

# THE EFFECT OF NATURAL SETTINGS ON STRESS REDUCTION

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## ABSTRACT

*The Stress Reduction Theory suggests that natural environment elicits greater calming responses which indicates a general reduction of psychological symptoms of stress by viewing natural setting features with restorative quality. The aim of this paper was to analyze literature on a range of natural settings to support the evidence of stress reduction effect related to exposure to the different types of landscape settings. A systematic review was carried out to examine 42 publications in order to identify the current state of the research. The review provides an overview of the relationship between nature setting of green spaces and stress reduction. Findings have shown that nature settings that helped in stress reduction could be divided into five main categories such as tended green spaces, forests, specific landscape elements, restorative landscape characters and nature sounds. Further research is recommended to assess the detail of the landscape characters to help establish the future framework for another population in developing countries in order to provide the best solution in restorative design and planning context.*

**Keywords:** Environmental health design, human well-being, restorative design and planning

## 1. INTRODUCTION

Empirical studies have demonstrated experimentally that spending time outdoor and direct or visual contact with nature including time spent in a park or garden, in a room with plants, or looking at green spaces, or street trees from windows help reduce negative psychological effects and restore psychological health by reducing stress (Cole & Hall, 2010; Hartig, et. al; 2003). It was after Hartig (1996) claimed that he found no statistically significant difference in the evaluation of a restorative quality obtained between the real exposure visits and simulations. Later, Ulrich (2002) found positive changes in blood pressure, heart rate, muscle tension and brain activity which were produced by significant restoration within less than 5 minutes after viewing the natural settings.

This paper aimed to identify the types of the natural setting used in past studies and analyze the effects of green spaces on stress reduction and human health. The need for studies on the selection of the different types of green spaces to promote psychological and physiological well-being was mentioned by Ulrich (1979). It is significant to identify the types of natural settings used in studies related to stress reduction for several reasons: 1) to provide an overview of the current state of the research on the relationship among green spaces, stress reduction, and human health; 2) to group the diversity of research approaches by identifying the types of natural setting in green spaces, methodology, target groups, and the main outcome measure; and 3) to highlight future prospects of research on green spaces and human health.

### 1.1 Stress Reduction Theoretical Foundations

The most prominent and long-standing theory concerning stress response is the Stress Reduction Theory (SRT) (Ulrich, 1983). The SRT tends to view the

role of certain characteristics in natural environment (Bermain et. al., 2008) as they convey psychological values, behavior, and perpetual process, and complement each other in regard to understanding the aesthetic response to the natural environment. SRT was developed by Ulrich (1983; 1991), and it was used to understand the aesthetic and affective responses to the natural environment as well as to explain the emotional and physiological reactions toward natural spaces (Ulrich, 1991). Natural elements can elicit greater calming responses that indicate a general reduction of the psychological symptoms of stress. Viewing natural elements such as vegetation and water with restorative quality can activate an individual's positive affective responses, thus decreasing stress by reducing the level of negative feelings and reducing elevated physiological conditions. Ulrich assumed that an individual's first level of response toward the environment is mainly an affective, perceived autonomic, evoked by the visual stimulus of the natural environment. This theory suggests that environmental preferences are affected by people's need to get restoration (Hidalgo et. al. 2006; Van den Berg et. al., 2003; Laumann et al., 2003; Staat et al., 2003; Peron et al., 2002; Purcell et al., 2001), and environment perceived as natural tends to be more restorative than environment perceived to be urban or artificial (Berto et al., 2008; Berto, 2005; Herzog et al., 2003; 1997).

In support of this theory, empirical studies have indicated higher positive effect and less negative effect in participants exposed to natural environments compared to those exposed to urban or built environments (Lee et al., 2011; Park et al., 2007; Hartig et al., 2003;). Higher positive effects were found in participants who were physically present in nature (Lee et al., 2009) and those exposed to laboratory simulations of nature such as the viewing of videos depicting natural environments (Ulrich et al., 1991). This paper reviews previous literature to better understand the state of the art concerning potential types of natural settings and elements that allow a shift toward mediating the negative effects of stress to reduce the negative mood state and enhance positive emotions.

## 2. MATERIALS AND METHODS

### 2.1 Literature Search

In order to generate the initial source articles, peer-reviewed articles published in international scientific journals were selected. Studies that were published in national reports or local planning documents or 'grey literature' were omitted. An electronic database search was conducted on PubMed, Medline, American Horticultural Therapeutic Association Journal, Elsevier, Springer, Science Direct, and Academic Press. Full text electronic access was carried out through Universiti Putra Malaysia's link and websites such as Google

Scholar, Therapeutic Landscape Network, OPENspace, and Collaboration for Environmental Evidence. The terms used during the search were: 1) health related terms (restorative, health-promotion, recovery, stress, well-being psychology, nature therapy, and health psychology) and 2) environmental related terms (natural environments, natural settings, green space, open space, garden, and forest). The main search strategy as indicated in Figure 1 considers articles published between 1979 and 2017. The search process of this review was adapted from PRISMA diagram whereby a single diagram showed the multiple results from the search which was the simplest option to summarize for the reader in the least complicated way (Stovold, Beecher, Foxlee, & Noel-Storr, 2014). The search yielded a total of 1,100 documents in the form of peer-reviewed journal papers, dissertations, grey literature, and best practice guidelines. Reference titles and abstracts were independently double-screened against the inclusion criteria. Studies that meet the criteria were retrieved in full text, summarized and organized according to the data extraction items to provide an overview of the findings. From 1100 unique record of peer-reviewed journal papers, forty-two articles between 1979 and 2017 that met the inclusion criteria.

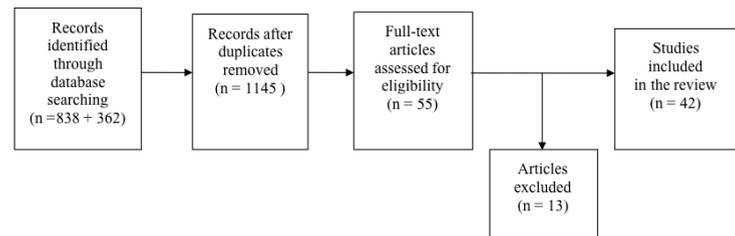


Figure 1: An adapted PRISMA flow diagram for the search of references .

### 2.2 Inclusion Criteria

Studies were deemed eligible for this review if they met the inclusion criteria: 1) published only in English language peer-reviewed journals, (2) real and virtual exposure stimuli, (3) the outcome related to stress-reduction measures, (4) experimental designs included randomized controlled trials, quasi-experimental studies (nonrandomized controlled trials; randomized or nonrandomized crossover trials) and natural experiments. As for the natural experiments, non-randomized studies were included in order to identify if recorded measures of restoration before and after exposure to nature/non-nature settings as well as excluded the baseline measures after exposure were carried out. However, since the inclusion criteria included only full-text publications in English, therefore this review was effected in a publication and substantial bias on selection.

### 2.3 Data Extraction Criteria

These data extraction criteria consist of two groups: (1) structural criteria (author, publication year); (2) content criteria that focus on the i) region: where the study took place, ii) target group: who the participants were, iii) study design: how the study was conducted, iv) natural setting: this described the content of the landscapes in the categories of natural/urban and landscape/no-landscape in the reviewed papers, v) stimuli: types of the landscape stimulus used in the exposure, and vi) measure: how stress was measured. Each study selected in the review was divided into eight sub-groups with frequencies of the studies by 1) authors and year, 3) region, 4) target group, 5) study design, 6) natural settings, 7) landscape stimuli used, and 8) stress measures.

## 3. RESULTS

### 3.1 Overview and General Patterns

The study on natural settings revealed an overview of the previous four decades of the study area. It is a growing research field, with an increasing number of publications i.e. 12% between the 1970s and 1990s, and most of the 88% (40 studies) were published from the year 2000 onwards (Figure 2). Most of these studies focused on respondents such as university students, the general public, patients suffering from stress, prisoners, and the elderly. These studies were also dominated by findings from Europe, the United States and the United Kingdom with a few coming from Asia and other continents such as Southern America, Africa, and Australia (Figure 3).

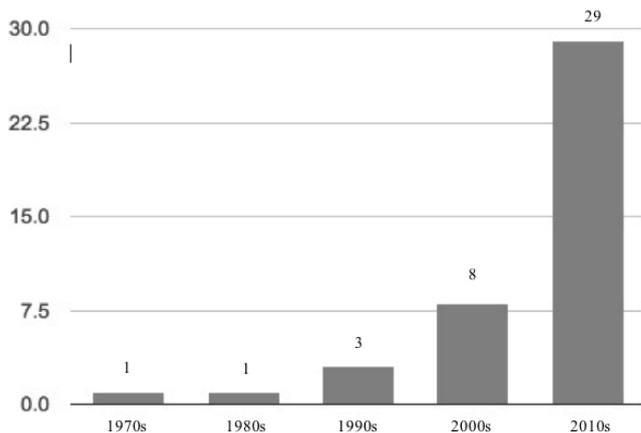


Figure 2: Growing Research Fields from 1970s – 2010s

### 3.2 Target Groups and Region

Studies on stress-reduction effects and aspects of related natural setting began in 1979 with only one publication, and over the decade, it has become a growing research field, with an increasing number of publications particularly after the 1990s. 14 studies (33%) addressed university students; 13 studies (31%) addressed the general adults; 7 studies (17%) focused on the general public; 4 studies (10%) focused on specific workers; 2 studies (2%) focused on patients suffering from stress; and one study (1%), each focused on prisoners and the elderly, respectively (Figure 3). Additionally, most research were dominated by findings from Europe (50%) and the U.S and U.K (19%), with few findings from Russia, South America and Asia which means there exists a large geographical knowledge gap despite the growing number of papers published on the research area.

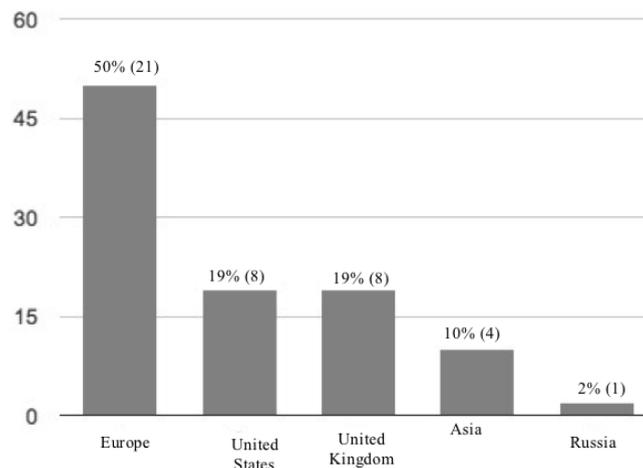


Figure 3: Regional Distribution in the Previous Study

### 3.3 Study Design, Landscape Stimulus and Natural Setting

Both quantitative (experiments and surveys), qualitative (interview) and mix methods (survey and interview) have been used in the various types of study designs applied in previous studies (Figure 4a). Most of the studies (32%) applied field experiment (outdoor environment and intervention program); 29% of the studies were laboratory experiments; 27% of the studies used the survey method (e.g.; face-to-face, focus group, mail questionnaire); 9% of the study applied mix methodology (survey and in-depth interview); and the remaining 3% of the studies applied the in-depth interview to retrieve important data from participants. Previous study designs have also utilized

several types of natural environment stimuli such as (1) view and walk through in a real exposure of natural setting, (2) view still images of photographs on screen, (3) view a moving image of films on various screen sizes, (4) view combinations of video films and photographs, and (5) view immersive of a virtual reality simulation (Figure 4b).

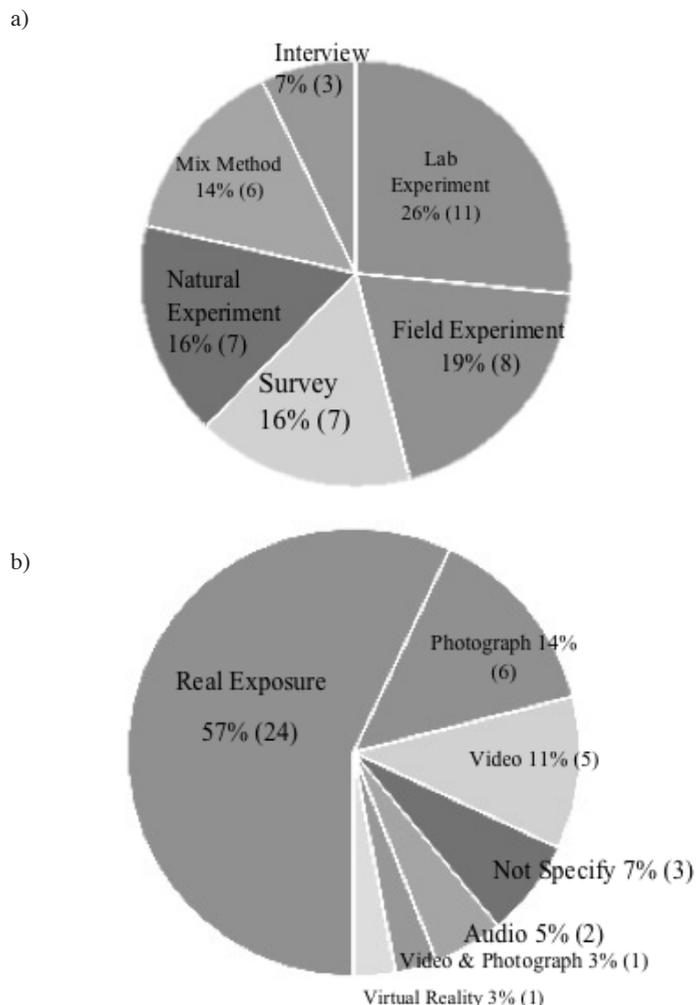


Figure 4(a): Methods and 4(b) Types of stimuli used in the previous studies

Figure 5 shows the types of natural setting used on the effects of stress-reduction identified and grouped into five categories: 37.5% of the studies were assessed in the range of tended green spaces which are the most common natural settings applied in the studies, followed by 25% in natural forests; 22.5% surrounded by specific landscape elements; 10% in potential restorative environments; and 5% involves the use of natural sounds.

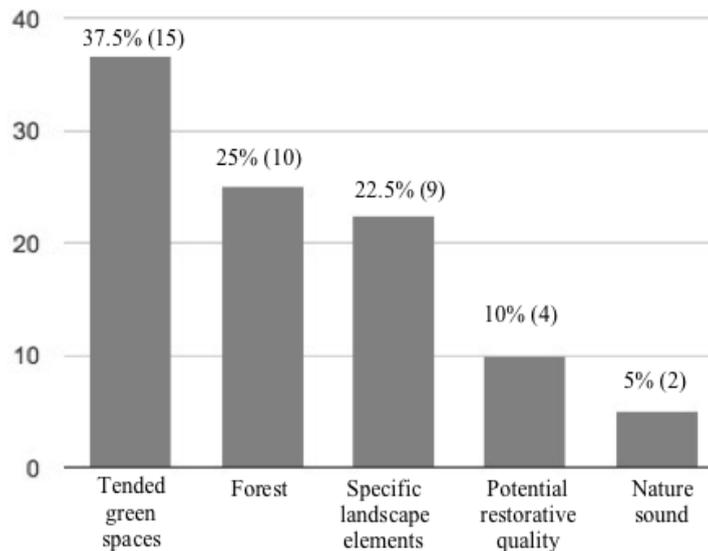


Figure 5: Types of Natural Setting in the previous studies

### 3.4 Stress Measure Used in the Literature

The research designs used in the reviewed studies involved a range of stress measurements i.e. quantitative, qualitative, and mix-methods (Table 1). The quantitative method is the most common research method (emotional state, frequency of sick-call visits, brain activity, heart rate, pulse rate, blood pressure, skin conductance response, muscle tension, salivary cortisol, emotion test, attention-tests, frequency of follow up sessions, respiratory rate, hair cortisol, and nervous response), followed by the qualitative method (interviews).

Table 1: Types of Stress Measure Applied in the Studies

Types of Measure	Author
Self-Reported Emotional State	Triguero-Mas et al. (2017), Wang et al. (2016), Tyrväinen et al. (2014), Annerstedt et al. (2013), Brown et al. (2013), Sonntag-Öström et al. (2011), de Kort (2006), Hartig et al. (2003), Rodiek (2002), Ulrich (1979)
Frequency of sick-call visit	Moore (1981)
Brain Activity	Change et al. (2008),
Heart Rate (Electrocardiogram)	Triguero-Mas et al. (2017), Wang et al. (2016), Tyrväinen et al. (2014), Annerstedt et al. (2013), Brown et al. (2013), Alvarsson et al. (2010), de Kort (2006), Ulrich (1991)
Pulse Transit Time	Ulrich (1991)
Blood Pressure	Triguero-Mas et al. (2017), Tyrväinen et al. (2014), Brown et al. (2013), Hartig et al. (2003), Ulrich (1991)
Skin Conductance Response	Wang et al. (2016), Alvarsson et al. (2010), de Kort (2006), Ulrich (1991)
Muscle Tension	Ulrich (1991)
Workload Pressure	Leather (1998)
Self-Reported Well-Being State	Ward Thompson et al. (2016), Brown et al. (2013), Ward Thompson et al. (2012), Leather (1998)
Salivary Cortisol	Triguero-Mas et al. (2017), Ewert et al. (2016), Tyrväinen et al. (2014), Roe et al. (2013), Annerstedt et al. (2013), Beil & Hanes (2013), Ward Thompson et al. (2012), Rodiek (2002)
Emotion Test	Triguero-Mas et al. (2017), Van den Berg et al. (2014), Van den Berg et al. (2003)
Attention Test	Triguero-Mas et al. (2017), Wang et al. (2016), Tyrväinen et al. (2014), Brown et al. (2013), Sonntag-Öström et al. (2011), Van den Berg et al. (2003), Hartig et al. (2003)
Interview Questionnaires	Ratcliffe et al. (2013), Gatersleben & Andrews (2013), Ward Thompson et al. (2012), Adevi (2012), Stigsdotter & Grahn (2011), Sonntag-Öström et al. (2011), Stigsdotter (2014), Grahn & Stigsdotter (2003)
Self-Rating on Perceived Health	Triguero-Mas et al. (2017), Arnberger & Eder (2017), Stigsdotter et al. (2017), Memari et al. (2017), Gidlow et al. (2016), Ward Thompson et al. (2016), Wang et al. (2016), Sidenius et al. (2015), Sahlin et al. (2014), Roe (2013), Beil & Hanes (2013), Gatersleben & Andrews (2013), Ward Thompson et al. (2012), Stigsdotter (2010), Grahn & Stigsdotter (2009), Hansmann et al. (2007),
Frequency of Follow-up Session	Sidenius et al. (2015), Corazon et al. (2002)
Respiratory Rate	Brown et al. (2013)
Behavioral Observation	Sidenius et al. (2015), Sahlin et al. (2014)
Self-Rating Green Space Access	Gidlow et al. (2016), Ward Thompson et al. (2016),
Hair Cortisol	Gidlow et al. (2016),
Nervous Response Rate	Triguero-Mas et al. (2017)

## 4. DISCUSSION

### 4.1 Measurement of Environmental Influence Variables

While the majority of the assessed studies were exploratory in nature settings, they were also predominantly empirical, which means that many of the potentially influential environmental variables were defined by the investigators in advance of research commencement with the input from research target group. Environmental variables that were commonly assessed as having potential influence on stress reduction effects included measures of: nature dominated by vegetation (Ulrich, 1979); farmland (Moore, 1981);

nature setting with water (Ulrich, 1981); trees, vegetation, plants and foliage (Leather et al., 1998); forest roadside (Parsons, Tassinari, Ulrich, Hebl, & Grossman-Alexander, 1998); horticultural garden (Rodiek, 2002); vegetated hillsides (Hartig, 2003); natural element with and without creek (van den Berg et al., 2003); urban green space (Grahn & Stigsdotter, 2003); garden at workplace (U. A. Stigsdotter, 2004); semi open landscape area (de Kort, Meijnders, Sponselee, & IJsselsteijn, 2006); city park (Hansmann, Hug, & Seeland, 2007); wilderness area (Chang, Chen, Hammitt, & Machnik, 2007); restorative environment (Grahn & Stigsdotter, 2010); natural sounds (Alvarsson, Wiens, & Nilsson, 2010); green space (Stigsdotter & Grahn, 2011); forest (Lee et al., 2011); different types of forest (Sonntag-Öström et al., 2011); potential restorative green space character (Ulrika Karlsson Stigsdotter & Grahn, 2011); rehabilitation garden (Adevi & Grahn, 2012); healing forest (Corazon, Schilhab, & Stigsdotter, 2011); green space at residential area (Ward Thompson et al., 2012); natural area (Gatersleben & Andrews, 2013); different types of outdoor setting (Beil & Hanes, 2013); nature and built environment (Brown et al., 2013); virtual natural environment with and without sound (Annerstedt et al., 2013); nature element sounds (Ratcliffe, Gatersleben, & Sowden, 2013); green space in neighborhood park (Roe et al., 2013); types of nature, gardens, and green space (Sahlin, Ahlberg, Matuszczyk, & Grahn, 2014); different types of urban environment (Tyrväinen et al., 2014); different types of green space setting (Van den Berg, Jorgensen, & Wilson, 2014); therapy forest (Sidenius, Stigsdotter, & Refshauge, 2015); different types of public spaces (Arnberger & Eder, 2015); different types of urban green spaces (Wang, Rodiek, Wu, Chen, & Li, 2016); types of green spaces at residential areas (Ward Thompson, Aspinall, Roe, Robertson, & Miller, 2016); green space and agriculture land (Gidlow, Randall, Gillman, Silk, & Jones, 2016); undeveloped natural area (Ewert, Klaunig, Wang, & Chang, 2016); different characters of potential restorative environment (Memari, Pazhouhanfar, & Nourtaghani, 2017); different characters of forest (Ulrika Karlsson Stigsdotter, Corazon, Sidenius, Refshauge, & Grahn, 2017); green, blue, and urban environment (Triguero-mas et al., 2017); botanical garden (Vujcic et al., 2017); and forest environment (Ulrika K. Stigsdotter, Corazon, Sidenius, Kristiansen, & Grahn, 2017). A common feature of most of the assessed studies is the use of researcher-defined definitions of environmental influences on the stress reduction effects on human health.

Based on the 42 studies assessed in this review, the types of natural setting used on stress-reduction effects were identified and grouped into five categories: 1) 37.5% range of tended green spaces specifically for pleasure (horticulture garden, garden at workplace, therapy garden, and botanical garden) which are the most common natural settings applied in the studies; 2) 25% forests (natural woodland, parkland, wildwood, and therapy forest);

22.5% of the studies conducted in surrounding with specific landscape elements (trees, shrubs, stream, lawn, bushes, flower bed, water); 10% of the studies conducted in potential restorative characters (refuge, nature, prospect, serene and rich in species), and 5% of the studies conducted using natural sound (bird, water and pleasant natural sound). A majority (n=42) reported a significant, independent relationship between environmental conditions and human stress reduction through the psychological and physiological outcomes even though two studies identified used only natural sounds.

#### 4.2 Knowledge gap

The Stress Reduction Theory explains the relationship between environmental influences and health, especially those exploring the potential types of natural elements that allow a shift toward mediating the negative mood state and enhancing positive emotions by reducing stress (Ulrich, 1979). Therefore, this review helps to synthesize current research on the influences of different types of green spaces and stress reduction effects of different subject areas using a wide range of methods across unevenly distributed case areas from around the world. Having critically reviewed 42 research papers, some important future prospects in green space-related health studies and environmental health design and related research are highlighted:

- i- The review reveals that although previous studies compared the stress-reduction outcomes to the different types of natural settings, the categories compared are still very coarse and are barely related directly to specific elements. These coarse categories have clearly failed to reflect the variety of natural settings that are important in defining the landscape characters and elements.
- ii- Four studies analyzed responses toward specific elements that are related to the presence or absence of water in natural and urban scenes (Ulrich, 1979); trees and flowers (Leather, 1998); vegetated hill and stream (Hartig, 2003); lawn and bushes (de Kort, 2006; however, the number of representative case studies is limited to predominantly Western Europe, the U.S and the U.K thus, providing little information on which landscape elements that contribute the most to reduction of stress among adults, the public, patients, and the elderly (Velarde et al., 2007) from other regions. Therefore, developing countries need to contribute actively to the scientific research in order to establish a new framework that can be used and adapted in other climates such as the tropical region of Asia Pacific.

- iii- The selection of students as respondents has been used extensively in these studies due to easy access on data availability. Only one study analyzed responses to the garden and nature elements by comparing the effects of an outdoor garden and a non-garden group of the elderly (Rodiek, 2002). For an improved understanding of the nature setting issues among the elderly, it is important to encourage the elderly's participation in explaining the relationship between landscape elements and the health and well-being of the elderly as more empirical evidences that yield results that provide a reliable representation requires further validation.
- iv- Garden and urban green spaces have been known for their restorative effects on both psychological and physiological health. Several authors have analyzed a design framework that can contribute to improved stress outcome. Nevertheless, more empirical studies are needed to convince urban planners and designers on the multiple benefits of green spaces and landscape elements, and to provide the best solution on how to use the research results in the implementation of a specific national design and planning context with regard to spaces (Hartig & Jahncke, 2017).

## 5. CONCLUSIONS

The study has identified the types of green spaces that have an environmental influence in the relationship between stress reduction and human health. The findings show that the green spaces used in previous studies could be described into five main categories: 1) tended green spaces; 2) natural forests; 3) specific landscape elements; 4) restorative environment; and 5) natural sounds. Key findings from the literature review reveal that the main health aspects of exposure to green spaces are related to psychological outcomes (cognitive function, psychological stress, well-being, and depression and anxiety symptoms); physiological outcome (self-reported health, incidence of diseases, quality of life, and physiological measure); nature settings (tended green spaces, natural forests, specific landscape elements, and restorative environment); and specific landscape elements (trees, flowers, vegetated natural environment, stream, lawn, and bushes).

Regardless, although this review has the possibility of limitations, some strategies can be used to ensure the scientific rigor. Therefore, future research could continue to explore and confirm the initial findings by adding the mentioned landscape elements to the conceptual framework in different

context, location and culture in the effort to design a better responsive restorative outdoor spaces.

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