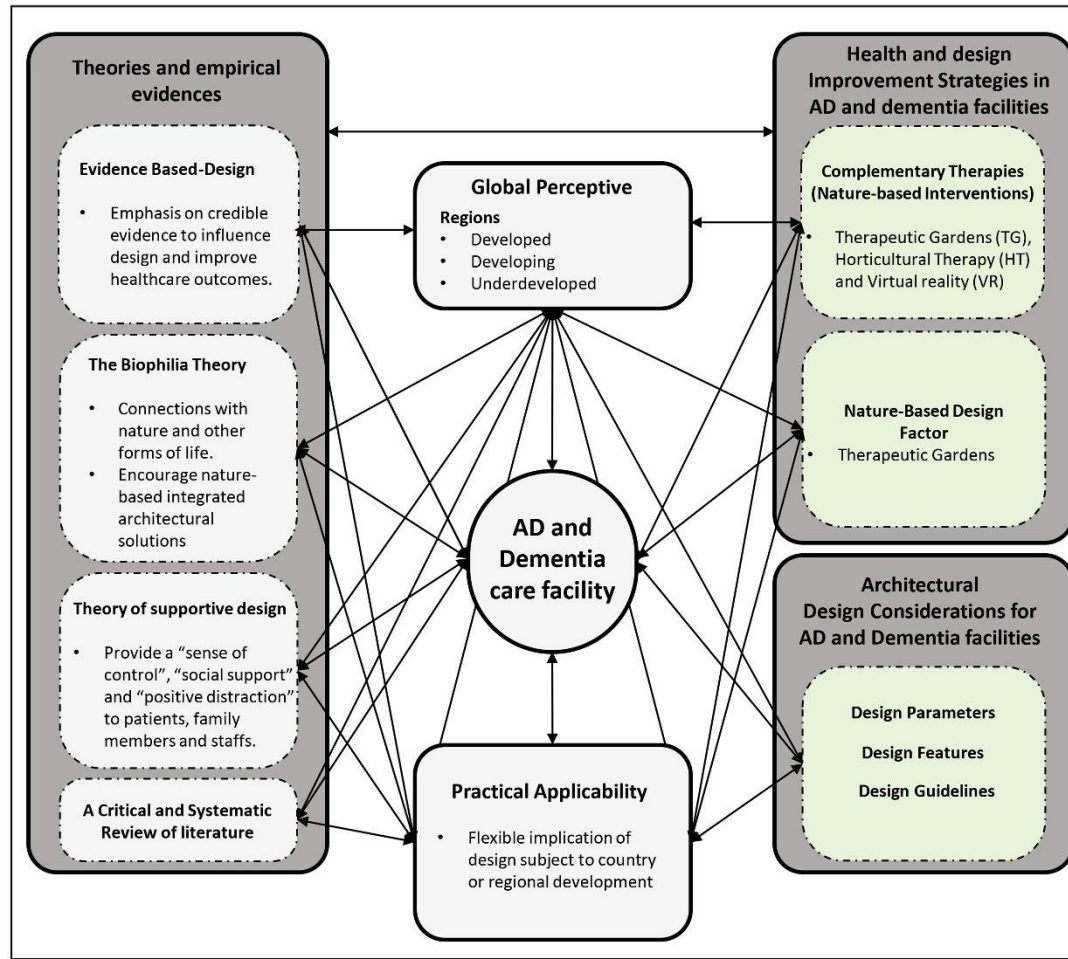


Figure 4.7. The Connection between All Sections of the Framework Showing Its Practical Application in Design (Authors compilation)

## **4.5 Design Recommendations**

### **4.5.1 Recommendations for Clinical Design Practice**

1. Evidence-Based Design strategies should be adopted in healthcare design process. Therapeutic gardens are designed with the intention to serve specific healing purposes to their users, thus involving client directly or indirectly throughout the design process yields better outcomes.

2. Evidences from clinical research on AD and dementia treatment should be combined with architectural design parameters, factors and guidelines from post occupancy evaluation results on existing gardens to guide the design of AD and dementia care facilities.

3. Landscape architects should incorporate the positive outcomes of horticultural therapy, therapeutic gardens and nature-based technologies through Virtual reality and expand the treatment options in AD and dementia care.

4. Courtyards should be designed in AD and dementia care homes where possible to foster access to nature through window views from patient rooms, waiting areas, and staff spaces.

5. Indoor potted plants should be strategically placed away from physical contact by patients in AD and dementia care facilities to prevent them from ingesting plants that may be poisonous, but visible enough to evoke the intended psychological health impact associated with visual contact.

6. Necessary precautionary measures must be taken when introducing indoor plants, because most individuals may suffer allergic reactions to certain flowering plants, as well as airborne pollutants that are not effectively phytoremediated can exacerbate ill health for building occupants.
7. Introduce indoor plant species such as "*Osmunda japonica*" commonly known as "Japanese royal ferns", or "zenmai" that can remove toxins, especially formaldehyde emitted from synthetic indoor furnitures.
8. Garden designs should foster social support for patients, such as sitting areas that encourage socialization between patients, family members and care teams.
9. The garden should provide positive distraction for patients. Positive distraction is a subliminal environmental, social and psychological phenomenon in a garden or natural settings, characterized by the ability to promote restoration from stress by distracting individuals with nature-based elements. Examples of positive distraction elements predominantly used in therapeutic gardens include animals, aquariums and greenery.
10. Nature themed wallpapers and illuminated stretched ceilings should be introduced in spaces without a view into the garden to simulate a feeling of being in an outdoor garden environment.
11. The design of therapeutic gardens should integrate wildlife such as butterflies, birds, and domestic animals including cats and rabbits. Natural sounds of nature from fountains, bird songs and breeze also provide a calming effect on users.

12. Nature-based VR technologies have been recently explored as a non-invasive treatment option in dementia care. The positive outcomes of this technology possess substantial benefits and should be considered as an alternative care option.




13. Pre and post occupancy evaluations should be carried out in AD and dementia care facilities to ensure the building complies with the intended design goals and nature-based interventions.




#### **4.5.2 Recommendations for Plants use in Therapeutic Gardens**




1. The use of plants in therapeutic gardens in AD and dementia facilities should not only provide an aesthetic appeal, but should also stimulate the senses and also reinforce the cycle of life and seasonal changes which could improve patients' cognitive gains by evoking memories of the past aroused by familiar plants, flowers or fragrance (Arslan et al., 2018).

2. Aromatic plants should be introduced in the design of therapeutic garden because they play a vital role in the healing process (medicinal purpose) of patients as well as in the aesthetic (colors, textures and shape) and functional (leaf forms, tree sizes and growth pattern) aspects (Arslan et al., 2018; Arslan & Akron, 2018). These studies suggest several aromatic plant species that can be used in therapeutic gardens and their characteristics, specifically those found in Turkey and most parts of the Mediterranean regions as shown in table 4.3 and 4.4.

Table 4.3. Selected Aromatic Plant species for Garden Design and their Characteristics (Adopted from Arslan et al., 2018; Predny, 1999).

Scientific Name	Plant	Flower Color	Seasonal Bloom period	Aromatic parts of plant
<i>Allium schoenoprasum</i> L.		Pink to pale purple	April to May	Fragrant Leaves
<i>Artemisia abrotanum</i> L.		Yellowish-white	August to October	Fragrant Leaves
<i>Cerastium tomentosum</i> L.		White	June	Fragrant Leaves

Scientific Name	Plant	Flower Color	Seasonal Bloom period	Aromatic parts of plant
<i>Foeniculum vulgare</i> Mill.		Yellow	June to July	Fragrant Leaves
<i>Melissa officinalis</i> L.		White to pale yellow	June to August	Fragrant Leaves
<i>Lavandula vera</i> DC.		Purple	June to August	Fragrant leaves and flowers

Scientific Name	Plant	Flower Color	Seasonal Bloom period	Aromatic parts of plant
<i>Mentha aquatica</i> var. <i>crispa</i> (L.)		Benth Silver	July to August	Fragrant Leaves
<i>Monarda</i> "Squaw"		Red	July to September	Fragrant Leaves
<i>Pelargonium crispum</i> (P.J. Bergius) L'Hér		Pink to white	Seasonal bloomer	Evergreen, Fragrant Leaves







Scientific Name	Plant	Flower Color	Seasonal Bloom period	Aromatic parts of plant
<i>Thymus citriodorus</i> (Pers) Schreb		Pale lilac	July	Fragrant Leaves
<i>Asarum europaeum</i> L.		Greenish-yellow to brown	April to May	Fragrant Leaves
<i>Asarum shuttleworthii</i> Britten and Baker f.		Purplish brown	April to May	Fragrant Leaves




Table 4.4. Selected Aromatic Tree species for Garden Design and their Characteristics (Adopted from Arslan & Ekren, 2018).


Scientific Name	Tree type	Characteristics
<i>Cupressus sempervirens</i> L. (Cypress/Servi)		<ul style="list-style-type: none"><li>• Column or pyramidal</li><li>• 25-30 m tall</li><li>• Antiseptic and antispasmodic effects of “oleum cupress oil” extracted from the tree</li></ul>

Scientific Name	Tree type	Characteristics
<i>Cydonia oblonga</i> Mill. (Quince/Ayva)		<ul style="list-style-type: none"><li>• Fleshy fruits.</li><li>• 4-6 m tall.</li></ul>
<i>Elaeagnus angustifolia</i> L. (Russian olive/İğde)		<ul style="list-style-type: none"><li>• Olive oil is obtained from its fruits.</li><li>• 3–12 m tall.</li></ul>


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<b>Scientific Name</b>	<b>Tree type</b>	<b>Characteristics</b>
<i>Laurus nobilis</i> L. (Daphne/Defne)		<ul style="list-style-type: none"><li>• Oleum Lauri (Daphne oil) is obtained from its fruits.</li><li>• It is used for flavoring food.</li><li>• 4-12 m tall.</li></ul>

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Scientific Name	Tree type	Characteristics
<p><i>Liquidambar orientalis</i> Mill.(Sweetgum/Günlük Ağacı-Anadolu Sığla Ağacı)</p>		<ul style="list-style-type: none"><li>• Oil balm with medicinal quality is obtained from the tree</li><li>• 20-25 m tall.</li><li>• Can be used to provide shade in seating areas.</li></ul>

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<b>Scientific Name</b>	<b>Tree type</b>	<b>Characteristics</b>
<i>Morus alba L.</i> (White Mulberry/Ak Dut)		<ul style="list-style-type: none"><li>• 10-15 meters</li><li>• Can be used to provide shade in seating areas.</li></ul>

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## **4.6 Summary of Chapter**

This chapter describes and summarizes the framework for improving Health, wellbeing and the Physical environment of AD and dementia care buildings. It explains the relationship between each section and sub component of the framework. The framework proposes that a good architectural design of care facilities, nursing homes or residential care home for the aging population is not enough to create a healing environment for individuals suffering from AD. However, the design of healthcare facilities should incorporate evidence-based design strategies and clinical research findings on health outcomes of these patients into the architectural design of care facility to achieve and optimal healing environment. This chapter buttresses the architectural design and health improvement strategies mined from empirical studies including design parameters, feature and guidelines for AD and dementia care facility. It presents schematic diagrams to explain the connection between these constructs and summarizes the various sections in a way that can be easily applied practically in a global scale. Finally, it documents recommendations for therapeutic garden applications in clinical practice and plant use.

## **Chapter 5**

### **CONCLUSION**

This chapter presents a summary of the research findings and proposes recommendations for clinical design practice. This study proposes that the design of care facilities for AD and dementia patients should be a consolidated approach that integrates clinical findings with architectural design solutions. It has been generally misconceived that dementia is a constant and inevitable part of aging. However, the WHO reinforces that AD and dementia is not a normal part of aging and that there are lifestyle changes people can and should take to potentially lower the risk (Abbott, 2019).

Through a critical and systematic review, the study reiterates evidences from empirical literature on the positive outcomes of nature-based interventions and treatment options for AD and dementia patients, given the fact that there is currently no cure for the disease. The theoretical core of this research was based on the tenets of three theories namely; Evidence-Based design (EBD), the biophilia theory and the supportive design theory. The rationale for selecting these theories stems from the fact that they all utilize therapeutic gardens and nature as a positive distraction and mediator between the healthcare physical environment and wellness improvement. Also, they incorporate physical, social, and psychological factors as well as technological advancements to promote healthcare designs.

A properly planned nursing home that incorporate therapeutic gardens as Evidence-Based Design factors will not only offer therapeutic benefits for specific patient groups, but can serve a wholesome purpose of optimizing the healthcare environment. The population of older adult has been projected to increase exponentially between the year 2000 to 2050. This suggests an urgent need for global sensitization on the treatment options for cognitive decline as well as the design of healthcare facilities for AD and dementia care. Several studies have been conducted on the benefits of therapeutic gardens as an architectural design factor. These environmental factors have been applied for many centuries for therapeutic purposes in healthcare environments and its benefit to human health has been well documented in research. Against this backdrop, this study proposes that the justification for providing outdoor spaces specifically designed for individuals with AD and dementia is dependent on the therapeutic and wellness benefit inherent in natural environments. Thus, puts forward a framework that employs the use of therapeutic garden as an environmental factors to improve the design of AD and dementia care facilities.

To answer the main research question of this study, which is: How can landscape and garden improve the wellbeing of AD and dementia patient's and the design of care facilities? The study mined the relevant themes, and keywords associated with the selected theories that are related to the patient group considered in this research. The research question was answered with the findings from empirical studies on the therapeutic benefits of nature-based interventions as well as therapeutic gardens for AD and dementia patients. These health benefits include reduced agitation, isolation and vulnerability, depression, aggressive behaviors and provided opportunity for walking and socialization, promotes physical activities, self-esteem, ambulation, positive reminiscences, improved short-term and long-term memories and improved



behavioral symptoms, improved strength and stamina, mobility, flexibility and endurance, enhanced coordination and social interaction, improved coping skills and motivation, reduced anxiety, increased confidence and hope, stimulates the sense through touching, tasting and smelling of plants as well as an overall improvement in quality of life.

The sub questions (1 and 2): What are the health benefits of nature in healthcare environments? What are the health benefits of therapeutic gardens for cognitive rehabilitation of AD and dementia patients?, further stimulated an investigation into the role of TG as a design intervention for improving the physical and mental health for AD and other dementias. Based on research findings, TG and HT has been predominantly used as an alternative treatment for AD and dementia. TG and HT were shown to have profound impacts on the physical, social, psychological and cognitive health status of AD and dementia patients. It was also established that TG should be used as a non-pharmacological intervention in the day-to-day care of AD and dementia patients for stress reduction, pain management and improvement of cognitive gains. Furthermore, results from the literature showed that nature-based intervention (including forest bathing) reduced blood pressure, improved stress and anxiety level, as well as cognitive decline and negative mood state. VR can be utilized to simulate or recreate a boundless range of environments or multi-sensory conditions that enhances mood, cognition and overall experience in AD and dementia patients.

The sub questions (3, 4, 5 and 6): How has research on the use of therapeutic gardens as an architectural design factor in AD and dementia care facilities evolved between 1984 –2019? What is the country or regional distribution of studies on the use of therapeutic gardens as design factors in AD and dementia care facilities? What is the

most common method used in research on therapeutic garden as an architectural design factor in AD and dementia care facilities? What are the architectural parameters to consider in the design of therapeutic gardens in AD and dementia care buildings?, were answered through a systematic review and content analysis of data retrieved from existing literature.

The findings of the systematic review revealed a preponderance of awareness on the use of therapeutic gardens as design factors in the academic domain (pedagogy) than in scientific research. This implies that more research emphasis has been laid on clinical treatment and health outcome than the environmental and architectural design considerations for improving healthcare facilities in AD and dementia care. Additionally, the findings suggest that academicians are less aware of the positive clinical outcomes and health impacts of therapeutic gardens and other nature-based interventions for improving wellness in AD and dementia facilities. This consolidates the need to approach the investigation of treatment options for AD from a research-design and design-research approach to achieve a consolidated health outcome. The findings revealed a decline in research publications on the use of landscape and garden as a design factor in AD and dementia facilities. This has led to a slow rate in knowledge building and research development of proper healing environment for patients. The decline concretizes the call for more studies and research, giving the progressive rate of the disease as projected by WHO.

The study highlights that the highest number of studies on the use of therapeutic garden as an architectural factor in the design of AD and dementia care facilities has been recorded in the United States of America (USA) and most parts of Asia. This is mainly due to the developed structure of health care systems in these regions. Also, most of

the case-based studies were sponsored by health care organizations and supported with research grants by the government. Furthermore, the support of health care regulatory bodies facilitate research on AD and dementia care by furnishing investigators with first-hand information about patients and their needs. This approach to research has been shown to yield better results. Case study method was shown to be the most used method in studies that focused on the use on therapeutic gardens as a design factor in AD and dementia care facilities. Occupancy evaluation methods (pre and post) was shown to be the second most used approach to research. This is as a result of real time information gathered from facility visits, focused group interviews and physical observation of care facilities. These observations are then compared against the original plan and as-built design conditions of the building to draw credible design conclusions. Furthermore, this study reveals that architectural design approach to garden for therapeutic outcomes, sensory factors in gardens and the integration of gardens as part of the overall design were mostly considered as key parameters in the design of AD and dementia care facilities. Design guidelines and recommendation was revealed to be a consistent requirement adhered in all the selected studies reviewed between the years 1991 to 2019.

This study reveals that architectural features such as (visibility and views, routes and entrances, footpaths, signage, 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, pergola, climbing plants and trees, seats and arm rests, summer houses, huts and screened porches, soil type, hard scape and pavements, drainage, fences, anti-elopement strategies, consistency in floor levels, smooth edged planters, physical support features: hand rails

and covered metal grills, non-toxic or thorny plants, surveillance measures and education) are a prerequisite for therapeutic gardens designs in AD and dementia care facilities. Much study has been and continues to be conducted by practitioners in the medical field, psychology and environmental sciences towards developing a cure for AD and dementia. However, as the population of older adults rapidly grows, the need to reconsider the care and design of AD facilities remains a global concern until a cure is found.

The guidelines presented in this framework are not intended to replace existing design considerations and theories currently practiced by healthcare professionals, rather, they are designed to aid landscape architects, healthcare team or people living with individuals suffering from AD dementia, to be more informed as well as make better health and design decisions. The findings of this research, address the general population of individuals with AD or dementia, reflecting key elements synthesized from evidences across several studies towards the design of care facilities. However, they may not yield a wholesome result due to the sensitive nature of these patient group. This implies that the parameters, features and factors mentioned in this framework should be applied subject to the specific needs and health conditions of the total population of patients in a single care facility.

The framework proposed in this study foregrounds that the architectural design quality of AD and dementia care facilities can be optimized through the integration of a well-planned therapeutic garden. Its applicability is flexible and can be globally adopted at regional levels according to their capacities. It will serve as a useful tool for healthcare administrators, policy makers, and landscape architects at the planning stages of AD and dementia healthcare facilities as well as academic practitioners to create more

awareness and education about design strategies for this studies patient population. TG should be evaluated based on the specificity of its site and users physical, social, cultural and psychological conditions. Thus, the design recommendations and parameters presented in this framework are intended to serve a general guideline for dementia garden designs. As this knowledge becomes more evident, designers and their collaborators are faced with the challenge to create therapeutic environments that would accommodate and improve the experience of people living with AD and dementia. This approach should be extended to other patient populations as well. In conclusion, it is important to note that the prevention and treatment of AD and other dementias may ultimately be dependent on the precedents of successful therapeutics from other chronic illnesses such as cancer, cardiovascular disease, and acquired immunodeficiency syndrome.

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## **APPENDICES**



## **Appendix A: Hypothesis on the Pathogenesis of AD**

As shown in Figure A.1, studies have proposed several hypotheses that may explain AD pathogenesis. For example, (i) the A $\beta$ -amyloid hypothesis, (ii) the A $\beta$ -amyloid oligomer hypothesis, (iii) the presenilin hypothesis, (iv) the Ca<sup>2+</sup>dysregulation hypothesis, (v) the lysosome hypothesis, and (vi) the tau hypothesis, (Kocahan & Doğan, 2017). Although, other investigators have earlier suggested a weak correlation between A $\beta$  deposition, neuronal atrophy and cognitive impairment (Rosales-Corral et al., 2012). Jucker and Walker (2011) considers the A $\beta$  hypothesis as the major cause of AD, driven by the accumulation and deposition of A $\beta$  peptide aggregates in the brain, a continuous imbalance between production and clearance of A $\beta$ <sub>40–42</sub> fragments by  $\beta$ - and  $\gamma$ -secretases which leads to accumulation of A $\beta$  peptide monomers, oligomers, and finally, large aggregated A $\beta$  plaque in the brain. Conversely, Kametani and Hasegawa (2018) considers the accumulation and deposition of oligomeric or fibrillar amyloid  $\beta$  (A $\beta$ ) peptide as the primary cause of AD and all attempts to develop A $\beta$ -targeting drugs to treat AD have ended in failure, thus, propose that the main factor causing progression of AD is Tau, not A $\beta$ .

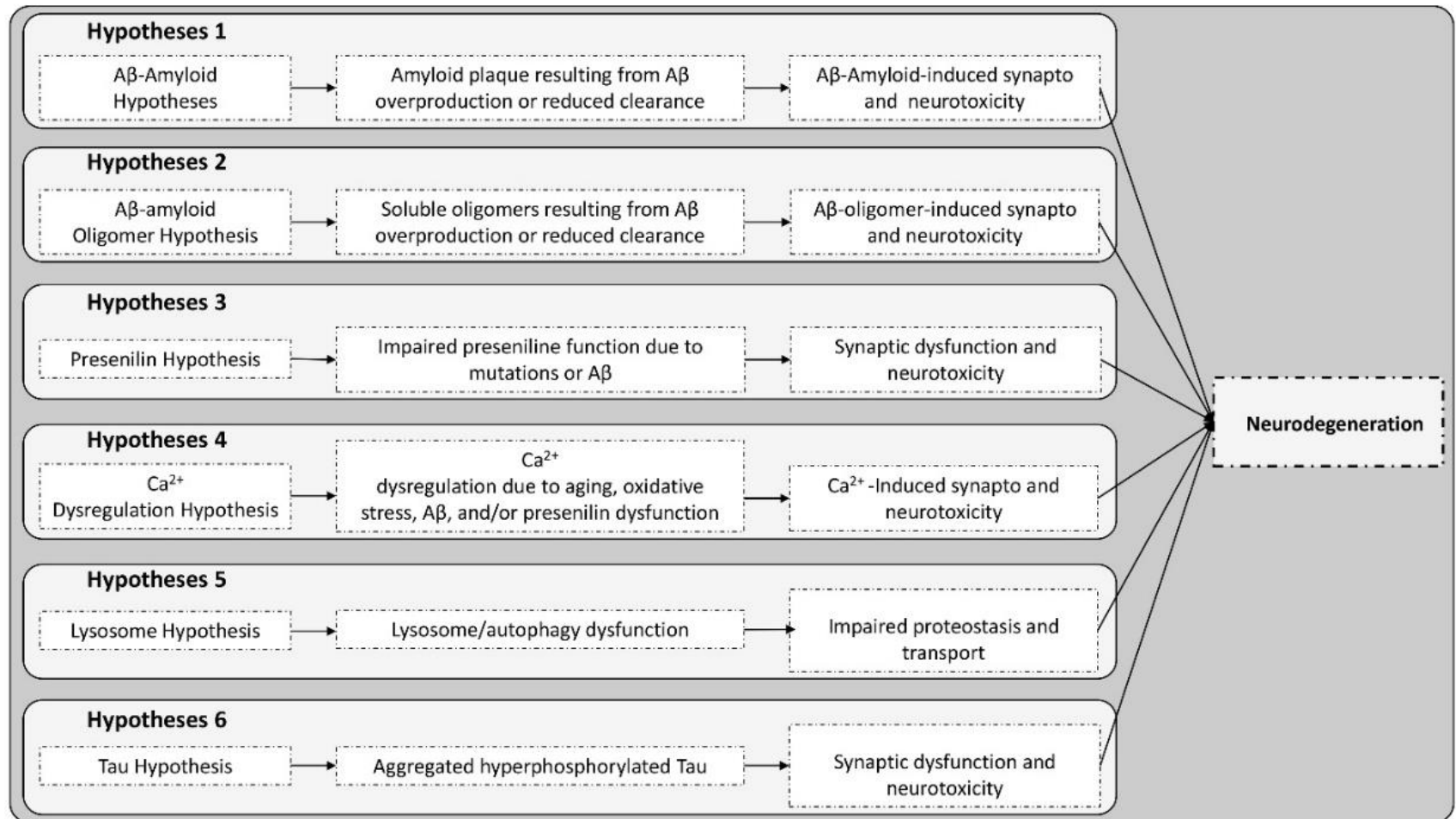


Figure A.1 Pathogenic Hypotheses of Synaptic and Neural Toxicity in AD (Adapted from Rosales-Corral et al., 2012).

AD related proteins in spinal fluid and brain gene expressions have been clinically used to test the thinking and concentration levels in older adults. The results reveal that older adults with and without dementia think and concentrate well in the late summer and early fall than in the winter and spring, suggesting a need to increasing dementia diagnosis and care resources during the winter and early spring (Lim et al., 2018).

## **Appendix B: Nature-Based Therapy on Behavioral and Physiological**

### **Indicators**

Public health benefits of interactions with the natural environment has revealed short-term recovery from stress and mental fatigue, faster recovery from physical illness, and improvements in long-term health and wellbeing (Maller et al, 2006). The introduction of biological markers in the clinical management of AD will not only improve diagnosis relating to early detection of neuropathology, but will also provide tools for the assessment of objective treatment benefits (Hampel et al., 2009). Recent investigations assessing physiological indicators, such as brain activity, autonomic nervous activity, endocrine activity, and immune activity, are accumulating from in situ and laboratory tests (Song et al., 2016). Nature-based therapy including horticultural, therapeutic gardens and forest bathing, presents a substantial positive role in the future of complementary medicine (Chan et al., 2017; Mao et al., 2017; Ochiai et al., 2015; Kotozaki, 2014; Detweiler et al., 2012; Li, 2010; Van Den Berg & Custers, 2011; Li et al., 2008; Li et al., 2007). Over the years, investigations in the fields of preventive and alternative medicine have also shown an interest in the therapeutic effects of forest therapy (Kamioka et al., 2014; Frumkin, 2001).

Research has shown that green landscape may help one recovery from stress by lowering blood pressure, increasing alpha brain wave amplitude, and reducing muscle tension (Kamioka et al., 2012; Takayanagi & Hagihara, 2006). The effect of forest bathing trips on human immune function has also indicated that forest bathing trips resulted in an increase in Natural killer (NK) activity, which was mediated by increases in the number of NK cells and the levels of intracellular anti-cancer proteins and phytoncides released from trees (Li, 2010). A study found that group walks in nature

were associated with significantly less depression, perceived stress, and negative affect and greater positive affect and mental well-being (Marselle et al., 2014). Current literature supports the comprehensive health benefits of exposure to nature and green environments on the physiological and psychological effects of Shinrin-yoku (forest bathing) including stress and burnout (Stigsdotter et al., 2018; Hansen et al., 2017). The results of an investigation on the effects of forest bathing on stress recovery showed that negative mood states, anxiety levels and systolic blood pressure were significantly reduced after visiting forests. Conversely, they also found improvement in positive mood state (vigor) after the program (Chen, et al., 2018). A study on the benefits of forest bathing for elderly patients with chronic heart failure (CHF) revealed an induced reduction of brain natriuretic peptide (BNP), inflammatory cytokines and oxidative stress levels in CHF participants. They also found that cardiovascular disease related pathological factors, including endothelin-1 (ET-1), and constituents of the renin-angiotensin system (RAS), angiotensinogen (AGT), angiotensin II (ANGII), and ANGIID receptor type 1 or 2 (AT1 or AT2) in subjects exposed to the forest environment were lower than those in the urban control group (Mao et al., 2017).

It has also been suggested that the physiological and behavioral reactions to stress involves a two-way communication of the brain with multiple biological indices, including the immune, endocrine, and cardiovascular systems (Detweiler et al., 2012; Viamontes & Nemeroff, 2009). Neuroendocrine indices, including salivary cortisol levels (Kotozaki, 2014; Van Den Berg & Custers, 2011), aliquoted plasma from blood (Chan et al., 2017) have also been explored through HT as well as gardening and reading activities to reduce stress on elderly health. The effects of stress on cognitive aging, physiology, and emotion project (ESCAPE) has been used to evaluate the short- and long-term impact of engaging in stress-related unconstructive repetitive thought

(URT) on cognitive health using psychological and physiological mediators through a multivariable approach that simultaneously assesses C-reactive protein (CRP) in blood plasma, and biomarkers including interleukin (IL)-1 $\beta$ , IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, tumor necrosis factor (TNF)- $\alpha$ , interferon (IFN)- $\gamma$  and granulocyte macrophage colony-stimulating factor (GM-CSF) (Scott et al., 2015). A randomized controlled trial on older adults investigated biomarkers including IL-1, IL-6, sgp-130, CXCL12/SDF-1, CCL-5/RANTES, BDNF (brain-derived neurotrophic factor), hs-CRP, cortisol and DHEA (dehydroepiandrosterone) to examine the effect of HT on psychosocial measures such as cognitive functions, depression, anxiety, psychological well-being, social connectedness and satisfaction with life. The findings reveal that engaging in HT reduces plasma IL-6 and may prevent inflammatory disorders, while maintaining plasma CXCL12 (SDF-1) may maintain hematopoietic support to the brain (Ng et al., 2018)

## Appendix C: Studies on the Design Impact of Therapeutic Gardens in AD and Dementia Care Buildings

Table 5.1. Summary of Previous Studies that highlight the Design Impact of Therapeutic Gardens in AD And Dementia Care Buildings

S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendati on(s)
1.	Beckwith & Gilster, (1997).	Article	Activities, Adaptation & Aging	Taylor and Francis	The paradise garden: A model garden design for those with Alzheimer's disease.	USA (Europe)	Elderly Care home	Garden	N/A	Case study	AD and dementia patients	Physical Landscape elements of garden design	Designing a restorative space for AD and dementia patients requires five elements including: Enclosing Wall. Water features. Canopy (Tree or Trellis). Mount or Hill. Paving.
2.	Heath & Gifford, (2001)	Article	Activities, Adaptation & Aging	Taylor and Francis	Post-Occupancy Evaluation of Therapeutic Gardens in a Multi-Level Care Facility for the Aged.	Canada (Europe)	Multi-level care facility	Garden	N/A	Post-occupancy evaluation	Cognitively impaired patients	Use of the Gardens, gardens goals, garden Features, cost effectiveness of the garden	Users reported satisfactory views into the garden, as well as frequent use and activity in the garden Main garden activities included sitting, walking, and interaction with people.

<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D iscipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
													<p>Users reported that the garden goals were met except for the provision of spaces for actual gardening and planting activities.</p> <p>High satisfaction on garden safety, wheelchair-accessibility, pathways, chairs, and raised garden beds.</p> <p>Users reported a lack of satisfaction on shading with trees, evening lighting, and water features in the garden.</p> <p>Cost effectiveness of the garden design features</p>



S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendati on(s)
													and goals had a higher satisfactory report compared to dissatisfaction.
3.	Zeisel, (2007).	Article	Journal of Housing for the Elderly	Taylor and Francis	Creating a Therapeutic Garden That Works for People Living with Alzheimer's	N/A	Elderly Care home	Garden	N/A	Exploratory study	AD and dementia patients	Architectural design approach to garden for therapeutic outcomes	The interior and exterior environments of AD and dementia care facilities must be harmoniously designed to respond to their mental health state. Design approach to gardens for AD and dementia patients should involve 3 critical step in including: Image information ( <i>Loss of complex brain function,</i>

S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendati on(s)
													<i>Indoor/outdoor unity, Natural mapping, temporal support, Learning support, and Land marking).</i> Presenting <i>(Design interior and exterior spaces together, design a "park" in the garden, maintain continuous visible re-entry in garden, design the entrance and exit to and fro the garden as a landmark, safety and security considerations, maintain 90° shortcuts).</i> Testing information <i>(Safety and</i>

S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendati on(s)
													<i>security, Walking pathways, Landmarks, Territory, Shared places, Sensory experiences, Prosthetic supports, Residential and normal).</i>
4.	Moore, (2007).	Article	Journal of Housing for the Elderly	Taylor and Francis	Restorative dementia gardens: Exploring how design may ameliorate attention fatigue.	USA (Europe)	Elderly Care home	Garden	N/A	Case study	AD and dementia patients	Design implicatio ns of Kaplan's Attention restorative theory on fatigue in gardens	Garden designs should incorporate the four properties of Kaplan theory of restorative environments including: being away, fascination, extent and compatibility to improve executive brain functioning and reduce fatigue

<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D iscipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
5.	Marcus, (2007).	Article	Journal of Housing for the Elderly	Taylor and Francis	Garden of the Family Life Center, Grand Rapids, Michigan	USA (Europe)	Elderly Care home	Garden	N/A	Case study	AD and dementia patients	Physical features of Therapeuti c outdoor gardens	in dementia patients. The study documents architectural design recommendatio ns including: Visibility and accessibility. Covered Patio or Terrace. Simple returning pathways. Adequate Seating. Outdoor Space that are domestic and suitable to the local culture. Incorporate a wide variety of Perennials Plants. Adequate enclosure and security within the garden.

S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendati on(s)
6.	Grant & Winem an, (2007).	Article	Journal of Housing for the Elderly	Taylor and Francis	The Garden-Use Model– An Environmen tal Tool for Increasing the Use of Outdoor Space by Residents with Dementia in Long-Term Care Facilities	USA (Europe)	Long- Term care facility	Garden	N/A	Case study	AD and dementia patients	Physical and visual aspects of garden	Both physical and visual access to outdoor garden environments were considered most important by staff and patients.
7.	Hernan dez, (2007).	Article	Journal of Housing for the Elderly	Taylor and Francis	Effects of therapeutic gardens in special care units for people with dementia: Two case studies.	USA (Europe)	Special Care dementia units	Garden	N/A	Post occupa ncy evaluati on	AD and dementia patients	Therapeuti c garden design integration in dementia care facility	Therapeutic gardens can serve as a more holistic approach to treatment in AD and dementia cure until a cure is found. Therapeutic gardens should be considered as a new building standard in nursing homes.

S/N	Ref(s)	Study Type	Journal/Discipline	Database Source	Article topic	Study country and Regional	Study Setting	Design intervention	Intervention exposure dosage	Method	Patient group	Primary measured design factor	Design / recommendation(s)
													Design recommendations were proposed.
8.	Jonveaux, et al., (2011).	Article	Alzheimer's & Dementia: The Journal of the Alzheimer's Association	Elsevier Science Direct	Evaluation Of Benefits Of A Healing Garden For Alzheimer Patients: New Methodology To Evaluate A Design Concept Integrating Artistic And Neuropsychological Approaches	France (Europe)	University Hospital	Garden	N/A	Semi structured interviews	AD and dementia patients	Dimension of cultural invariants, emotion, and reminiscences.	HG that incorporate cultural and emotional factors of reminiscences improved behavioral disorders such as agitation, aggression aimless wandering deambulation, sleep, general health and nutritional status.
9.	Liu, et al., (2018)	Article	Alzheimer's & Dementia: The Journal of the Alzheimer's Association	Elsevier Science Direct	Quantifying Interactions Between Gaze Behavior And Physiological	Japan (Asia)	Experimental Space	Garden	N/A	Experimental Design	AD and dementia patients	Visual aspects of the garden design.	Visually appealing features in garden designs improves engagement. Ambient temperature was

S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendati on(s)
			Associatio n		Responses When Viewing Japanese Style Gardens								revealed to be an important factor for garden design.
10	Hoover, (1995)	Article	American Journal of Alzheimer' s Disease and other dementias	Sage	HG and Alzheimer's disease	USA (Europe)	Elderly care home	Garden	N/A	Case study	AD and dementia patients	Emotional and psychologi cal impact of garden design	AD and dementia gardens should be consciously designed to meet the needs of patients at their various stages of cognitive decline including: the mild or forgetful stage, the moderate or confused stage and the severe or demented stage
11	Furness & Moriart y, (2006).	Article	Dementia	Sage	Designing a garden for people with dementia –	UK (Europe)	Park	Garden	N/A	Case study	AD and dementia patients	Sensory dimensions in gardens for AD and dementia	Improving accessibility. Integrating sensory feature including water,

S/N	Ref(s)	Study Type	Journal/Discipline	Database Source	Article topic	Study country and Regional	Study Setting	Design intervention	Intervention exposure dosage	Method	Patient group	Primary measured design factor	Design / recommendation(s)
					in a public space							in public space	herb wheel and raised flower beds. Colour and texture of plants helps patients' sensory perception. Plants, furniture and garden features were used to improve reminiscence in the garden.
12	Weathey & Moriarty, (2006).	Article	Dementia	Sage	The Grange Garden Project: A garden for people with dementia—in a day centre	London (Europe)	AD and dementia care facility	Garden	N/A	Case study	AD and dementia patients	Physical dimensions of garden	Garden designs should include circular pathways and Pergolas that provide support for climbing plants.
13	Detweiler et al., (2008).	Article	American Journal of Alzheimer's Disease & Other Dementias	Sage	Does A Wander Garden Influence Inappropriate Behaviors In Dementia Residents?	N/A	AD and dementia care facility	Garden	N/A	Pre and post occupancy evaluation	AD and Dementia patients	Garden design impact on resident behavior	“Wander gardens” Reduced agitation in dementia care facilities



<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D iscipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
14	Charras et al., (2018)	Article	Dementia	Sage	Designing dementia-friendly gardens: A workshop for landscape architects: Innovative Practice	France ( Europe)	Elderly care home	Garden	N/A	Literature review	AD and dementia patients	Social and cultural design factors	Garden elements including vegetables, orchard and terrace familiar to users can improve their social-cultural dimensions of gardens. Garden design consideration should include: Attractiveness and control of outdoor spaces. Social use. Strategies that encourage curiosity. Accessibility and ergonomic characteristics. A structured design composition. Vegetation management strategies.

<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D iscipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
15	Landon , (2016).	Doctoral dissert ation	Architectur e	ProQuest dissertatio n and thesis global	A Proposal For Design Guidelines For Dementia Care Facilities In Hawai'i	USA (Europe)	AD and dementia care facilities	Garden	N/A	Case study	AD and dementia patients	Design guideline and recommen dation	Documented design guidelines for AD and dementia facilities. The study identified the most important features in AD and dementia facility as: The site General area Safety/security Ccorridors Activities
16	Gayna, (2013)	Master 's Thesis	Landscape Architectur e	ProQuest dissertatio n and thesis global	A Case Study Exploring Therapeutic Garden Design for Elderly with Dementia at the Jewish Home of San Francisco	USA (Europe)	AD and dementia Care home	Garden	N/A	Case study	AD and dementia patients	Design guideline and recommen dation	Design recommendatio n include: Circulation. Paved covered patios. Pagoda and covered areas. Therapeutic water feature. Planting palette or scheme.

<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D isipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
17	Amanda, (2012)	Master 's Thesis	Architecture	ProQuest dissertation and thesis global	An Urban Architecture to Nurture People Affected by Alzheimer's Disease	Canada (Europe)	AD and dementia Care home	Urban design	N/A	Case study	AD and dementia patients	Design guideline and recommen dation	Design parameters include: Mobility. Colour of fabrics, finishes and textures. Lighting. Sound. Material that stimulates the senses. Outdoor landscape and garden.
18	Cuiyan, (2012)	Master 's Thesis	Landscape Architecture	ProQuest dissertation and thesis global	Planting Design And Its Impact On Efficacy In Therapeutic Garden Design For Dementia Patients In Long-Term Care Facilities In North Texas	USA (Europe)	AD and dementia Care home	Garden plants	N/A	Case study	AD and dementia patients	Design guideline and recommen dation	Planting design recommendatio ns include: safety and security Orientation. Provide stimulation. Maximize autonomy, self- esteem, and dignity.

S/N	Ref(s)	Study Type	Journal/Discipline	Database Source	Article topic	Study country and Regional	Study Setting	Design intervention	Intervention exposure dosage	Method	Patient group	Primary measured design factor	Design / recommendation(s)
19	McKeron, (2010)	Master's Thesis	Architecture	ProQuest dissertation and thesis global	Architecture, Mind, and Memory: Design for Alzheimer's	USA (Europe)	AD and dementia Care home	Sensory features of space	N/A	Case study	AD and dementia patients	Design guideline and recommendation	The fields of neuroscience and architecture should be properly integrated to create physical environments that are more accustomed to human experience. Design considerations for AD homes should include: Lighting Colour Wayfinding Outdoor spaces Haptic Senses
20	Pense, (2009)	Master's Thesis	Plant and Soil Science	ProQuest dissertation and thesis global	Design And Case Study Of An Alzheimer's Garden In The Illinois Veterans Home At Anna	USA (Europe)	Veterans Home	Garden	N/A	Case study	AD and dementia patients	Design guideline and recommendation	Positive effects of gardens can be achieved if the design follows a principles based on facts about the disease and its symptoms.

S/ N	Ref(s)	Study Type	Journal/D iscipline	Database Source	Article topic	Study country and Regional	Study Setting	Design inter- vention	Inter- vention exposure dosage	Metho d	Patient group	Primary measured design factor	Design / recommendi on(s)
													Garden design should encourage exercise, support better health, maximize remaining abilities and reduce the need for prescription drugs.
21	Dixon, (2002)	Master 's Thesis	Landscape Architectur e	ProQuest dissertatio n and thesis global	A return to the garden: Design criteria for therapeutic exterior environmen ts for people with Alzheimer disease	Canada (Europe)	AD and dementia care facility	Garden	N/A	Literatu re review and concept ual design	AD and dementia patients	Design guideline and recommen dation	Macro Spatial Strategies including (the relationship of building to garden, adjacencies of living spaces, accessibility of the garden, relationship between interior and exterior spaces functions, views into the garden, monitoring and placement of windows)

<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D iscipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
													<p>should be considered.</p> <p>Meso Strategies including (special typology, garden layout element, microclimate, landmarks, sitting areas, pathways, and edges) should be considered.</p> <p>Micro strategies including (design guidelines for sensory perception such as olfactory, auditory and plant stimulation, building materials, site features and furniture) should be considered.</p>

<b>S/ N</b>	<b>Ref(s)</b>	<b>Study Type</b>	<b>Journal/D iscipline</b>	<b>Database Source</b>	<b>Article topic</b>	<b>Study country and Regional</b>	<b>Study Setting</b>	<b>Design inter- vention</b>	<b>Inter- vention exposure dosage</b>	<b>Metho d</b>	<b>Patient group</b>	<b>Primary measured design factor</b>	<b>Design / recommendati on(s)</b>
22	Gilson, (1994)	Doctor al dissert ation	Landscape Architectur e	ProQuest dissertatio n and thesis global	Design criteria for outdoor space and human behavior: A better fit for Alzheimer's disease patients	USA (Europe)	Special Care dementia units	Garden	N/A	Literatu re review and case study	AD and dementia patients	Design guideline and recommen dation	Design criteria include: Safety and security. Orientation and wayfinding. Stimulation Maximize autonomy.

