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## **ABSTRACT**

*Research on nature and human health relations has developed into a multidisciplinary, innovative and international field. It can be claimed that there is sufficient research evidence to support the assertion that natural environments can support health promotion and can act as supportive environments for nature-based therapies. Research is progressing and is getting closer to confirming the dominant theories from the field of environmental psychology. However, today, there is a gap between research and practice. This paper argues that not all nature environments support positive health outcomes. Relevant research for landscape architects is lacking and tools on how to work evidence-based in the design process are much needed. Also, knowledge on how the health supportive environments should be used in daily life or in therapies is weak.*

*This paper presents lessons learned from the University of Copenhagen's Nature, Health and Design Laboratory. The laboratory currently consists of the forest therapy garden Nacadia® where nature-based treatment is offered to individuals with stress-related diseases and the health forest Octovia®, which offers health promoting nature experiences and activities. The paper includes aspects on research methods, a model for evidence-based health design and some considerations on how research can be communicated to practitioners.*

**Keywords:** Nature and human health relations, evidence-based health design, nature-based therapy, applied research, mixed methods, research communication

## **1. INTRODUCTION**

### **1.1 Historical Hindsight**

Worldwide, there is an increasing interest and awareness of the positive relation between spending time in or viewing natural environments and human health. However, it should be stressed, by way of introduction, that this is not a new idea. Rather, it can be understood as the renewal of a notion that has been considered to be quite self-evident for a very long time. Written descriptions of city plans that explicitly mention health in relation to location, structure and access to parks have been traced back to antiquity [1,2]. The garden, as a phenomenon, may have been regarded as a healthy place from the very beginning [3,4], which has led to the use of gardens in medical care and treatment through history. The idea of a positive relation between human health and gardens can be traced back to the Middle Ages, the Roman Empire, and indeed as far back as the Persian Empire [3,4].

### **1.2 Research on nature and human health relations – state-of-the-art**

During recent decades, the aggregate amount of research evidence has confirmed the general idea that nature is a resource in relation to human health [5]. Research evidence from laboratory experiments as well as field studies indicates positive health outcomes of either visual or physical contact with natural environments. These positive effects are seen at the cellular [6], individual [7] and population levels [8,9]. Current research proposes that natural environments have positive impacts on human health in the following three main ways:

1. Encouraging physical activity
2. Encouraging social contact
3. Providing psychological and physiological restoration

There may also be synergies between the three; meaning physical activity in a natural environment having greater psychological and physiological outcomes than in a non-natural environment [10].

The state-of-the-art can be summarised as there is already sufficient evidence to support the idea that natural environments promote human health and can act as supportive environments for nature-based therapies, even though the dominant theories, e.g. the Affective Aesthetic theory (sometimes called the Stress Reduction Theory [11] and the Attention Restoration Theory [12,13] have not yet been confirmed.

Compared to many other fields, research on nature and human health relations is still rather new. It can also be claimed that it is a dynamic field of research with regard to the increasing number of published scientific articles, while the number of countries involved as well as the number of research disciplines conducting research related to this topic is increasing.

Further, it can be claimed that the scientific articles are presenting more and more innovative research designs, ranging from traditional case studies, to randomized controlled trials. Also, regarding the research methods, more creative methods are being used. For example, there is a current tendency to use physiological measurements, e.g. heart rate variability, but also qualitative methods are being combined with quantitative. This dynamic development has resulted in research evidence that is getting closer to 'proving' the dominant theories, which were formulated by researchers in psychology and environmental psychology almost 40 years ago [11,12,13].

## **2. DESIGNING FOR HUMAN HEALTH**

### **2.1 Health Design within Landscape Architecture**

The demand for different types of natural environment that promote health and or support treatment is increasing globally. However, not all natural environments are good for health. Indeed, examples of natural environments that have had negative health outcomes exist [14]. The conscious design of green spaces and gardens so that they, in a certain way, support health processes and result in improved health outcomes has evolved into a new branch of landscape architecture. The English-speaking countries refer to it as Health Design.

The research group 'Nature, Health and Design' at the University of Copenhagen asserts that Health Design within landscape architecture consists of four interacting main parts: the environment, the users, the human health aspect,

and the use. The environment includes natural environments at very different scales, ranging from large nature areas to small pocket parks. Depending on the assignment, both individual roles of the environments as well as linkages between them can be considered. The users or user groups must be clearly defined, since ill people may perceive and understand the environments differently from others [15]. By adopting an inclusive perspective, Universal Design is naturally linked to Health Design. Human health is a broad term, but in Health Design, the way in which the natural environment is expected to support health must be clarified, e.g. health promotion, ill health prevention or treatment/therapy. Most often, Health Design projects focus on public, mental, physical or social health. An alarming tendency that was noticed by the research group a few years ago is that some well-designed settings are being laid out, but not used, or not used in a way that was intended; the consequence being that the health supportive potential diminishes. Therefore, the use of the environment must be defined and incorporated into the concept of Health Design. The use may include, e.g. specific nature-based treatment programs or guided health promoting activities.

### **2.2 Evidence-Based Design**

Landscape architecture is gradually becoming a more evidence-based profession. Aesthetic skills are increasingly being integrated with research evidence in the planning, designing and management of the landscape. Some parts of landscape architecture have also previously had a tradition of working evidence-based, for example, within the field of landscape technology, which includes aspects such as water, terrain and plants, while other parts have been and still are less developed.

### **2.3 A Gap Between Research and Practice**

In several countries, an architect may not design a hospital unless he or she is qualified in evidence-based design (EBD) [16]. In Europe, we have not yet come so far, although there is a tendency that in architectural and landscape architectural design competitions for hospitals and care units, an evidence-based design process is more often demanded or recommended. Often, the architects and the landscape architects fall short here. This may be explained by the fact that very little current research on nature and human health relations has an architectural or landscape architectural perspective. In other words, few research results can be applied in the work of architects and landscape architects.

### **2.4 Communicate research evidence to practitioners**

Few landscape architects are researchers, and not many have the time to find research and read research publications. Some contact the university to obtain access to research material or direct design advice. Often, they have very precise questions such as: “How many square meters should a therapy garden be?”, “Which form should a therapy garden have?”, “How many trees are needed to make a green space health promoting?” or “Is a pond better than a fountain, viewed from a health perspective?” Questions like these are very difficult to answer. Therefore, the Nature, Health and Design research group has chosen to:

- Conduct research that might be more relevant and the results more applicable, e.g. design tools for landscape architects [e.g. 17,18]
- Communicate research evidence in pedagogical step-wise conceptual manuals [19,20]
- Construct demonstration sites
- Run a web-based information portal
- Develop a model that can guide the landscape architects through the evidence-based health design process

### 2.5 A model for evidence-based health design

The research group is working towards developing a transparent and exploratory model of the evidence-based health design (E-BHD) process, which is illustrated in figure 1. The model has three equally important main components that must initially be documented:

1. Aesthetic and practical landscape architectural skills and experience
2. Research evidence and valid practical experience
3. The specific user/patient group’s special needs, wishes and preferences. In case of treatment, the treatment program and the patient’s expected rehabilitation process must be included

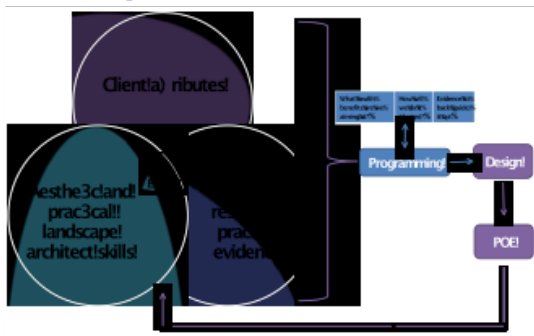


Figure 1: A schematic illustration of the evidence-based health design process.

It is vital to stress that the three parts are equally important, although finding a balance between them can sometimes be a challenge. This initial work constitutes the foundation for the next step of the model, which is the programming, which guides the subsequent design. Here, the desired health outcomes must be stated; how they will be achieved by the design as well as the evidence to support this. Evidence-based health design is, however, a process. An important aspect of this model is that the process does not stop when the design has been realized. The garden must be continuously evaluated. This is achieved by a post occupancy evaluation (POE), which evaluates whether the design fulfils the intentions, but it is also conducted so that any newly documented experiences or research results can be incorporated into the garden design. It is recommended that funding for a POE is taken into account in the budget of any health design.

### 3. THE NATURE, HEALTH AND DESIGN LABORATORY

In line with the three top bullet points in chapter 2.4, the research group’s ambition was to establish a Nature, Health and Design Laboratory to serve as a site for: research (both basic and applied), practice (nature-based treatment and health promoting activities), demonstration and teaching. Last year, in 2014, the laboratory became a reality thanks to the collaboration with the researchers in the research group and with financial support from the University of Copenhagen and several foundations.

The laboratory is located in the Hørsholm Arboretum, which is Denmark’s largest collection of trees and shrubs. The arboretum was established almost 80 years ago (in 1936) on what was almost bare ground. The arboretum was laid out with great knowledge on how to optimize the living conditions for the different plants from all over the world, but also with great knowledge and understanding of the aesthetic values regarding how to compose beautiful natural scenery. Today, the Arboretum is a majestic and exotic forest and belongs to the University of Copenhagen. From the outset, it has been used in botany and plant use research and teaching. During the last ten years, the Nature, Health and Design research group, who represent a totally different field of research, has been interested in conducting research in the Arboretum due to the rich nature experiences it provides. For the same reason, the Arboretum is a popular recreation area for the public.

The laboratory is the first of its kind, and the focus is generally on the interaction between nature, health and design. The laboratory currently consists of two projects; the forest therapy garden, Nacadia®, and the health forest, Octovia®. The two projects represents the two main perspectives: In Nacadia®, nature-based treatment is offered to people suffering from stress-

related diseases, while Octovia® offers nature experiences that aim to promote good health and prevent ill health. Both projects are based on a common theoretical framework, and are designed according to the evidence-based health design process. Further, two conceptual manuals have been published [19,20], which target practicing landscape architects. In the manuals, the evidence-based design processes for the projects are thoroughly described, from the initial idea to the construction phase, with the aim of serving as a practical guide for landscape architects.

The vision is that the laboratory will develop into a hub for researchers, practitioners, students and others who are interested in nature, health and design.

### 3.1 The Forest Therapy Garden Nacadia®



Figure 2. Site illustration, the forest therapy garden Nacadia®.

Nacadia® is the first therapy garden in Denmark to be connected to research and education at a university. The therapy garden covers 1.1 hectares and can be characterized as a forest garden, mainly constructed from plant materials (figure 2).

The research group defines a therapy garden as:

- A deliberately designed garden the intention of which is to actively and positively contribute to the clients' treatment and wellbeing
- A garden which matches the clients' treatment process by both supporting and challenging them

- A garden that provides meaningful activities, concrete and symbolic, all year around
- It is a prerequisite for conducting nature-based therapy that the design of the garden and the therapy program are closely related

Nacadia® has four main objectives:

1. To provide nature-based treatment for clients with stress-related illnesses
2. To obtain evidence-based knowledge about the effect of health design and nature-based therapy for the client group
3. To offer education within the field of health design and nature-based therapy
4. To serve as a knowledge and demonstration center

When conducting research on the impact of a garden's design on the clients' treatment process and health outcomes, many factors may bias the results. Therefore, five rooms were designed within the garden with some constant conditions: shape, size and direction, albeit with diverse content. Based on this, Nacadia® was designed according to ten overall criteria, which are based on research evidence as well as documented experiences from other therapy garden projects:

1. Spatial structure – The garden must be perceived as a whole. It consists of a large room with several smaller rooms.
2. Living building material – The walls of the rooms are formed by shrubs or green fences, the floors are made of grass or wood and the roofs are formed by treetops or pergolas with flowering climbers.
3. Easy to interpret – The clients must be able to interpret what the garden can offer them, and what they may do.
4. Security – The garden provides a sense of total security. The green walls block outsiders' visual or physical access.
5. Levels of Safety – During the treatment process, the clients must be exposed to less safe and more demanding areas. The location of the garden within the Arboretum offers an extra semi-safe zone, which the clients can visit as they become better.
6. Strength of Mind – The clients' experience of nature and the level of demands they are able to handle depend on their emotional and cognitive resources. This can be illustrated as a four-tier pyramid where the need for natural environments, which place few demands on the client, is large at the bottom, and smaller at the top. Nacadia® is designed to accommodate clients at all levels of emotional and cognitive strength.
7. Mental and physical accessibility - Mental accessibility is about attracting the clients into the garden. At the same time, it is important that the visible attractions are also physically accessible. By using different natural paving materials and varied terrain, the clients' body awareness and fitness are improved.

8. Flexibility and Participation – As a result of the evidence-based design process, the garden will be regularly evaluated and re-designed over the years. In one room of the garden called ‘the free forest’ the clients can be creative and influence the garden’s design.

9. Perceived Sensory Dimensions of Nature - Research shows that people classify natural environments in terms of eight specific characteristics called Perceived Sensory Dimensions (see chapter 3.4) [21,22]. Some of those are preferred over others by people suffering from stress. All eight PSDs are included in Nacadia®.

10. Opportunities for nature-based activities – It is fundamental that the garden offers opportunities for meaningful activities all year round. Some activities are practical in nature, while others are symbolic.

### 3.2 The Nature-Based Treatment

The mindfulness-inspired nature-based treatment offered in Nacadia® has a salutogenic (health creative) perspective, which means the emphasis is on what is strong and healthy within each client; the aim being to enable the clients to restore their physical, psychological and mental balance [23]. The focus is on developing and strengthening the clients’ capacities as a means to overcoming the illness and enhancing their overall quality of life. It is also important that the clients develop and establish healthy stress preparedness so they can prevent new negative stress from occurring in the future.

The mindfulness activities are used to bring the clients’ attention to and acceptance of the present moment by paying non-judgmental attention to their thoughts and feelings. The clients’ experiences, perceptions, nature-based activities, and the surrounding garden are essential parts of the therapeutic process.

The treatment is a ten-week program during which the patients receive three hours of therapy in the morning, for three days a week. The treatment is offered year-round and the therapy is conducted in a group of eight clients who are led by two trained horticultural therapists and an assistant gardener.

### 3.3 Ongoing Research at Nacadia®

A few years ago, a comprehensive research project was initiated called the Nacadia Effect Study (NEST), which consists of three main parts:

1. A randomized clinical trial (RCT), where the nature-based therapy in Nacadia® is compared to a validated form for Cognitive Behavioural Therapy.
2. A longitudinal study using register data regarding, e.g. return to work, use of medication and contact with health care services, ranging from three years prior to the NEST project until one year after the conclusion of the

therapy offered in the project.

3. An explorative study investigating the impact of the design of Nacadia® on the therapy and clients.

NEST is a time consuming project and all the data for the RCT and the longitudinal study will not have been collected until April 2016, after which the analysis of the data will start. The data for the explorative part has been collected, and all of it will be reported within the next couple of years.

### 3.4 The Health Forest Octovia®

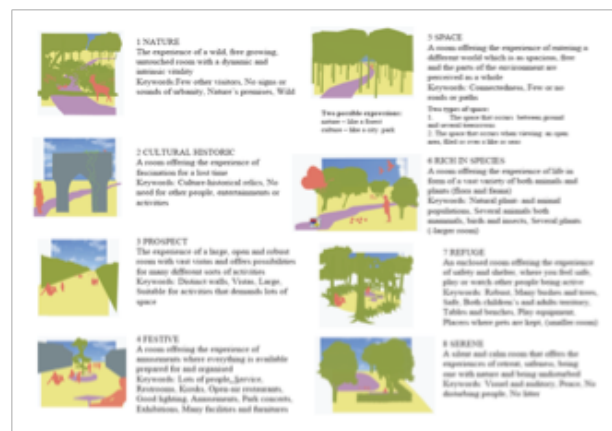


Figure 3. Visualisations and short descriptions of the eight perceived sensory dimensions (PSD).

The results from a research collaboration between the University of Copenhagen and the Swedish University of Agricultural Sciences (SLU) form the background for the Health Forest Octovia® [21,22]. The overarching hypothesis of the joint research project was that people perceive green spaces in terms of certain dimensions, where some dimensions are more important and preferred than others with respect to restoring people from stress. Based on questionnaire responses from almost 1,000 randomly selected informants including responses regarding preferences for natural qualities and self-estimations of health status, the results identified and described eight perceived sensory dimensions (PSDs) (figure 3). People, in general, prefer the dimension Serene, followed by Space, Nature, Rich in Species, Refuge, Culture, Prospect and Social. The dimensions Refuge and Nature are most strongly correlated with stress, which indicates a need to find the

most restorative environments. A combination of Refuge, Nature and Rich in Species, and the low presence or absence of Social may be interpreted as the most restorative environment for stressed individuals [21].

It is the third time these eight dimensions have been identified in research, but the first time they have been based on information from individuals instead of organisations, and the first time it has been possible to relate the dimensions to the respondents' health status [21].

Both policy makers and practitioners were interested in the PSD, and they have been mentioned in several health policies as well in nature policies in Denmark. However, policy makers and practitioners found it difficult to put the PSD into practice, and it became obvious that it was the result of research conducted by researchers for the benefit of other researchers. Therefore, the research group Nature, Health and Design initiated the Health Forest Octovia® project.

In Octovia®, all the eight PSD are designed in eight different rooms (figure 4). The process of redesigning the rooms is thoroughly described in a conceptual model [20] as well as on sign posts in the health forest.

Today, Octovia® is mainly used for research, education and demonstration. It is an integrated part of the Arboretum which is open to the public and is a popular recreation area.



Figure 4. Site illustration of the Health Forest Octovia®.

### 3.5 Ongoing Research in Octovia ®

The design of the health forest Octovia® is currently being investigated in a larger research project. Two main research questions will investigate whether the Health Forest Octovia® is experienced as a restorative environment, and which of the eight rooms are experienced as being the most restorative and why?

The project is designed as a cross-over-study with two types of environments that the informants must visit. Half of the informants start in the health forest and a few days later, they visit an urban environment, while the rest of the informants do the opposite. Mixed methods are being used, which means that physiological data (heart rate variability, pulse and blood pressure) are being collected, and both quantitative and qualitative questionnaires are being used, as well as in-depth interviews. The data will be analyzed during the autumn and winter of 2015.

### 3.7 Future Ambitions for the Nature, Health & Design Laboratory

Today, the laboratory consists of two settings, although the research group has ambitions to expand. Currently, funding is being sought to lay out a new setting focusing on evidence-based design solutions for making health supportive nature accessible for all. The project will consist of several phases, including an initial phase where the research group together with the National Institute of Public Health will compare the health status and use of natural environments of people with walking disabilities to the rest of the Danish population. Then phases will follow which will investigate the informants' preferences for nature qualities and barriers (physical, social and human) to visiting nature. The general idea is to design and test different design solutions together with the diverse group of people with walking disabilities, including both men and women, people of different ages and with different levels of disability. The Arboretum is very rich in nature qualities, including different types of wooded areas, terrain, and different sorts of water such as lakes, rivers and ponds. The ambition is that the new setting will serve as a demonstration site for professionals, who may be inspired by larger parts or just design details.

Another future ambition is to use the laboratory's facilities and outdoor settings for a new master program in nature-based therapy and health promotion. Until now, the research group has educated landscape architects in evidence-based health design, but now it is time to educate the people who will develop the

therapy programs and daily activities for different client groups. At present, there are no full-time education programs in Scandinavia with this focus.

#### 4. CONCLUSION

The ancient belief that nature and gardens can be positive resources in relation to people's health has been confirmed by modern research, e.g. green spaces in cities can promote human health and therapy gardens can support healing processes. However, landscape architects constantly need to improve their understanding of how to design, manage and promote these green spaces. It is recommended that the future planning and design of health promoting urban green spaces and therapy gardens have its foundation in an evidence-based health design/planning (E-BHD) process, which calls for practitioners to make practical decisions based on integration combination of the best available research evidence and proven experience with their practical expertise and their knowledge of clients' attributes (such as variation in perception, preferences, circumstances, values, needs and health status). It is crucial that the planner or designer is aware of the fact that a mentally weak, stressed or ill person understands and interprets the surroundings differently to a healthy individual. Therapy gardens for different patient groups need different designs and different therapy programs. Examples of green environments that have had negative health effects exist, and such negative effects are the result of a poor understanding of the user group's perceptions and health situation.

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