**Review Article**

**Examining the Relationship Between Health and Exposure to Nature: A Review**

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**Received**:29th July 2022

**Accepted**:06 September 2022

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**ABSTRACT**

There exists a substantial body of empirical research examining the correlation between exposure to natural environments and one's health. In this narrative review, we delve into the robustness of recent (i.e., within the last ten years) experimental and observational studies concerning nature exposure and health, with a particular emphasis on studies involving children and youth whenever feasible. Our findings reveal compelling evidence linking exposure to nature with enhancements in cognitive function, brain activity, blood pressure, mental well-being, physical activity, and sleep quality. Experimental investigations yield substantial evidence supporting the protective impact of natural environment exposure on mental health outcomes and cognitive function. Additionally, cross-sectional observational studies demonstrate favourable associations between nature exposure and increased physical activity levels as well as a reduced risk of cardiovascular disease. Furthermore, longitudinal observational studies have initiated the exploration of the enduring effects of nature exposure on depression, anxiety, cognitive function, and chronic diseases. It's important to note that our current understanding is encumbered by certain limitations, including inconsistent methods for measuring nature exposure, variations in the type and quality of green spaces, and uncertainties regarding the health effects of exposure duration and frequency. Future research should aim to employ more rigorous study designs, probe the underlying mechanisms connecting green spaces and health, advance methods for assessing exposure, and investigate sensitive developmental periods during the early stages of life.

**Keywords:** Health; Exposure to Nature; Review; Chronic Diseases; Mental health, Nature.

**INTRODUCTION**

The "biophilia hypothesis" suggests that humans have developed an inherent affinity for nature.1 Expanding upon this idea, two significant theories—Attention Restoration Theory and Stress Reduction Theory—have shed light on how spending time in natural settings can impact human well-being. Attention Restoration Theory (ART) posits that the mental fatigue associated with modern life stems from a diminished ability to focus attention.2 According to this theory, immersing oneself in natural environments allows individuals to alleviate this mental fatigue and restore their capacity to concentrate.3 Stress Reduction Theory (SRT), on the other hand, explains how spending time in nature can influence emotions by activating the parasympathetic nervous system, thereby reducing stress and autonomic arousal due to our innate connection with the natural world.4,5

Furthermore, proponents of the biophilia hypothesis argue that green spaces offer children opportunities for discovery, creativity, risk-taking, mastery, and control, all of which positively impact various aspects of brain development.6 In addition to the biophilia hypothesis, there are several other ways in which nature can potentially affect health. These include, but are not limited to, increasing opportunities for social interaction and providing space for physical activity, while also mitigating harmful environmental factors such as air pollution, noise, and heat.7,8,9,10 Although the evidence is not consistently clear, physical activity may serve as a crucial mechanistic pathway to achieve beneficial health outcomes by offering more opportunities for outdoor exercise, such as walking and play.7,8,9 The promotion of social contact is another promising mechanism that has emerged from recent research, as natural environments and green spaces provide avenues for increased social interaction and a greater sense of community.9,10 It's important to note that these mechanisms underlying the connections between nature exposure and health outcomes are diverse, not entirely comprehended, and can operate independently or in synergy.11

Although the exploration of the impact of nature exposure on health has significantly grown in recent times, there continue to be numerous unexamined connections, mechanisms, and demographic groups. Notably, there is a notably broader body of evidence regarding the links between nature and health, particularly in terms of experimental research, when it comes to adults as opposed to children. This narrative review aims to consolidate recent scientific literature pertaining to the relationships between nature and health. It places a particular emphasis on studies involving children and young individuals, whenever feasible. The review encompasses publications up to August 2020 and is based on two primary categories of research: (1) randomized experimental studies examining short-term nature exposure and its immediate effects, and (2) observational studies focusing on prolonged exposure to natural environments.

**METHODS**

A narrative review amalgamates findings from quantitative studies that employ various methodologies and/or theoretical frameworks, with a focus on the statistical significance of the study outcomes not being a primary concern.12,13 On August 31, 2020, we conducted a review based on keyword searches using PubMed Advanced Search for studies published within the past decade. We specifically sought studies with titles or abstracts containing terms such as "greenness," "green space," or "NDVI" (normalized difference vegetation index) as exposure factors and "health," "children's health," or "youth health" as outcome measures. Child participants were defined according to World Health Organization criteria as individuals younger than 10 years old, while youth encompassed those aged from 10 to 24 years.14

This narrative review is limited to research involving human subjects, and it encompasses English-language international peer-reviewed articles (including primary research and reviews), online reports, electronic books, and press releases. Our scope encompasses both experimental and observational studies, and we employed a snowballing search approach by examining the references cited in the articles identified during the literature search. Each item identified underwent relevance assessment by a member of our research team. It's important to note that this review is not exhaustive in its coverage but rather aims to provide a summary of recent literature regarding the relationship between exposure to nature and health.

 **RESULTS**

When gathering literature regarding the connections between nature and health, we conducted an extensive review encompassing a diverse array of studies spanning various health-related fields, geographical areas, and participant demographics. The evidence discussed in the following sections, drawn from both experimental and observational studies, primarily originates from recent research conducted within the past decade. It's worth noting that the majority of this literature hails from Western countries.

***Experimental Studies***

Our exploration uncovered a significant volume of research that employed an experimental approach to assess the impact of natural environments on health. These interventions involved various forms of interaction with the natural environment, including active engagement (such as walking or running), passive engagement (such as relaxing outdoors or having a natural view), or virtual exposure (like watching videos or viewing images of nature).15,16 In the majority of these experimental studies, the focus was on evaluating mental health and neurological outcomes. The findings from these experimental studies indicated that exposure to natural environments appeared to have a protective influence on mental health outcomes and cognitive function.

***Stress***

Numerous experimental investigations have explored perceived stress and other subjective indicators of stress, such as sleep quality. A recent systematic review, which encompassed more than 40 experimental studies, has highlighted that measurements like heart rate, blood pressure, and perceived stress furnish the most compelling evidence suggesting that exposure to nature or outdoor settings might alleviate the adverse impacts of stress.17 In particular, findings related to perceived or self-reported stress following exposure to natural environments appeared to exhibit greater consistency compared to outcomes observed in studies utilizing physiological stress metrics (such as cortisol levels) among adult participants.

Furthermore, a recent meta-analysis discovered supporting evidence that exposure to natural environments could lead to reduced cortisol levels, a frequently examined biological marker of stress. Notably, Song et al. conducted a review of 52 articles from Japan that investigated the physiological effects of nature therapy. The collective evidence strongly indicated a decrease in cortisol levels when individuals were exposed to natural surroundings. In multiple studies, salivary cortisol levels exhibited a decline following mild to moderate physical activity conducted in a natural environment when contrasted with an urban setting.18

While many studies have reported notable reductions in measured salivary cortisol levels following exposure to natural environments, others have failed to detect significant differences in salivary cortisol levels before and after such exposure.17,19 However, it's crucial to acknowledge a significant limitation associated with using cortisol as a stress biomarker in experimental studies, which is the diurnal variation of cortisol levels over a 24-hour period. To ensure a fair comparison, it is essential to consider diurnal cortisol fluctuations. Nevertheless, most of the existing literature on nature exposure and stress has only examined cortisol levels before and after exposure.17

Regarding experimental studies involving children or youth, there is a shortage of research in this area.20,21 One quasi-experimental study, conducted among 10-12-year-olds within a school setting, investigated the impact of natural environments on stress responses.22 The researchers noted higher tonic vagal tone, an indicator of heart rate variability, in natural environments but did not find any associations with event or phasic vagal tone.

***Affective State***

Research has also explored the connection between exposure to natural settings and individuals' self-reported affective state, which pertains to their emotional experiences and mood. Although the measurement methods in these studies may vary, investigations among adults have generally revealed links between exposure to natural environments and affective state. These associations typically involve positive connections with positive emotions and negative associations with negative emotions.16,22,23

For instance, in a study conducted in Palo Alto, California, sixty adults were randomly assigned to a 50-minute walk in either a natural or an urban environment. The findings indicated that compared to urban settings, experiencing nature led to emotional benefits such as reduced anxiety, rumination, and negative emotions, while preserving positive emotional states. Additionally, there were cognitive advantages, including improved working memory performance.23

Moreover, research on forest bathing, known as shinrin-yoku, demonstrated that spending time in forests correlated with reduced feelings of hostility, depression, and anxiety among adults experiencing acute and chronic stress.24 Another study examining walks in various environments discovered that the most substantial and consistent enhancements in psychological well-being were associated with forest walks.25

However, it's important to note that the lack of studies focused on children or youth limits the extent to which these findings can be generalized across a broader age spectrum.26

***Anxiety and Depressive Mood***

Exposure to natural surroundings has been associated with reductions in both anxiety and rumination, both of which are linked to negative mental health outcomes such as depression and anxiety.23,27 Nature-based health interventions (NBI) are interventions designed to involve individuals in nature-centered experiences with the aim of enhancing health and well-being.28 An example of such an intervention is a wetland NBI in Gloucestershire, UK, which was specifically designed to engage individuals diagnosed with anxiety and/or depression in nature-based activities. The study revealed that the wetland site offered participants a sense of escape from their everyday environments, leading to relaxation and reduced stress levels.27

Furthermore, a recent systematic review and meta-analysis found a decrease in depressive mood following short-term exposure to natural environments.21 However, the authors of the review noted that the overall quality of the studies examined was generally low, primarily due to a lack of blinding among study participants and insufficient information on the quality of randomization in randomized trials.

**CONCLUSION**

The aim of this review was to analyse recent literature concerning the relationship between nature exposure and health, with a particular emphasis on studies involving children and youth whenever possible. We evaluated the strength of evidence derived from both experimental and observational studies, uncovering indications of links between nature exposure and enhancements in cognitive function, brain activity, blood pressure, mental well-being, physical activity, and sleep quality.

Experimental studies offered insights into the protective effects of exposure to natural environments on mental health outcomes and cognitive function. Cross-sectional observational studies furnished evidence supporting positive associations between nature exposure, increased physical activity levels, and reduced risk of cardiovascular disease. Moreover, longitudinal observational studies have commenced the exploration of the prolonged effects of nature exposure on depression, anxiety, cognitive function, and chronic diseases.

However, it's important to acknowledge the limitations and gaps in the existing body of research on nature exposure and health. These limitations encompass inconsistent measures for quantifying nature exposure, a need to understand the impacts of the type and quality of green spaces, and the health consequences of exposure duration and frequency across diverse populations (e.g., adults, children, historically marginalized groups). To advance our understanding, future research should incorporate more rigorous study designs, delve into the underlying mechanisms connecting green space and health, refine exposure assessment methods, and explore sensitive periods throughout the various stages of life.

**ACKNOWLEDGEMENTS**

The authors would like to thank the university for their support.

**Funding:** No funding sources

**Conflict of Interest:** None declared

**Ethical Approval:** The study was approved by the Institutional Ethics Committee.

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