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Review Article

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Ecotherapy Research: A Narrative Review

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ABSTRACT

Method: This narrative review summarizes research on ecotherapy or experiences in green and blue spaces that have been considered therapeutic.

Results: This recent literature includes several reviews and meta-analyses of research conducted during the last two decades as well as more recent empirical studies. Some of the reviews and studies have explored the effects of walking through forests versus walking through urban areas. Others have involved the participants walking through parks or viewing green scenes from videos or windows and engaging in blue water activities and walking on the beach. The therapeutic effects have included decreased depression, anxiety, blood pressure, heart rate and cortisol and increased serotonin as well as a reduction in cardiopulmonary and hypertensive conditions.

Discussion: The studies in this review highlight the therapeutic effects of being in nature. However, the research is limited by small samples and by the lack of active comparison groups, and the experience in nature is confounded by other therapeutic activities in the research protocols including walking, yoga, tai chi and massage.

Keywords: Ecotherapy, Nature Therapy, Forest Therapy, Green Therapy, Blue Therapy

Ecotherapy Research: A Narrative Review

Ecotherapy has been defined as "experiences in the natural environment that have been therapeutic" [1]. These experiences have been assessed for their therapeutic value or they have been prescribed as therapies for different medical problems. Ecotherapy has been reportedly effective for alleviating several medical conditions including hypertension, obesity, post-surgical recovery, and for reducing psychological problems including depression, anxiety, stress, and ADHD [1]. According to these authors, the theoretical models that have been advanced to explain its effects include biophilia (a desire or tendency to commune with nature), ego existential positive psychology, attention restoration theory, and stress reduction theory.

This narrative review summarizes 57 papers on what is commonly referred to as ecotherapy that were found from searches on PubMed and PsycINFO using the terms ecotherapy, nature therapy and the publication years 2017-2024. Exclusion criteria for this review included papers on proposed protocols, case studies and non-English language papers. The publications can be categorized as systematic reviews, meta-analyses and empirical studies. Although most of the reviews and studies have focused on walking through forests, others have included the experiences of viewing videos of forests, walking in parks, viewing nature from windows, gardening and blue water diving activities and walking on the beach. Some of the studies have been based on assessments of one-time experiences in green or blues spaces and others on multiple session protocols assessing the effects of exposure to those spaces. This review is divided into sections that correspond to reviews and studies on forest exposure and therapies and reviews on exposure to other experiences in green and blue spaces.

Overview of the Origins of Forest Therapy

Forest therapy, first known as forest bathing, was one of the first ecotherapies that was researched [2]. This therapy was developed by the Japanese Forestry Agency in 1982 according to a recent

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review [3]. Based on this review of 27 articles, forest therapy has been notable for preventative medicine and stress management. The authors suggested that this therapy was explored for its stress reduction effects. They suggested the need for the therapy because exposure to environmental factors like noise, crime, pollution and lack of calming scenery was causing stress. They reported that 75% of physician visits were stress-related, with stress leading to heart disease, cancer, lung disease, accidents, cirrhosis of the liver and suicide. Stress reduction theory had suggested that stress could be reduced by forest therapy which they defined as a combination of relaxing activities, light exercises and the natural therapeutic atmosphere of the forest.

Reviews on Forest Exposure and Therapy Research

Many studies have occurred in forest environments and have been referred to as forest bathing or forest therapy (see table 1) [2]. Several of the forest therapy studies were conducted during the last two decades. They have been summarized in recently published reviews. In one of these, 14 studies were reviewed on forest bathing effects on pre-hypertensive and hypertensive individuals [4]. The results suggested a decrease in blood pressure and heart rate, an increase in heart rate variability and improvement in cardiopulmonary and metabolic function. An increase in positive mood and quality of life and decreased anxiety were also reported. Forest walking and forest healing (walking combined with other therapeutic activities like warm-up exercises, woodwork, and singing bowl meditations) were the most effective forest bathing interventions. The forest healing effects per se were confounded by the effects of these other therapeutic activities and the forest walking effects could have derived from the therapeutic effects of walking itself.

Table 1: Effects of forest therapy given in reviews and studies (and first authors).

Effects in forest therapy reviews	First authors
Preventative medicine and stress management	Rajoo
Decreased depression, anxiety and stress	Chaughury
Decreased blood pressure & heart rate, increased heart rate variability	Yau
Improved cardiopulmonary and neurochemical function	Piva
Increased natural killer cells and NK activity	Li
Improved cardiovascular and immune function	Stier-Jarmer
Decreased blood pressure and cortisol	Qiu
Decreased systolic blood pressure	Ideno
Decreased inflammatory cytokines	Wen
Release of phytoncide and air ions	Franco
Effects in forest therapy studies	
Decreased blood pressure and POMS scores	Furuyashiki
Increased sleep efficiency and total sleep time	Kim
Decreased blood pressure, pulse rate and POMS scores	Yu
Increased heart rate variability and increased EEG alpha waves	Young-Suwn
Increased natural killer cells and decreased C-reactive protein	Tsao
Increased natural killer cells and NK activity	Lyu
Increased EEG alpha waves and increased EEG beta waves	Hassan
Increased sleep quality and serotonin levels	Li
Decreased anxiety	Zabini
Decreased stress	Maund
Decreased heart rate and increased heart rate variability	Song
Increased social interaction terms in essays	Kim
Increased openness	Montag

In a similar review on the effects of forest walking on physical and mental health in elderly samples, 10 articles were included [5]. Once again, forest walking was considered therapeutic. As in the previous review, forest walking led to decreased blood pressure and heart rate and improved cardiopulmonary and neurochemical function. Psychologically, forest walking reduced depression and stress. The authors concluded, however, that there was a lack of high-quality studies Included in their review.

A third review was focused on the effects of the forest environment on health promotion and disease prevention in general [6]. This review again suggested that blood pressure and heart rate were decreased, which was considered a preventative for hypertension. In addition, natural killer (NK) cells and NK cell activity increased, suggesting that those effects could result in lower levels of viral, bacterial and cancer cells. The increase in NK activity could relate to the increase in parasympathetic activity which would result in decreased stress hormones, especially urinary norepinephrine and salivary cortisol, as has been noted in studies on other therapies like massage therapy [7]. Sleep quality also improved and negative moods decreased as reported on the Profile of Mood States Scale including anxiety, depression, anger, fatigue, and confusion.

In a more comprehensive systematic review of 11 systematic reviews and 31 primary studies, the authors noted improved cardiovascular activity and immune function as well as reduced stress, depression, and anxiety [8]. However, most of the studies were conducted in Asian countries and on older adults, suggesting limited generalizability of the findings.

In a meta-analysis on the data from 21 studies (considered more empirically robust than a systematic review) (N=270 urban residents), forest therapy reduced systolic and diastolic blood pressure as well as salivary cortisol levels [9]. These results were more evident for older individuals and for those who had higher baseline levels of blood pressure and cortisol. A greater decrease was also noted for longer-term forest therapy protocols.

In another meta-analysis that was focused on the blood pressure-lowering effect of Shinrin-Yoku (N= 732 participants and 20 trials), only systolic blood pressure was decreased [10]. Surprisingly, diastolic blood pressure and heart rate decreases

were not noted in this meta-analysis as they were in the previous meta-analysis and systematic reviews. However, this meta-analysis was based on smaller sample studies which may have reduced the power of the analysis.

In a more guarded review entitled "Medical empirical research on forest bathing: a systematic review", 28 research protocols involved not only forest exposure but also walking, meditation, yoga, Pilates, sightseeing and crafts with a focus on the experience of the five senses as well as the exercise [2,11]. These generally suggested improved cardiovascular, hemodynamic, neuroendocrine, metabolic, immune and inflammatory function as well as decreased anxiety and depression. However, as the authors suggested, of the 57% of studies that combined self-report and physiological measures, only 4 of 8 studies reported reduced blood pressure, 2 of 3 studies noted reduced heart rate, 4 of 7 studies increased heart rate variability, 2 of 4 studies decreased IL- 6, 2 of 3 studies decreased TNF-alpha and 1 of 3 studies decreased C-reactive protein (the last 3 measures being pro-inflammatory cytokines).

These authors, unlike most forest therapy researchers, speculated about potential underlying mechanisms for the positive effects of forest therapy. First, they suggested that the prohibition of electronic products, social interaction, caffeine, smoking and drinking during the forest therapy sessions would contribute to a "slowing of the nervous system". Further, they suggested that the tree species composition and the color and density of the forest were contributory factors. The forest environment also features phytoncide with antioxidant and antiseptic properties that would enhance immunity [12]. Further, the negative air ions would increase parasympathetic activity and decrease blood glucose (both being positive effects) [12]. In addition, increased human thermal comfort would lead to reduced heat stress. The authors commented, however, that adverse events were rarely considered in these studies including snake bites, pollen allergies, falls and bruises reported by others [11]. Also, some individuals may be irritated by insects and others may fear potentially dangerous animals living in the forest.

Studies on Forest Exposure and Therapy

Several examples of forest therapy studies that focused on these variables have appeared in this recent literature. In one of these studies, physiological and psychological effects of forest bathing were assessed in working-age people with and without depressive symptoms [13]. In this study (N= 155), 37% of the sample had depressive tendencies. For the forest bathing, the participants spent two hours walking around a forest with a guide who demonstrated breathing methods, yoga, and hammock experiences. On average, the participants walked 5710 steps (almost 3 miles). Decreases in systolic blood pressure and diastolic blood pressure were reported. In addition, negative moods on the Profile of Mood States (POMS) scale decreased. The forest bathing effects in this study were confounded, however, by the therapeutic effects of the walking, yoga and hammock experiences as well as the breathing methods.

Multiple Cofounding Activities

The results of several of the forest therapy studies have been confounded by multiple therapeutic activities being included in the forest therapy protocols. For example, in a study on forest therapy across six days for menopausal women with insomnia (N=35), the women received several therapies following forest walking including leg massages, stretching, and bathing in warm and cold water (Kim et al, 2020). This protocol resulted in increased sleep efficiency and total sleep time. However, it is not clear how much each of the different activities contributed to the sleep effects.

Heart Rate Variability

Another study explored the effects of short forest bathing on autonomic nervous system activity and mood states of middle-age and older-age individuals (N=128) [14]. Systolic and diastolic blood pressure and heart rate decreased and POMS Scale scores on anxiety, depression and fatigue were also decreased. However, surprisingly, compared to other forest bathing studies, no effect was noted on heart rate variability. This result could relate to heart rate variability decreasing during the forest walking activity and then returning to baseline after the activity resulting in no measurable effect.

In one of these other studies, for example, the high frequency component of heart rate variability was increased, suggesting enhanced parasympathetic activity (relaxed nervous system) but this was based on measurement following the therapy [15]. In this study on forest healing (N= 60 adults older than 65), 11 short forest therapy sessions were held specifically for older adults experiencing cognitive decline. An increase in EEG alpha waves, indicating relaxation, was also reported as well as decreased depression following the forest therapy.

Natural Killer Cells

In a study that was focused on the effects of forest environments on natural killer cells, one group from Taipei (N= 90) was given a five-day trip to a forest and their immune measures were compared to those of a group who walked in the city (N=110) [16]. Natural killer cells increased for the forest group, and that group also had lower C-reactive protein levels. These were both therapeutic effects as C-reactive proteins are pro-inflammatory, and natural killer (NK) cells kill bacterial, viral and cancer cells.

In another study that noted increased natural killer (NK) cells and NK cell activity, college students spent three days in a bamboo forest (N=60 males 19-to-24-years-old) [17]. A comparison between the experience of the bamboo forest versus a city site revealed decreased blood pressure and heart rate along with the NK cell increases following time in the bamboo forest. Although heart rate variability was not measured, it likely increased. That increase would naturally lead to a decrease in stress hormones that would, in turn, lead to the increases noted in NK cells and NK cell activity [7].

EEG Alpha Waves

Brain wave activity while walking in a bamboo forest versus a city environment has also been assessed (N=60 university students) [18]. Increased positive mood, meditation and attention were noted along with decreased anxiety. The EEG recordings yielded increased EEG alpha waves (associated with increased relaxation), and increased beta waves (associated with enhanced attentiveness). The special effects of the bamboo forest beyond those of walking were not determined. EEG alpha waves also increased in a study already described [15].

Sleep and Serotonin Levels

In one of the few within-subjects studies, the effects of forest bathing were assessed on depressive symptoms, sleep quality and serotonin levels in middle-age males (N= 20) [6]. In this study, the men spent one day in the forest and one day in an urban area with no trees. On both days they walked 1.5 miles in the morning and 1.5 miles in the afternoon. Reduced fatigue on the POMS scale and decreased sleepiness were noted as well as increased serotonin (anti-depressant) levels for the walk-in-the-forest experience. The within-subjects comparison was a strength of this study, although the sample size was small. Another control group could have been included for a walk-on-a-city street with trees.

Variations of Forest Therapy

A variable that has affected forest therapy is walking in the forest alone or with a guide. That comparison (N= 37 undergraduate students) suggested that when students were alone, more self-reflection words were noted in their essays and when they were in guided therapy, a greater change of emotional and social interaction terms appeared in their essays [19]. Unfortunately, the therapy was again confounded by various co-occurring activities including clapping, folk-dancing, walking, taking photos, talking to nature and hand massage. The authors also mentioned a couple variables that might have made walking alone more pleasurable including hearing the sounds of birds and the rustling sounds of stepping on fallen leaves.

Sitting and viewing landscapes of a forest has also been explored as an alternative of walking in a forest. In a study that involved participants sitting and viewing a forest landscape versus a city landscape, lower heart rate and greater heart rate variability were noted following the viewing of the forest [20]. This study was limited by being a small, homogeneous sample (N= 20) of Japanese hypertensive men (40-to-72-years-old), limiting its generalizability.

In a variation of "forest therapy", videos of the forest and urban areas were shown to 90 individuals from Italy who viewed the videos for five minutes for each of five days during their COVID-19 lockdown [21]. Anxiety symptoms and scores on the State-Trait Anxiety Index decreased following the viewing of the forest versus the urban videos.

In another variation, viewing deciduous trees during winter and spring when there are no leaves had positive effects (N= 54 students), most especially in the winter, suggesting that woody plants in their environments (European beech trees) decreased stress [22]. This finding was not easy to interpret, although it suggests that greenness is not necessarily the therapeutic variable. The view of the trees may be therapeutic in itself.

In a paper from Germany entitled "An attempt to assess individual differences in Shinrin-Yoku tendencies and associations with personality and life satisfaction", a Shinrin-Yoku scale was created (N= 96) [23]. The Shinrin-Yoku scale includes several experiences in the forest including seclusion, relaxation, and fresh air. This scale was used along with the Big Five Personality Traits Scale and the Quality of Life Scale. Openness was associated with Shinrin-Yoku tendencies, which in turn were associated with life satisfaction, pro-environmental behavior as well as more conscientiousness and agreeableness. This study was limited by being self-report and cross-sectional, and, surprisingly, very few participants actually spent time in the forest.

In addition to the limitations already noted, comparisons of these studies would be difficult because some were self-guided alone experiences and others were group-guided forest therapy experiences. Some involved various forms of exercise and other therapeutic activities and other variations were the time of year the studies were conducted, the different types of trees and the different intensity of greenness.

Reviews on Other Forms or Places for Green Ecotherapy

Review papers and studies on other forms or places for green ecotherapy have also appeared in this literature (see table 2). The researchers have conducted empirical and observational studies on children's and adults' responses to these ecotherapy experiences.

Table 2: Effects given in reviews and studies on other forms or places for green ecotherapy (and first authors).

Effects given in reviews	First authors
Increased self-esteem, creativity and cognition in children	Summers
Improved lung function in children	Fernandes
Reduced stress	Kondo
More positive mood	LI
Decreased heart rate, blood pressure and pain	Summers
Increased well-being and connection to the earth	Thomas
Effects given in studies	
Decreased body mass index and blood pressure in children	Dzambov
Increased activity and enhanced mental health in adolescents	Belanger
Improved cognitive processing and better mood	Tomasso
Lower blood pressure and heart rate and less negative moods	Pratiwi
Less fatigue and insomnia	Kuballa
Decreased blood pressure	Kabisch
More positive moods	Stigsdotter
Lower blood pressure, pulse, cortisol and alpha amylase	Xiang
Less tension	Janeczko
Less hypertension	Huang
Decreased cortisol and alpha amylase	Hunter
Less fatigue and depression	Yu
More connectedness to nature and pro-environmental behavior	Cologiuri
Lower blood pressure and more positive mood	Li
Decreased alpha amylase and increased heart rate variability	Tu
Increased aesthetic delight with the natural world	Dobson
Increased general health and well-being	Kanelli
Improved health	Franco

Horticulture and stimulation of the senses	
Decreased alpha amylase and increased heart rate variability	Tu
Increased aesthetic delight with the natural world	Dobson
Increased general health and well-being	Kanelli
Improved health	Franco
Pro-environmental Behavior	
Recycling, buying eco-friendly products	Texeira
Delivering flyers on environmental issues	Calogiuri
Petition against plastic production	Chirico

On Children

Several studies on ecotherapy effects on children have been reviewed in a paper entitled "The role of interaction with nature in childhood development: an underappreciated therapy" [24]. These authors reported increased self-esteem, creativity, cognition, independence, well-being and life satisfaction in children following encounters with nature. These studies have the confounding effects of children engaging in play, physical activity, and interaction with their peers which are likely to have effects that are similar to those of their encounters with nature.

In a meta-analysis of European children from eight countries (N=35,000), exposure to green spaces during the prenatal period and childhood was assessed [25]. Exposure to green spaces in childhood (but not pregnancy) was associated with improved lung function, and the effect was stronger in female children.

On Adults

In a review entitled "Does spending time outdoors reduce stress? A review of real-time stress response to outdoor environments", 43 non-laboratory studies were summarized [26]. Several forms of ecotherapy were effective including viewing nature, outdoor walking, outdoor exercise, gardening and water activities.

In a meta-analysis of controlled trials on the psychological benefits of exercise in wild or urban green spaces, 19 studies (N = 1662 participants) were included [6]. Exercise led to more positive mood, and wild environments were viewed more positively than urban green space.

In a general review of ecotherapy that described interventions as viewing scenes from windows and observing indoor plants, heart rate and blood pressure decreased and surgery recovery and cardiopulmonary rehabilitation were faster [27]. Pain was also reduced as well as negative moods and stress. Specifically, PTSD, anxiety, and addiction were decreased, and self-esteem and mental well-being were increased. The authors also noted a decrease in ADHD symptoms, dementia, obesity, and vitamin D deficiencies.

In another review prescribing ecotherapy for adults with mental illness, 12 databases were searched and 7 publications were reviewed [28]. This included 5 UK and Australian studies using mixed methods, 1 using a qualitative method and 1 using a randomized controlled trial (N=344 adults who were 35-to-70-years-old). As in other studies, an increase was noted in bio-psychosocial well-being, as well as an increased connection to the earth and an intention to further access nature.

Studies on Other Forms or Places for Green Ecotherapy

Youth in Home Gardens

In a study on children entitled "Natural and built environments and blood pressure of Alpine school children" Austrian and Italian mountain valley children were assessed for body mass index (BMI) and blood pressure [29]. The children (N= 1251 children 8-to-12- years-old) who were exposed to higher tree cover and vegetation (home gardens) had decreased blood pressure. Having more play spaces was a mediating variable as it led to lower BMI which led to lower blood pressure. Based on structural equation modeling, play space as well as BMI were mediators of the effects of the garden exposure on blood pressure.

In a study on the relationship between outdoor time and mental health (N= 242 15-year-old students from Canada), physical activity mediated the relationship between outdoor time and mental health [30]. The students recorded the time they spent outdoors and the time they were engaged in moderate to vigorous physical activity. The outdoor time led to increased physical activity which in turn led to enhanced mental health.

Adults Walking in Urban Parks

In a study on outdoor walking in city parks, all durations of outdoor green space walking led to greater cognitive processing speeds and better mood [31]. Briefer but more frequent walking led to greater affinity to nature.

In a study comparing walking in urban parks versus city streets, middle age and older adults were assessed [32]. The walks were 11-to-15-minutes long. Those who walked in the urban parks had lower blood pressure and heart rate and less negative moods on the POMS scale.

In another park study, one group spent time in a park while the other group spent time inside their daycare center building (N= 107 cancer patients) [33]. Therapy was conducted over a period of 12 weeks. At a 24-week follow-up assessment, the park group had better quality of life, mindfulness and self-compassion and less fatigue and insomnia. However, this was not a randomized controlled trial, and no cancer measures were included as outcomes. In addition, being in the outdoor park versus being indoors was confounded by the inclusion of other therapeutic activities in the park including yoga, tai chi and self-massage.

In still another park study, old parks were compared to new parks with old parks being less busy and new parks having more people, bikes and sports [34]. The old parks had greater effects on reducing blood pressure than the new parks. This study from Germany (N= 33) suggested that both sitting and walking in the parks decreased blood pressure.

In an arboretum study held in Denmark (N=51 female university students), walking in an arboretum was compared to walking in a downtown urban area [35]. Surprisingly, the results suggested that there were no differences between the groups on heart rate variability. As the authors suggested, both experiences were

more restorative than being in an office or on a minibus. The arboretum group experienced more positive moods than the downtown urban group.

Wildness in Urban Parks

A preference for wilderness has led to the replication of wilderness or wildness in some city parks. Wilderness is preferred by most people as being more restorative than domesticated nature (e.g. groomed parks) or urban spaces [36]. Urban rewilding has been beneficial for humans, as is reflected in a study entitled "Wildness in urban parks is important for human well-being" [37]. As these authors suggested, relatively wild urban parks, for example, Discovery Park in Seattle, can promote human resilience.

Suburbs

In a suburb with more greenery versus a city study, the benefits of ecotherapy were explored in older women with and without hypertension (N=60 older women, mean age=65 years) [38]. The ecotherapy was held on city fringes or suburbs that had more greenery. Lower blood pressure, pulse and salivary alpha-amylase and cortisol levels (stress hormones) were reported as well as less sleep dysfunction for the suburb greenery group. Like other studies, however, the ecotherapy results were confounded by the positive effects of the other therapeutic activities including tai chi, gardening and walking.

In a study entitled "When urban environment is restorative", walking in the suburbs was as effective as walking in forests [39]. These findings were based on self-report questionnaires including the POMS, the Positive and Negative Affect Scale, and the Subjective Vitality Scale. Comparisons were also made between the effects of forest deciduous (no leaves) and forest coniferous (pine) trees. Students from Warsaw University (N=75 who were 19-to-24-years-old) reported less tension in the coniferous forest. Photos of these two environments suggested cloudy conditions in both spaces. Interestingly, the effects of sunshine and cloudiness have not been compared in this recent literature.

In a paper entitled "Greenness - air pollution - physical activity - hypertension association among middle - aged and older adults", the Global Aging and Adult Health in China database (N=11,486 adults older than 50 years) was analyzed for greenness and hypertension [40]. Neighborhood greenness in rural China was associated with less hypertension, but not in urban areas with greenness. The relationship between rural greenness and less hypertension was mediated by physical activity and low pollution. The relationship between greenness and hypertension in urban areas was mediated by air pollution, but not physical activity. Although these findings from China might not generalize to other cultures, at least one comparison between individuals from China and the U.S. suggested that they had similar responses to nature [41]. This study asked Chinese and U.S. undergraduate students to keep a diary of their "awe of nature experiences" for two weeks [41]. The most common awe of nature experiences in both cultures involved another person or nature.

In an unusual study that allowed the participants to select the time and place for their urban nature experience in the context of their daily lives, ten minutes of being outdoors three times per week for eight weeks led to decreased salivary cortisol and alpha amylase [42]. In this study on 36 urban dwellers, a 21% per hour decrease in cortisol was experienced beyond that of the average 12% diurnal decrease in cortisol. In addition, a 28% per hour decrease was noted in saliva alpha amylase, but only for those who were less active.

Nighttime versus Daytime

In another variation on green space versus urban walking, different time frames were explored including nighttime and daytime [43]. In this study, the participants (N= 48) walked 1.6 kilometers (.99 miles) through a green space and an urban area during daytime and nighttime. Daytime walking in the green area led to lower blood pressure and more positive mood, although night time walking decreased blood pressure in both the green and urban areas. The authors suggested that the urban areas are noisy and irritating during the daytime but more peaceful at night. Their data suggested that blood pressure decreased but only during green walking at night.

Virtual Nature Settings

As some researchers have suggested, "virtual reality provides the potential to simultaneously measure psychophysical measurements in real-time, such as skin conductance, respiration, heart rate, facial movements, and posture" [44]. Their research suggested that immersive videos, a highly realistic form of virtual reality, that displayed "vast and panoramic scenes of natural beauty from a 360-degree perspective" resulted in more intense awe of nature experiences than watching normal 2D videos [44].

In a study that reported restorative effects of virtual natural settings, virtual reality was used with elderly adults (N=34) [45]. Videos of virtual nature versus urban settings were shown. These included waterfalls, creeks, forests and bird songs versus buildings, signs, crowds and traffic noises. Although, surprisingly, the physiological responses did not differ between the virtual nature and urban settings, more positive feelings and less fatigue and depression were reported after the virtual nature videos.

In a paper entitled "The impact of visualization techniques of immersive virtual scenarios in promoting nature connectedness", adults (N= 60) walked on a treadmill while facing a blank wall (control group) or they were exposed to immersive virtual nature either on a 360-degree video or a matching computer-generated scenario (virtual) [46]. The Connectedness to Nature Scale was completed. Nature connectedness led to engaging in pro-environmental behavior, happiness, vitality, and life satisfaction. In addition, more time spent in nature in childhood led to greater connectedness to nature.

Horticulture Activity Effects

Horticulture activity (gardening) has also had positive effects on the physical and mental state at least for elderly individuals (N= 27 adults who were 60-to-76-years-old) [47]. This study that was conducted in Taiwan involved rocky leaf printing, herb tasting and smelling (mint, rosemary and lavender) and potting and transplanting plants. Decreases were noted on the POMS negative emotions and salivary amylase. Increased heart rate

variability was also observed. The leaf printing group showed larger decreases in negative emotions and salivary amylase followed by herb tasting and smelling, cultivating and flower viewing. The leaf printing effects were confounded by those of hand massage, and the leaf printing also resulted in an artistic creation which may have impacted the results. Because the study was conducted with groups of five to six people, the social interactions likely confounded the effects as well. It also wasn't clear how separate measures were taken of smell and taste since they are typically experienced together.

In a paper entitled "'My little piece of the planet' and the multiplicity of well-being from allotment gardening", urban horticulture was studied in the UK [48]. Adults on the waitlist for allotments (public garden plots) in the UK (N= 163) were interviewed. The benefits reported for allotments were the sharing of surplus food, knowledge exchange, awareness and interaction with wildlife, emotional connection to the allotment, appreciation of time spent outside and aesthetic delight in the natural world.

The Senses

Although many ecotherapy researchers have referred to the stimulation of the five senses being a part of the therapy, they are rarely reported in their papers. An exception is a study entitled "Engaging the senses: the association of urban green space with general health and well-being" [49]. In that study from Greece (N= 24), the hearing sense reportedly had the most positive effects (sounds of birds, streams, rustling leaves, serenity, and the lack of noise). This was followed by the sense of smell (pines, wet soil, and inhaling fresh air). The sense of touching rough bark on the trees or the velvety moss on the ground was not mentioned. Surprisingly, the physical conditions of temperature and humidity did not differ between the urban green and non-green space.

In a paper entitled "A review on the benefits of nature experiences: more than meets the eye", most of the studies involved stimulation of the visual sense (greenness and blueness) [12]. Sounds and smells, touch and taste have been relatively ignored senses in this literature. Other senses that have received some attention include ingestion or inhalation of phytoncides, negative air ions and microbes [12].

Pro-environmental Behavior Resulting from Green Space Exposure

Pro-environmentalist activities have resulted from green space exposure. In one study (N= 194) individuals (Age range =18-75 years) were given questionnaires on nature visits to city green space, connectedness to nature, activity and pro-environmental behaviors [50]. More nature visits resulted in more moderate-to-vigorous activity as well as more environmental behaviors based on a 7-item scale (including recycling, buying eco-friendly products, buying local products, walking/cycling instead of using a car, encouraging others to be pro-environmental, environmental volunteering and environmental organization membership).

In another study already mentioned on 60 adults who were exposed to immersive virtual nature either on a 360-degree video or a matching computer-generated scenario, connectedness to nature led to engaging in pro-environmental behavior [51]. Those who experienced more connectedness to the nature scene spent more time delivering flyers on environmental issues to their friends.

In still another pro-environmentalist study entitled "'Standing up for earth rights': an awe-inspiring virtual nature for promoting pro-environmental behaviors", adults (N=119) were exposed to an "awe-inspiring virtual nature scenario" [52]. Participants signed a petition against plastic production, consumption, and in favor of plastic recycling. The awe-inspiring nature group versus the control group distributed more flyers to spread the word to friends about plastic recycling.

Reviews on Exposure to Blue Nature

Although ecotherapy studies have typically involved exposure to greenery, more recent studies have appeared in the literature on short-term exposure to blue scenes. In a systematic review on 33 studies on exposure to blue water entitled "Blue care: a systematic review of blue space interventions for health and well-being", mental health and psychosocial well-being were noted effects [53]. The authors suggested that these are relevant studies given that "most of the earth's surface is water and most of the human body is composed of water".

Most of these studies could not be compared to green therapy studies because they involved very different samples, i.e. much younger, athletic participants in the blue therapy samples. And, they are confounded by much different activities. Instead of being confounded by walking or sitting or getting massages as in the green therapy studies, the blue therapy studies are confounded by very active sports including walking on the beach, surfing, river running, kayaking, scuba diving, fly fishing, dragon boat racing, and sail training. The blue therapy samples are also predominantly male and none of the studies involved participants greater than 65-years-old in contrast to most of the green therapy studies that typically involved older adults. In addition, most of the green therapy studies included physiological and biochemical measures while those were not included in the blue therapy studies that typically focused on physical fitness measures.

Studies on Blue Water Exposure

In a study entitled "Wetlands for well-being", nature-based health interventions resulted in increased relaxation and decreased stress [54]. These results were based on the Perceived Stress Scale and the Positive and Negative Affect Schedule.

In a study on water rafting, the authors found decreased stress and increased well-being after rafting in military veterans and youth from underserved communities [55]. The authors suggested that the amount of awe of nature that the participants experienced could predict the extent to which their symptoms of stress and well-being improved one week later. The awe they experienced was confounded by the activity they experienced rafting. These authors also noted that undergraduate students reported feeling more awe of nature as well as greater life satisfaction and well-being on those days that they spent time in nature.

In a less physically active walking along a blue space study, a sample of 59 adult office workers was randomly assigned to a

blue space, urban space or control site on 4 days each week, for 3 weeks [56]. For 20 min per day, they either walked along a blue or an urban space or rested at a control site. Before, during and/or after the exposure, the authors assessed self-reported well-being and mood, and monitored blood pressure, and heart rate variability parameters. The results suggested improved well-being and mood immediately after walking in the blue space compared with walking in the urban space or when resting in the control site. Cardiovascular responses showed increased sympathetic activity both during and after walking along the blue and urban spaces. The unexpected increase in sympathetic activity may have derived from the exercise of walking.

Another study in this recent literature was focused on nature therapy involving blue water at a beach in Barcelona [57]. The participants were instructed to do what they would usually do for 30 or 180 minutes of exposure to a green park or to blue water viewed from the beach. The exposure to the green park resulted in lower stress and cortisol. This association was mediated by physical activity and the experience of "restoration". The exposure to the blue water led to increased heart rate variability which was mediated by physical activity and air quality. Potential confounds in this study were air pollution, noise exposure, physical activity, social interaction, restoration experience, temperature, humidity and wind. The authors noted that half of the studies on water therapy have occurred in Japan and half in the U.S. and Europe, that most of the samples were less than 20 participants and that only half of the studies were randomized controlled trials.

Theories on Potential Underlying Mechanisms for Ecotherapy Effects

Several different psychological theories have been advanced for potential underlying mechanisms for ecotherapy effects [1]. These include the "Biophilia Hypothesis", the "Eco-Existential Positive Psychology Perspective", Attention Restoration Theory, and Stress Reduction Theory. A theory on the "awe of nature" could be added to that list of psychological theories. Biological theories have also been suggested based on parasympathetic activity and ions in the air [7,20,58]. Several studies that support these theories have appeared in this literature and are given below. Some of the studies are examples of the specific theories but most of the studies provide support for multiple theories.

In the **"Biophilia Hypothesis"**, human identity and personal fulfillment depend on a relationship with nature [1]. Biophilia is considered an innate human need to relate to the natural world. In a meta-analysis of 49 studies (N=3201 participants), exposure to natural environments increased positive affect and decreased negative affect [59]. As already noted, positive mood has been enhanced in many different green spaces including the forest and urban parks [13,32].

The **Eco-Existential Positive Psychology** perspective suggests that "experiences in the natural environment play an important role in addressing the six existential anxieties of identity, happiness, isolation, meaning in life, freedom and death" [1]. That involvement, in turn, enhances well-being by helping manage existential anxieties about isolation and unhappiness. In a study entitled "Is nature relatedness associated with better mental and physical health?", nature relatedness was associated with decreased depression, anxiety and stress [60]. As described earlier in this review, both anxiety and depression have decreased in green spaces in both adults with hypertension and in the elderly [4,14].

In the **Attention Restoration Theory**, natural environments are rich in stimuli that engage involuntary attention ("soft fascination") which is relaxing and stress-reducing [1]. In turn, this leads to better performance on memory and attention tests. In a meta-analysis of studies on attention restoration in natural environments, at least 3 of the studies confirmed attention restoration [61]. These data were based on adults performing the digit span forward, the digit span backward, and the trail-making test. Enhanced attentiveness and performance on cognitive tasks have also been shown in children following exposure to nature including on the Attention Network and Mobile Eye Tracking tasks [62].

In the **Stress Reduction Theory**, natural environments have a restorative advantage over artificial environments due to the role that they played in evolution [1]. In this view, nature reduces stress and autonomic arousal. These effects have been shown by decreased heart rate and blood pressure in virtually every green nature study in this literature. In a meta-analysis of stress reduction interventions (N=43 studies), undergraduate and graduate students experienced significant reductions in stress [63]. Reduced stress and arousal have also been described in other studies both in green spaces and blue spaces [5,54].

Still another potential underlying mechanism involves the **awe experienced in nature**. In one study entitled "Seeing awe: How children perceive awe-inspiring visual experience" 4-to-9-year-old children were shown "awe-inspiring nature" which positively affected their sense of self [64]. Other researchers have reported that undergraduate students who had been water rafting reported feeling more awe of experiencing nature on days when they spent time in nature [55]. In the study that invited Chinese and U.S. undergraduate students to keep a diary of their awe of nature experiences for two weeks, the most common awe of experiencing nature elicitors in both cultures were experiences involving another person or nature [41]. In a study also already mentioned, adults exposed to an awe-inspiring virtual nature scenario versus a control group distributed more flyers to spread the word to friends about plastic recycling [52]. These people experienced the awe of experiencing nature, and others reading about them would likely also experience awe of their pro-environmental behaviors.

Biological theories are focused on increased parasympathetic activity following exposure to nature. Increased heart rate variability (parasympathetic activity) has been documented in both the viewing of green nature and in blue water activity [20,57]. Both the forest and the beach environments feature negative air ions that increase parasympathetic activity [12]. In addition, the other therapies that have been included in ecotherapy protocols, for example yoga and massage therapy have also enhanced parasympathetic activity [7,58]. The stimulation of pressure receptors under the skin in these therapies leads to increased heart rate variability, the reduction of stress hormones including cortisol and alpha amylase and, in turn, the increase of natural killer cells (that kill bacterial, viral and cancer cells) and natural

killer cell activity showing enhanced immune function [7]. The phytoncide with antioxidant and antiseptic properties found in both green and blue environments also enhances immunity [12].

Empirical studies comparing these potential underlying psychological and biological mechanisms have not been conducted, although It is likely that all of these phenomena underly the multiple psychological and physiological effects of nature exposure/therapy that have been reported in this recent literature. The suggestion of future research directions like these highlights the limitations of this recent literature.

Limitations of the Recent Literature

Several methodological limitations can be noted for this literature including sampling, measurement, data analysis and results that are often confounded. Many different medical conditions have been assessed for green therapy effects and the participants with medical problems have not been compared to healthy participants. In addition, for the purposes of documenting ecotherapy effects, most of the samples have not been randomly assigned to ecotherapy or control groups, as in randomized controlled trials. Further, many studies have not included active (other therapy) control groups.

Green ecotherapy groups have typically been older adults with medical conditions who have been assessed primarily by physiological measures including heart rate and blood pressure. In contrast, the blue ecotherapy samples have typically been young athletic individuals who are engaging in active sports including kayaking and surfing and have been assessed for their physical fitness. These methodological differences suggest that green and blue ecotherapy samples cannot be reliably compared.

Table 3: Studies on blue ecotherapy (and first authors)

Effects	First Authors
Increased physical fitness	Britton
Increased physical activity and heart rate variability	Triguero-Mas
Increased relaxation and decreased stress	Maund

Although many of the green ecotherapy studies are focused on different conditions, for example, hypertension, insomnia and dementia, their effects have been assessed by physiological measures but not disease markers. Thus, the results don't indicate whether the medical conditions have been lessened by the therapies.

The colors green and blue are reputedly the most calming colors on the color spectrum, so it's not clear how much the effects of forest and ocean could be partially related to the calming effects of the green and blue colors. The calming effects of these colors may have happened over evolution due to exposure to green and blue environments. In one of the studies, those adults who had been exposed to green environments during childhood were positively affected by green ecotherapy later in adulthood. However, in the absence of studies on other color nature environments like the beige of marshes or deserts, the degree to which color might contribute to the therapeutic effects of green and blue ecotherapies is unclear.

Although several researchers have suggested that the five senses are involved in the effects of exposure to nature, the studies have not examined the nature effects on the different senses. For example, bamboo forests have not been compared to pine forests for their olfactory effects. The visual sense has clearly been the primary focus in this literature. Extrasensory stimulants have emerged in green and blue ecotherapies like phytoncides, negative air ions and microbes that may underly the positive effects of those ecotherapies.

The demographics of the samples have rarely been mentioned except occasional gender differences that vary across studies. Age differences would be expected especially on the physically active aspects of the protocols. Individual differences in preferences for different green or blue spaces would be expected to affect results. Except for one research group that reported openness as an individual difference personality factor, researchers have not explored individual differences on preferences. Some individuals might not like the silence, the darkness, the insects and the unknown animals in the forest. Similarly, some might be frightened by the possibility of encountering unfriendly fish and sharks lurking in the waters. Others might be more adventuresome or have less fear. Awe of the forest and ocean can be positive as in joy or negative as in fear. The awe of experiencing nature has been defined as potentially both positive and negative.

The therapy protocols often involve walking through a forest or sitting on its edge or watching a video of a forest scene. The differences in physical activity of these three conditions could seemingly explain some of the mixed findings. For example, heart rate variability (parasympathetic activity) has increased in some studies involving more activity and has remained the same in other less active therapy protocols. Various activity levels that might have confounded the results have not been compared. The protocols assessing the effects of the forest and the ocean are confounded by the other activities that are occurring. For example, walking and swimming would be expected to enhance parasympathetic activity, as they have in other studies, while sitting and viewing may not. The effects of the green and blue ecotherapies are confounded by the effects of these other therapeutic activities.

The green and blue ecotherapy effects are also confounded by differences in light, for example, walking in the forest compared to walking on city streets without trees in sunshine and the heat of the sunshine. Other confounding factors are noise levels and noise types which vary in their unpleasantness. The hooting of owls in the forest or the sounds of frogs, crickets and peepers on ponds are more calming than the beeping of cars or the sirens of emergency vehicles. None of the studies have controlled this confound, for example, by the use of earplugs or earbuds.

The measures have typically been physiological or self-report without confirmatory data from the alternative/complementary data. Although the POMS and the PANAS scales have been used in several studies, scores from the different subscales have been reported in the different studies. Typically, the results have been reported as decreased negative emotions, blood pressure and/ or heartrate in those adults experiencing green ecotherapy and increased fitness in those experiencing blue ecotherapy. However, the outcomes have rarely been compared with baseline

levels of those measures within groups or by comparisons with the same measures on other non-therapy or other active therapy groups. The relative contribution of the different aspects of the therapy protocols have not been assessed, for example the effects of walking or yoga or self-massage by regression analysis or structural equations modeling. Also, the relative significance of the reductions in heart rate versus blood pressure, for example, have not been assessed for their impact on the disease biomarkers of hypertension, for example.

Several potential underlying psychological and biological mechanisms have been suggested for the effects of green and blue ecotherapies and studies have been presented to support those mechanisms. It is likely that each of these mechanisms are involved in each of the studies. For example, the psychological stress reduction and the reduced cortisol and increased natural killer cells that result from stress reduction may all underly the effects of ecotherapies. These underlying mechanisms could also function in an inverted U-shaped fashion such that too much stress reduction could have boredom effects or awe of experiencing nature could happen at one extreme as fear instead of joy at the other extreme and the net effects could be negative.

Table 5: Potential underlying mechanisms/psychological and biological theories for ecotherapy (and first authors)

Theories	First Authors
Psychological Theories	
Biophilia hypothesis-love of life	Chaughury, Gaekwad
Eco-existential Positive Psychology-managing anxieties	Chaughury, Dean
Attention Restoration Theory-involuntary attention	Chaughury, Hertig
Stress Reduction Theory	Chaughury, Yusufov
Awe of nature	O'bi, Chirico
Biological Theories	
Phytoncide with antioxidant and antiseptic properties	Franco
Negative air ions increasing parasympathetic activity	Franco
Stimulation pressure receptors increasing parasympathetic activity	Field

Despite these methodological limitations, these studies suggest future research directions. The recent literature on ecotherapy has revealed many positive psychological, physiological and biochemical effects. These positive effects highlight the impact of green and blue ecotherapies on mental and physical health.

References

1. Chaudhury P, Banerjee D. Recovering With Nature: A Review of Ecotherapy and Implications for the COVID-19 Pandemic. Front Public Health. 2020. 8: 604440.
2. Antonelli M, Donelli D, Carlone L, Maggini V, Firenzuoli F, et al. Effects of forest bathing (shinrin-yoku) on individual well-being: an umbrella review. Int J Environ Health Res. 2022. 32: 1842-1867.
3. Rajoo, K. The physiological and psychosocial effects of forest therapy: A systematic review. Urban Forestry & Urban Greening. 2020. 54: 126744.
4. Yau KK, Loke AY. Effects of forest bathing on pre-hypertensive and hypertensive adults: a review of the literature. Environ Health Prev Med. 2020. 25: 23.
5. Piva G, Caruso L, Gómez AC, Calzolari M, Visintin EP, et al. Effects of forest walking on physical and mental health in elderly populations: a systematic review. Rev Environ Health. 2022. 39: 121-136.
6. Li Q. Effects of forest environment (Shinrin-yoku/Forest bathing) on health promotion and disease prevention -the Establishment of "Forest Medicine". Environ Health Prev Med. 2022. 27: 43.
7. Field T. Massage therapy research: A narrative review. Current Research in Psychology and Behavioral Science. 2024. 5: 10108.
8. Stier-Jarmer M, Throner V, Kirschneck M, Immich G, Frisch D, et al. The Psychological and Physical Effects of Forests on Human Health: A Systematic Review of Systematic Reviews and Meta-Analyses. Int J Environ Res Public Health. 2021. 18: 1770.
9. Qiu Q, Yang L, He M, Gao W, Mar H, et al. The Effects of Forest Therapy on the Blood Pressure and Salivary Cortisol Levels of Urban Residents: A Meta-Analysis. Int J Environ Res Public Health. 2022. 20: 458.
10. Ideno Y, Hayashi K, Abe Y, Ueda K, Iso H, et al. Blood pressure-lowering effect of Shinrin-yoku (Forest bathing): a systematic review and meta-analysis. BMC Complement Altern Med. 2017. 17: 409.
11. Wen Y, Yan Q, Pan Y, Gu X, Liu Y. Medical empirical research on forest bathing (Shinrin-yoku): a systematic review. Environ Health Prev Med. 2019. 24: 70.
12. Franco LS, Shanahan DF, Fuller RA. A Review of the Benefits of Nature Experiences: More Than Meets the Eye. Int J Environ Res Public Health. 2017. 14: 864.
13. Furuyashiki A, Tabuchi K, Norikoshi K, Kobayashi T, Oriyama S. A comparative study of the physiological and psychological effects of forest bathing (Shinrin-yoku) on working age people with and without depressive tendencies. Environ Health Prev Med. 2019. 24: 46.
14. Yu CP, Lin CM, Tsai MJ, Tsai YC, Chen CY. Effects of Short Forest Bathing Program on Autonomic Nervous System Activity and Mood States in Middle-Aged and Elderly Individuals. Int J Environ Res Public Health. 2017. 14: 897.
15. Lim YS, Kim J, Khil T, Yi J, Kim DJ. Effects of the forest healing program on depression, cognition, and the autonomic nervous system in the elderly with cognitive decline. Journal of People, Plants, and Environment. 2021. 24: 107-117.
16. Tsao TM, Tsai MJ, Hwang JS, Cheng WF, Wu CF, et al. Health effects of a forest environment on natural killer cells in humans: an observational pilot study. Oncotarget. 2018. 9: 16501-16511.
17. Lyu B, Zeng C, Xie S, Li D, Lin W, et al. Benefits of A Three-Day Bamboo Forest Therapy Session on the Psychophysiology and Immune System Responses of Male College Frames on Physio-Psychological Responses of Middle-Aged and Older People in Chengdu, China. Int J Environ Res Public Health. 2020. 18: 90.
18. Hassan A, Tao J, Li G, Jiang M, Aii L, et al. Effects of Walking in Bamboo Forest and City Environments on Brainwave Activity in Young Adults. Evid Based Complement Alternat Med. 2018. 2018: 9653857.

19. Kim JG, Shin WS. Forest Therapy Alone or with a Guide: Is There a Difference between Self-Guided Forest Therapy and Guided Forest Therapy Programs? Int J Environ Res Public Health. 2021. 18: 6957.
20. Song C, Ikei H, Kobayashi M, Miura T, Li Q, et al. Effects of viewing forest landscape on middle-aged hypertensive men. Urban Forestry & Urban Greening. 2017. 21: 247-252.
21. Zabini F, Albanese L, Becheri FR, Gavazzi G, Giganti F, et al. Comparative Study of the Restorative Effects of Forest and Urban Videos during COVID-19 Lockdown: Intrinsic and Benchmark Values. Int J Environ Res Public Health. 2020. 17: 8011.
22. Bielinis E, Omelan A, Boiko S, Bielinis L. The restorative effect of staying in a broad-leaved forest on healthy young adults in winter and spring. Baltic Forestry. 2018. 24: 218-227.
23. Montag C. An attempt to assess individual differences in Shinrin-Yoku tendencies and associations with personality and life satisfaction: a study from Germany. Trees, Forests and People. 2024. 15: 100475.
24. Summers JK, Vivian DN, Summers JT. The Role of Interaction with Nature in Childhood Development: An Under-Appreciated Ecosystem Service. Psychol Behav Sci. 2019. 8: 142-150.
25. Fernandes A, Avraam D, Cadman T, Dadvand P, Guxens M, et al. Green spaces and respiratory, cardiometabolic, and neurodevelopmental outcomes: An individual-participant data meta-analysis of >35.000 European children. Environ Int. 2024. 190: 108853.
26. Kondo MC, Jacoby SF, South EC. Does spending time outdoors reduce stress? A review of real-time stress response to outdoor environments. Health Place. 2018. 51: 136-150.
27. Summers JK, Vivian DN. Ecotherapy - A Forgotten Ecosystem Service: A Review. Front Psychol. 2018. 9: 1389.
28. Thomas T, Aggar C, Baker J, Massey D, Thomas M, et al. Social prescribing of nature therapy for adults with mental illness living in the community: A scoping review of peer-reviewed international evidence. Front Psychol. 2022. 13: 1041675.
29. Dzhambov AM, Lercher P, Markevych I, Browning MHEM, Rüdisser J. Natural and built environments and blood pressure of Alpine schoolchildren. Environ Res. 2022. 204: 111925.
30. Bélanger M, Gallant F, Doré I, O'Loughlin JL, Sylvestre MP, et al. Physical activity mediates the relationship between outdoor time and mental health. Prev Med Rep. 2019.
31. Tomasso LP, Spengler JD, Catalano PJ, Chen JT, Laurent JGC. In situ psycho-cognitive assessments support self-determined urban green exercise time. Urban For Urban Green. 2023. 86: 128005.
32. Pratiwi PI, Xiang Q, Furuya K. Physiological and psychological effects of walking in urban parks and its imagery in different seasons in middle-aged and older adults: Evidence from Matsudo City, Japan. Sustainability. 2020. 12: 4003.
33. Kuballa L, Kessler CS, Kandil FI, von Scheidt C, Meinköhn M, et al. Effects of an Integrative Day Care Clinic Program with a Focus on Nature Therapy in a Hospital Park Setting on Quality of Life in Oncological Patients-A Non-Randomized Controlled Study. Cancers (Basel). 2023. 15: 4595.
34. Kabisch N, Pueffel C, Masztalerz O, Hemmerling J, Kraemer R. Physiological and psychological effects of visits to different urban green and street environments in older people: A field experiment in a dense inner-city area. Landscape and Urban Planning. 2021. 207: 103998.
35. Stigsdotter UK, Corazon SS, Sidenius U, Kristiansen J, Grahn P. It is not all bad for the grey city - A crossover study on physiological and psychological restoration in a forest and an urban environment. Health Place. 2017. 46: 145-154.
36. Barbiero G, Berto R, Senes G, Fumagalli N. Wilderness Is the Prototype of Nature Regardless of the Individual's Connection to Nature. An Empirical Verification of the Solastalgia Effect. Int J Environ Res Public Health. 2023. 20: 6354.
37. Lev E, Kahn Jr PH, Chen H, Esperum G. Relatively wild urban parks can promote human resilience and flourishing: A case study of Discovery Park, Seattle, Washington. Frontiers in Sustainable Cities. 2020. 2: 2.
38. Ye X, Dou Z, Jiang M, Luo Z, Li M, et al. Effects of Linpan nature therapy on health benefits in older women with and without hypertension. Front Public Health. 2023. 11: 1208481.
39. Janeczko E, Bielinis E, Wójcik R, Woźnicka M, Kędziora W, et al. When urban environment is restorative: The effect of walking in suburbs and forests on psychological and physiological relaxation of young Polish adults. Forests. 2020. 11: 591.
40. Huang B, Xiao T, Grekousis G, Zhao H, He J, et al. Greenness-air pollution-physical activity-hypertension association among middle-aged and older adults: Evidence from urban and rural China. Environ Res. 2021. 195: 110836.
41. Bai Y, Maruskin LA, Chen S, Gordon AM, Stellar JE, et al. Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. Journal of Personality and Social Psychology. 2017. 113: 185-209.
42. Hunter MR, Gillespie BW, Chen SY. Urban Nature Experiences Reduce Stress in the Context of Daily Life Based on Salivary Biomarkers. Front Psychol. 2019. 10: 722.
43. Li H, Liu H, Yang Z, Bi S, Cao Y, et al. The Effects of Green and Urban Walking in Different Time Frames on Physio-Psychological Responses of Middle-Aged and Older People in Chengdu, China. Int J Environ Res Public Health. 2020. 18: 90.
44. Chirico A, Cipresso P, Yaden DB, Biassoni F, Riva G, et al. Effectiveness of Immersive Videos in Inducing Awe: An Experimental Study. Scientific Reports. 2017. 7: 1-11.
45. Yu CP, Lee HY, Lu WH, Huang YC, Browning MH. Restorative effects of virtual natural settings on middle-aged and elderly adults. Urban Forestry & Urban Greening. 2020. 56: 126863.
46. Calogiuri G, Petersen E, Haile A, Flaten OE, Fröhlich F, et al. The impact of visualization techniques of immersive virtual scenarios in promoting nature connectedness: A blind randomized controlled trial with mixed-methods approach. Journal of Environmental Psychology. 2023. 90: 102102.
47. Tu PC, Cheng WC, Hou PC, Chang YS. Effects of Types of Horticultural Activity on the Physical and Mental State of Elderly Individuals. Int J Environ Res Public Health. 2020. 17: 5225.

48. Dobson MC, Reynolds C, Warren PH, Edmondson JL. "My little piece of the planet": the multiplicity of well-being benefits from allotment gardening. British Food Journal. 2021. 123: 1012-1023.
49. Kanelli AA, Dimitrakopoulos PG, Fyllas NM, Chrousos GP, Kalantzi OI. Engaging the senses: the association of urban green space with general health and well-being in urban residents. Sustainability. 2021. 13: 7322.
50. Teixeira A, Gabriel R, Martinho J, Santos M, Faria A, et al. Pro-Environmental Behaviors: Relationship with Nature Visits, Connectedness to Nature and Physical Activity. Am J Health Promot. 2023. 37: 12-29.
51. Calogiuri G, Petersen E, Haile A, Flaten OE, Fröhlich F, et al. The impact of visualization techniques of immersive virtual scenarios in promoting nature connectedness: A blind randomized controlled trial with mixed-methods approach. Journal of Environmental Psychology. 2023. 90: 102102.
52. Chirico A, Pizzolante M, Borghesi F, Bartolotta S, Sarcinella ED, et al. "Standing up for earth rights": Awe-inspiring virtual nature for promoting pro-environmental behaviors. Cyberpsychology, Behavior, and Social Networking. 2023. 26: 300-308.
53. Britton E, Kindermann G, Domegan C, Carlin C. Blue care: a systematic review of blue space interventions for health and wellbeing. Health Promot Int. 2020. 35: 50-69.
54. Maund PR, Irvine KN, Reeves J, Strong E, Cromie R, et al. Wetlands for Wellbeing: Piloting a Nature-Based Health Intervention for the Management of Anxiety and Depression. Int J Environ Res Public Health. 2019. 16: 4413.
55. Anderson CL, Monroy M, Keltner D. Awe in nature heals: Evidence from military veterans, at-risk youth, and college students. Emotion. 2018. 18: 1195.
56. Vert C, Gascon M, Ranzani O, Márquez S, Triguero-Mas M, et al. Physical and mental health effects of repeated short walks in a blue space environment: A randomised crossover study. Environmental Research. 2020. 188: 109812.
57. Triguero-Mas M, Gidlow CJ, Martínez D, de Bont J, Carrasco-Turigas G, et al. The effect of randomised exposure to different types of natural outdoor environments compared to exposure to an urban environment on people with indications of psychological distress in Catalonia. PLoS One. 2017. 12: e0172200.
58. Field T. Yoga therapy research: A narrative review. Current Research in Complementary and Alternative Medicine. 2023. 7: 23.
59. Gaekwad JS, Sal Moslehian A, Roös PB, Walker A. A meta-analysis of emotional evidence for the biophilia hypothesis and implications for biophilic design. Frontiers in Psychology. 2022. 13: 750245.
60. Dean JH, Shanahan DF, Bush R, Gaston KJ, Lin BB, et al. Is nature relatedness associated with better mental and physical health? International journal of environmental research and public health. 2018. 15: 1371.
61. Hartig T, Jahncke H. Attention restoration in natural environments: Mixed mythical metaphors for meta-analysis. Journal of Toxicology and Environmental Health. 2017. 20: 305-315.
62. Stevenson MP, Dewhurst R, Schilhab T, Bentsen P. Cognitive Restoration in Children Following Exposure to Nature: Evidence from the Attention Network Task and Mobile Eye Tracking. Front Psychol. 2019. 10: 42.
63. Yusufov M, Nicoloro-SantaBarbara J, Grey NE, Moyer A, Lobel M. Meta-analytic evaluation of stress reduction interventions for undergraduate and graduate students. Journal of stress management. 2019. 26: 132-145.
64. O'bi A, Yang F. Seeing awe: How children perceive awe-inspiring visual experiences. Child Dev. 2024. 95: 1271-1286.