



**Promoting nature connectedness through  
nature-based activities: an underestimated  
pathway to healthy urban living**

Supervisor: Dr. Hanneke Posthumus

First examiner: Dr. Ulrike Gehring

Second reviewer: Dr. Gerard Hoek



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## ABSTRACT

Natural green and blue spaces in urban environments are associated to numerous benefits, and increased nature connectedness (NC) has emerged as a potential mediator of nature exposure health benefits. However, there is still a lack of understanding of how to promote NC in urban natural spaces. Availability of natural spaces does not mean actual exposure, nor time spent in them necessarily means active engagement with nature. In this context, nature-based activities (NBA) are well-designed experiences that engage people in nature with the goal of improving health and well-being. The purpose of this review is to provide an integrative synthesis of the existing literature regarding NBA in urban environments that examined their relationship with NC as a health mediator. NBA are first categorized in different types. A total of 26 studies were included and summarized. With few exceptions, most of the studies showed positive correlations between a variety of NBA and increased levels of nature connectedness, which were also linked to markers of mental health and well-being. No studies directly examining physical health outcomes were identified, and most of the available research was conducted in green spaces. Further research exploring specific characteristics of NBA and subgroups of the population that could benefit the most from these interventions should be conducted. This evidence might later contribute to additional societal benefits promoting cost-effective interventions for healthy urban living. Activities in direct contact with urban nature may become an effective way of promoting NC and increasing health and well-being in a highly urbanized world.

**Keywords:** urban nature, nature connectedness, nature-based activities, healthy urban living, literature review.

**Number of words:** 250



## LAYMAN SUMMARY

A lot of scientific evidence has demonstrated the association between time spent in nature and health benefits, including reduced stress, improved mental health, lower levels of blood pressure, and less risk of obesity and type 2 diabetes. However, more than half of the global population now lives in cities, with decreased space for nature. Therefore, it is important to understand how to promote access to green and blue natural spaces in urban environments. Green spaces are the ones dominated by grasslands, trees, or other vegetation, such as urban parks, whereas blue spaces are those made up of waterbodies, like rivers, canals, and lakes. Still, having more natural spaces in cities does not mean people use them and get exposed to nature. In the same way, spending more time in nature does not necessarily mean people actively engage and connect with nature. In this regard, independent of the time spent in nature, those who feel a greater sense of connection with nature seem to be the ones who gain more health benefits.

However, there is still a lack of understanding of how to promote connection to nature in the context of urban natural spaces. For this purpose, nature-based activities (NBA) might be of help. NBA are well-designed experiences, such as exercising in urban parks, practicing meditation in nature, or growing food in urban gardens, that engage people in nature with the goal of improving health and well-being. Therefore, the purpose of this literature review is to summarize the scientific evidence that have studied a variety of NBA and their relationship to nature connectedness and health benefits. With some exceptions, most of the studies covered in this review showed positive correlations between a variety of NBA and increased levels of nature connectedness, which were also linked to better mental health and increased well-being. No studies directly examining the effect in physical health outcomes were identified, although a few of them measured their impact in some lifestyle habits (dietary habits, levels of physical activity, and sleep quality). Most of the available research was conducted in green spaces and very little has been studied in blue spaces. Further understanding is needed to explore



characteristics of these interventions that can make them more beneficial, including the type of activity, their duration and frequency. In the future, it is also important to identify subgroups of the population that could benefit the most, with a focus in different stages of life and socioeconomical status, among others.

In summary, more research is needed, but available evidence is encouraging. Activities in direct contact with urban nature may be useful to promote connection to nature and increase health and well-being in a highly urbanized world. In the future, this can ultimately provide societal benefits contributing to successfully engage people with urban nature using cost-effective individualized interventions and promote a healthier urban living.

**Number of words:** 472



## INTRODUCTION

### *1. Urban nature: health and societal benefits*

Spending more time in nature has been associated to many health benefits, ranging from improved mental health, lower levels of blood pressure, less risk of type 2 diabetes and obesity, lower rates of preterm-birth, reduced all-cause and cardiovascular mortality, with some preliminary evidence in cancer [1-7]. In addition to contributing to reduce the risk for many chronic diseases that account for a high percentage of years of life lost due to premature mortality and years lived with disability [8], increased contact with nature provides other societal benefits. More community cohesion, social engagement, lower crime, and higher workplace productivity have been documented when more time is spent in local nature [9-10]. Moreover, exposure to natural environments have been suggested as promoter of pro-environmental behaviours [11-12]. However, more than half of the global population now lives in urban environments, a percentage that is expected to increase in the next decades [13]. Urban environments are characterized by a high population density and an increased density of human structures, with decreased space for nature. In this context, more focus must be placed on how to promote people's exposure to urban nature. Although no consensus definition exists, green spaces are urban natural areas dominated by grasslands, trees, or other vegetation, whereas blue spaces are those made up of waterbodies and watercourses (rivers, canals, lakes, and sea), both types often coexisting [14].

### *2. Nature-based interventions to increase nature exposure in urban environments*

To guarantee that urban natural areas are used and provide the described benefits, they must first appeal users and be accessible. A variety of epidemiological data have linked some specific characteristics of these natural spaces to increased use, and therefore, to their associated health benefits. Most of the evidence highlights the importance of a higher density and less distance from home to these natural spaces. However, proximity or availability does not



necessarily mean actual exposure, so other relevant features have emerged as key factors [15-16]. Nature-based interventions (NBI) are all types of strategies, programs or activities that engage people in nature with the goal of improving health and well-being [17]. In this regard, providing easy access, including pedestrianizing adjacent street segments, offering sufficient amenities, promoting safer spaces with clear signs and adequate lighting to reduce antisocial behaviour, are important strategies. These go along with prioritizing better aesthetics, greater amount of greenery, and adequate maintenance. In addition, community involvement in designing these areas can engage users and create a sense of neighborhood pride. Still, more evidence is needed, as the majority of these interventions have been analyzed for green areas and in relationship to only few health outcomes, mostly obesity, levels of physical activity, and mental health [18-30]. One specific intervention is well-designed activities in direct contact with nature. Nature-based activities (NBA) cover a variety of experiences that range from supervised to unsupervised programs, mostly by increasing levels of physical activity or promoting interactions with others. However, still the evidence on NBA and health benefits is low quality [31-36] and they seem to be insufficient to increase overall use of natural parks in low-income neighborhoods [37]. For the case of blue spaces, active interventions in waterbodies have shown benefits for health, especially mental health and well-being, with the majority of studies conducted in subgroups with existing psychological disorders and in populations living near the coast, with less data for inland waters [38-39]. Coventry et al (2021) summarized and highlighted the overall beneficial effect of nature-based outdoor activities in health and well-being [40]. Three recent systematic reviews reported the added benefits of nature-based programs, compared to only standard clinical interventions, for people suffering from long-term health conditions and/or stress-related illness on mental and physical health outcomes. They highlight, however, the lack of understanding of the underlying mechanisms [41-43].



### *3. Beyond nature exposure: nature connectedness as a mechanism for health*

Health benefits provided by increased exposure to green and blue spaces in urban environments are due to various mechanisms including among others, stress relief, exposure to sunlight, higher levels of physical activity and social interactions [44-48]. Only recently, nature connectedness has been suggested as a potential mediator of nature exposure health benefits. Previous literature has found that people who report more connection to nature have increased life satisfaction, positive emotions, and well-being [49-52], and engagement with nature seems to be more relevant than time spent in nature to predict mental health [53-55]. More recently, greater levels of nature connectedness have been associated to a better dietary intake with increased consumption of fruits and vegetables [56]. Nature connectedness has also been identified as the key factor that moderates more sustainable behaviours in people who engage more frequently in nature experiences [57].

In this regard, one overlooked aspect in the literature is the fact that time spent in nature is not the same as actively engaging with nature (connection to nature), and there is a lack of understanding of how to increase not only exposure but also connection to nature in urban natural spaces. Zylstra et al (2014) defined nature connectedness as "a state of consciousness that reflect a sustained awareness of the interrelatedness between one's self and the rest of nature" [58]. Giusti et al (2018) presented a framework to facilitate assessment on how urban nature can be designed to promote human-nature-connectedness [59]. A recent review by Lengieza and Swim (2021) delineates the process by which nature connectedness is developed, highlighting the fact that not all activities in contact with nature increase connectedness, placing the focus in psychological states and individual differences [60]. Still, it remains unclear what type of nature-based activities can promote effective nature connectedness and lead to greater health benefits.





#### 4. *The present literature review:*

The purpose of this literature review is to summarize the existing evidence on nature-based activities (NBA) that have examined their effect on promoting nature connectedness as a health mediator. For this purpose, different types of NBA are first categorized. Then, the general state of the literature studying the relationship of NBA with nature connectedness and health outcomes is summarized. Lastly, some implications of the reviewed findings are discussed, with a specific focus on urban environments, characteristics of NBA, and subgroups of the population that could benefit the most from these interventions.

This review is not meant to be exhaustive since nature connectedness is a relatively new concept in human health research. Instead, it can help identify literature gaps and may provide the key elements that could serve to guide future research. Therefore, this information might ultimately contribute to advise urban planners and local decision makers in what characteristics of urban nature-based interventions and activities should be considered to maximize cost-effectiveness for achieving nature connectedness and provide a stronger justification for better public health policy making.

## **METHODS**

- Classification of nature-based activities (NBA):

NBA were first classified in 10 categories based on the author's knowledge and on a preliminary study of available literature.

- Search strategy:

The literature search was conducted using PubMed, Embase and Epistemonikos as electronic databases through to 12 December 2022. The search was using a combination of the index term "Nature" AND the terms from the columns presented in table 1.



Table 1: Search terms used in the literature search. Column A covers nature connectedness, column B covers interventions, and column C covers specific types of nature-based activities (NBA). All columns were combined with the Boolean operator AND. All terms from each column were combined with the Boolean operator OR.

A. Nature connectedness	B. Interventions	C. Type of NBA
'connectedness' 'relatedness' 'connection' 'connect' 'connectivity' 'engagement'	'intervention' 'experience' 'activity' 'activities' 'program' 'programme'	'blue' 'blue care' 'green' 'green exercise' 'exercise' 'physical activity' 'meditation' 'mindfulness' 'forest based' 'social prescribing' 'art' 'ecotherapy' 'garden' 'care farm' 'horticulture' 'community' 'school' 'work' 'animal'

o Elegibility criteria:

All publications in English that appeared from 2015 onwards were considered and assessed for eligibility. Articles were pragmatically analyzed by the author based upon the title and abstract. Inclusion criteria were original scientific studies (both observational and interventional) and systematic reviews of interventions written in English, studying any type of nature-based activities in relationship to any health outcome. Studies that did not report nature connectedness at any stage were excluded. Studies that did not measure any health outcome were also excluded.



## RESULTS

Studies covered in this review researched a variety of nature-based activities (NBAs) in natural spaces, which are categorized and outlined in table 2. The body of this review is organized based on these categories.

**Table 2:** *Types of nature-based activities in natural spaces: definitions and some examples.*

Type	Definition and/or examples
Physical activity programs	<ul style="list-style-type: none"> <li>- Green exercise: active work in an outdoor green environment, including walking or green gyms.</li> <li>- Blue exercise: Water- or shoreline-based activities like swimming or surfing.</li> </ul>
Ecotherapy and nature-assisted therapy	Psychotherapeutic techniques based on environmental interventions, such as forest bathing, nature meditation, birdwatching, noticing nature activities, and horticulture or care farming (smelling flowers and urban gardening).
Blue care	Therapeutic nature-based interventions within blue spaces.
School/ work interventions	<ul style="list-style-type: none"> <li>- Outdoor classrooms: teaching lessons in an urban garden, park or other natural space.</li> <li>- Nature-based interventions at the work environment.</li> </ul>
Cultural-based interventions	Photography, painting, nature arts, crafts, or writing in urban natural spaces.
Animal-assisted interventions	Activities in urban natural spaces with domesticated animals (walking pets, riding horses, etc).
Environmental conservation activities	Engaging in environmental conservation work in urban natural spaces, like recycling or cleaning litter.
Community-engagement activities	Activities in urban nature that intentionally bring together the local community to know one another.



Engagement with nature-based programs	Nature-based activities specifically designed to promote active engagement and connection with nature.
Social prescribing	Nature-based non-medical interventions with a preventive or therapeutic purpose at the level of the primary health care sector.

The total number of articles included and assessed in this review was 26 (25 primary articles and 1 systematic review), with sample sizes ranging from 6 to 5460 participants. Duration and intensity of the interventions included were diverse, ranging from only one session to daily sessions for a week, once a week for 4 months, up to a one-year follow-up. Both studies on children and adults were found, with six studies researching university students. Only three studies researching "vulnerable" subgroups were found (foster care children, pregnant or parenting teenagers, and adults with clinical depression). All studies measured mental health outcomes or markers of well-being. No interventions measuring nature connectedness directly as a mediator for physical health outcomes were found, although two studies reported results on lifestyle habits (dietary habits and levels of physical activity), and two studies reported measurements on physiological markers of health (heart rate variability and fecal markers). Studies included in this review with their descriptions are summarized in table 3.

1. *Physical activity:*

Increased participation in nature activities during childhood, including green exercise (physical activity within a natural environment), has been associated with increased contact with nature, higher participation in green exercise, and greater levels of nature connectedness during adulthood. Remarkably, those with higher levels of nature connectedness had significantly lower levels of perceived stress and higher heart rate variability (a marker of better health) [61]. A small pilot intervention study also correlated levels of nature connectedness with future exercise intention, and participants exercising in



nature, compared to indoors, had greater affective responses (perceiving exercise as more enjoyable) and increased future exercise intention [62]. More recently, a regular practice of physical activity in nature, compared to exercising in an urban context, was associated with a more positive appreciation and acceptance of own body, and the authors suggest this was at least partially mediated by increased connectedness with nature [63].

## *2. Ecotherapy and nature-assisted therapies:*

An observational study based on a survey showed that people who regularly engage in bird feeding activities have increased feelings of being relaxed and connected to nature [64]. A different study on people entering a community gardening experience, compared with individuals with no experience in gardening, showed no difference on physical activity parameters, social/health, environmental and economic lifestyles components, nor on nature connectedness, after a year of follow-up [65]. As for interventional studies, an urban forest-based 8-week health program in socioeconomically vulnerable children promoted positive changes in emotional and social health, but with no statistically significant changes in nature connectedness [66]. A different study in children measured the effect of a 30-minute walk in a natural park compared to an urban environment, showing positive results in endogenous attention (ability to direct voluntary attention) but not on exogenous attention (passive or automatic). However, this study did not measure nature connectedness post-intervention and only measured trait levels of nature connectedness, for which both groups were comparable at baseline [67]. Outdoor experiences in undergraduates, including one in a desertic outdoor environment, have resulted in improvements to wellbeing and connectedness to nature [68-69].

A lot of recent attention has been put into studying meditation techniques for therapeutic reasons in a variety of settings. Nisbet et al. (2019) compared the effect of a 20-minute walk indoors, outdoors (guided), and outdoors with a mindfulness intervention. Both outdoors groups reported greater levels of nature connectedness and better mood, with the mindfulness group showing a stronger



connectedness with nature and less negative affect [70]. Two randomized controlled trials have added extra evidence. A 5-day mindfulness program, either indoor or outdoor, was compared to a control group for outcomes on mental health. The nature connectedness levels were higher in the outdoor group, but no difference was seen in the primary outcomes between the two intervention groups [71]. A different trial compared outdoor mindful walking in nature (public park) versus an urban environment (city streets), showing improvement in mood and sleep quality, but with no significant mental health benefits when this activity was performed in nature, and with no differences in nature relatedness after the intervention [72].

A particular type of nature-based well-being intervention is "noticing nature", which covers activities focused on paying attention to nature in everyday surroundings. Three noticing nature interventions meeting the inclusion criteria were found. Participants assigned to an intervention where they had to pay attention to how nature or human-built objects made them feel showed significantly better markers of well-being, prosocial orientation, and a higher general sense of connectedness when assigned to the nature group, despite the fact of not spending more time in nature [73]. This same intervention was repeated during winter months showing consistent results [74]. Similar results were seen in a different study with a smartphone app-noticing nature intervention, where the improvement in well-being was partially explained by increases in nature connectedness in participants noticing urban nature versus built spaces (control group) [75].

### 3. *Blue care:*

The only studies investigating nature connectedness and blue care that met the inclusion criteria of this literature review were observational and based on data collected from interviews. Their preliminary data suggest a correlation between the regular practice of both sea and freshwater wild swimming and a greater sense of nature connectedness and increased well-being [76-77].



**Table 3:** Summary of studies included in the current literature review.

Study (Citation/year/ country)	Study design	Type of nature-based activity	Intervention / data collection	Participants	Nature connectedness measurement*	Primary health outcomes
Wood & Smyth (2020) UK	Quantitative Pilot study	Physical activity	Questionnaire and heart rate variability monitor for 24 hours.	45 healthy adults	Quantitative (CNS)	Lower levels of perceived stress and increased mental well-being Higher heart rate variability
Calogiuri et al. (2015) Sweden	Mixed-method Pilot assessment and interventional study	Physical activity	Two weekly exercise sessions (indoors or natural space)	19 adults (n = 14 for the interventional study)	Quantitative (CNS) / Baseline	Positive effects in restoration and affective responses Increased future exercise intention
Sundgot-Borgen et al. (2022) Norway	Quantitative Cross-sectional	Physical activity	Online questionnaire	360 adults	Quantitative (CNS)	More positive body appreciation Self-compassion
Cox & Gaston (2016) UK	Quantitative Cross-sectional	Bird feeding	Survey	331 questionnaires from urban household	Quantitative (self-developed five-point Likert Scale)	Increased psychological well-being
Tharrey et al. (2020) France	Mixed method Quasi-experimental	Urban gardening	Data collection and questionnaire at baseline and 12 months later	155 adults	Quantitative (NRS) / Before-after measure	No differences in well-being, social health, lifestyle parameters, and economic variables
Song et al. (2020) Republic of Korea	Mixed method Pilot interventional study	Forest activities	Forest activities once a week per 8 weeks	8 children living in foster care group homes	Qualitative and quantitative (CNS) / Before-after measure	Improvement in perceived health status, self-esteem, depression, perceived stress, behavior problems and restoration



Table 3 (Continued)

Study (Citation/year/ country)	Study design	Type of nature-based activity	Intervention / data collection	Participants	Nature connectedness measurement*	Primary health outcomes
Johnson et al. (2019) Canada	Quantitative Quasi-experimental	Walk in nature	30-minute walk in natural versus urban environment	71 children	Quantitative (CNS) / Baseline	Increased endogenous attention, no difference in exogenous attention.
Down et al. (2022) Australia	Quantitative Pilot interventional study	Outdoor expedition	3-day/2-night immersion expedition	54 undergraduate students	Quantitative (CNS) / Before-after measure	Increased well-being
Garza-Teran et al. (2022) Mexico	Quantitative Quasi-experimental	Outdoor expedition	2-mile walk along a desertic island, compared to a contrast group	61 undergraduate students	Quantitative (LCN, NRS & INS) / Before-after measure	Increased well-being (measurements of positive and negative affect)
Nisbet et al. (2019) Canada	Quantitative Quasi-experimental	Mindfulness-guided walk	20-minute guided walk	100 university students	Quantitative (NRS) / Before-after measure	Better mood, less negative affect
Djernis et al. (2021) Denmark	Quantitative Pilot randomised controlled trial	Mindfulness retreat	5-day mindfulness program.	60 university students	Quantitative (CNS) / Before-after measure	Non-significant changes in self-compassion and perceived stress levels
Ma et al. (2022) UK	Mixed method Randomised controlled trial	Mindfulness-guided walk	Daily 35-minute walk for 7 days	104 university students	Quantitative (NRS) / Before-after measure	Improvement in sleep quality and mood. No difference with urban environment.
Passmore & Holder (2016) Canada	Mixed method Randomised controlled trial	Noticing nature intervention	Assignments to notice nature and be mindful in daily life for 2 weeks	364 undergraduate students	Quantitative (self-reported connectedness scale) / Before-after measure	Better markers of well-being (positive and negative affect, satisfaction in life, meaning in life). Increased general sense of connectedness





Table 3 (Continued)

Study (Citation/year/ country)	Study design	Type of nature-based activity	Intervention / data collection	Participants	Nature connectedness measurement*	Primary health outcomes
Passmore et al. (2022) Canada	Mixed method Randomised controlled trial	Noticing nature intervention	Assignments to notice nature and be mindful in daily life for 2 weeks	65 adults	Quantitative (CNS & INS) / Before-after measure	Better markers of well-being (positive and negative affect, satisfaction in life, meaning in life). Increased general sense of connectedness
McEwan et al. (2022) UK	Quantitative Randomised controlled trial	Noticing nature intervention	Smartphone app to notice good things about urban nature, once a day for 7 days	582 adults	Quantitative (NRS) / Before-after measure	Improvement in self-reported well-being
Denton & Aranda (2020) UK	Qualitative Semi-structured interviews	Blue care	Swim-along and follow up land-based interviews	6 sea swimmers	Qualitative	Improvement in subjective well-being
McDougall et al. (2022) UK	Qualitative Cross-sectional	Blue care	Semi-structured interviews	12 freshwater swimmers	Qualitative	Improvement in self-perceived physical and mental health
Pirchio et al. (2021) Italy	Quantitative Quasi-experimental (two studies)	Outdoor education	Four visits to natural protected areas	338 primary and secondary school students	Quantitative (adapted from CNS) / Before-after measure	Improvement in psychological well-being, empathy, life satisfaction, pro-social behaviour, and pro-environmental attitudes.
Moula et al. (2022) UK, US, Ireland, Australia and Hong Kong	Mixed method Systematic review	Arts	-	11 studies (602 participants in total)	Qualitative and quantitative (CNS, NRS & IAT Nature)	Increased sense of well-being
Schwarz Müller-Erber et al (2020) Austria	Quantitative Cross-sectional	Horseback riding	Questionnaire	184 participants aged 45 years or older	Quantitative (NRS)	Increased well-being and better mood No difference in levels of physical activity



Table 3 (Continued)

Study (Citation/year/country)	Study design	Type of nature-based activity	Intervention / data collection	Participants	Nature connectedness measurement*	Primary health outcomes
Ward Thompson et al. (2018)	Mixed method Quasi-experimental	Community engagement	A variety of social interventions over a 9-month period	5460 individuals aged ≥ 16 years	Quantitative (INS)	Increased levels of perceived stress level More social cohesion No changes in quality of life
Sobko et al (2017) Hong Kong	Quantitative Pilot interventional study	Engagement with nature	One workshop a week for 4 months	38 preschool children	Quantitative (self-developed nature relatedness scale)	Improvement in dietary and physical activity habits of caregivers
Sobko et al (2020) Hong Kong	Quantitative Randomised controlled trial	Engagement with nature	10-week structured program	54 preschool children	Quantitative (self-developed nature relatedness scale)	Reduced psychological stress Stable levels of fecal serotonin Changes in gut microbiome profile
Sachs et al. (2022) US	Mixed method Pilot intervention study	Engagement with nature	8-week program (online and in-person group meetings)	17 pregnant and parenting teenagers (aged 14-19)	Qualitative	Increased social connectedness, self-value and sense of belonging
Salonen et al. (2022) Finland	Qualitative Semi-structured interviews	Engagement with nature	12 meetings of one-and-a-half hours	82 adults with clinical depression	Qualitative	Positive changes in well-being, restoration and social support
Richardson & McEwan (2018) UK	Mixed method Semi-structured interviews	Engagement with nature	Daily for 30 days	308 adults (aged 18-85)	Quantitative (INS) / Before-after measure	Improved self-perception of health and well-being

\*Quantitative measurements of nature connectedness used a variety of scales: CNS = Connectedness to nature scale (Mayer&Frantz 2004), NRS = Nature relatedness scale (Nisbet et al. 2007), LCN = Love and Care for Nature Scale (Perkins 2010), INS = Inclusion of Nature in Self (Schultz et al 2001), GSC = Self-reported General Sense of Connectedness scale, combining connectedness to other people, to nature, and to life as a whole (Zelenski & Nisbet, 2014), IAT = Implicit Association Test (Schultz et al. 2004).



*4. School/work interventions:*

A different set of interventions are the ones performed at the school or work environment. No nature-based interventions in the work environment specifically measuring nature connectedness were found. Remarkably, the combined results of two outdoor education interventions in school students (visiting natural protected areas), improved psychological well-being, pro-social behaviour, and measures of nature connectedness [78].

*5. Cultural-based activities:*

A recent systematic review by Moula et al. (2022) summarized the literature on arts-based interventions in nature for children and young people. This review suggests how this type of activities can increase nature connectedness and the sense of well-being; however quantitative evidence was scarce [79].

*6. Animal-based activities:*

Horseback riders have shown significantly higher levels of nature connectedness and subjective well-being, similar to dog owners, when compared to people without pets [80], with no difference in weekly levels of physical activity. No studies on animal-assisted interventions measuring their impact on nature connectedness as a mediator for human health outcomes were identified.

*7. Environmental conservation activities:*

No studies on environmental conservation activities measuring nature connectedness and their effect on health outcomes were found.

*8. Community-engagement activities:*

An intervention in socially deprived urban communities using the "Woods In and Around Towns (WIAT) programme" [81] was tested. It involved both physical changes to the woods and community engagement activities in nearby nature, including photography and art workshops, guided walks, activities for school children, and family events. This intervention was implemented over a period of several months, and it was associated to increased levels of perceived



stress and no changes in quality of life. There were, however, some positive results, with increased levels of physical activity, nature connectedness and social cohesion [82].

9. *"Engagement with nature" programs or experiences:*

Although all NBA are meant to engage people in nature to promote health and well-being, some interventions can be specifically designed to promote increased nature connectedness. A few studies on interventions that met this criterion were found. In Hong Kong, the "Play&Grow" program has been designed to promote increased connection to nature and healthier lifestyle habits through "connectedness to nature" experiences for families and young children. The program includes workshops and nature-related outdoor activities, such as nature games, noticing nature practices, group activities, environmental care training and nature homework [83]. Until now, this intervention has proven to be effective in reducing perceived stress levels in preschool children, along with increased nature connectedness and changes in the gut microbiota profiles [84]. An ongoing randomized-controlled trial is aiming to investigate its effect in physical activity (active playtime) and healthy eating routines [85]. A different social program in the United States, designed to promote nature connection to reduce social isolation in pregnant or parenting teenager students is the "Meeting in Nature Together program". This 8-week program is based on group meetings with park excursions, journaling, creative activities, and nature photography, among others. A pilot study aimed to prove its feasibility showed some encouraging results. Almost all participants mentioned an increased and deeper sense of nature connection, along with reduced social isolation, based on a qualitative methodology [86]. A preliminary analysis of a larger randomized-controlled trial using an integrative rehabilitation program in people with clinical depression ("Flow With Nature" treatment) measured its impact based on a qualitative analysis. Participants underwent a variety of interventions, including exercise, mindfulness, and other group experiences in nature, which was divided in 12 meetings in nearby parks, forests, or by water. Compared to a control



group, they reported positive effects in restoration, social support, and connection to nature [87]. Finally, a large-scale intervention in the UK was designed to increase public connection with nature (Wildlife Trust's 30 Days Wild campaign). By encouraging people to interact with nature every day for one month, participants showed significant increases in their levels of nature connection, conservation behaviours, and engagement with natural beauty, along with better perception of own levels of health and well-being [88].

#### *10. Social prescribing:*

No studies investigating the relationship between NBA and nature connectedness in the context of a nature-based social prescription were identified.

## **DISCUSSION**

Although there is already a certain agreement in the importance of nature connectedness in promoting health and well-being, this knowledge is of limited use if we do not understand how to foster it in an increasingly urbanized society. Previous literature on nature connectedness has shown several omissions. Most of the research has been conducted in rural nature, and the majority of the studies have investigated interventions that link nature connectedness with pro-environmental behaviours. However, to the author's knowledge, this is the first review that summarizes the results of NBA in nature connectedness as a mediating factor of human health outcomes and well-being.

The main purpose of this literature review was to provide an overview of the available literature to help understand if NBA in urban spaces could be effectively linked to increased nature connectedness as a pathway to health. The main finding is that, with some exceptions, most of the studies show positive effects, demonstrating that a variety of activities organized in urban green and blue spaces may lead to better health and well-being, at least partially mediated by increased levels of nature connectedness. However, despite the importance of nature connectedness, this topic has been insufficiently examined and this



review mostly serves the purpose of creating awareness. Many studies on NBA were found, however, most of them examine their relationship to health outcomes or to increased nature connectedness, but not both; therefore, were not included in this review. Available studies on well-designed NBA which directly measure nature connectedness in relation to health outcomes are scarce, and mostly focused on mental health and well-being.

A strength of the approach taken in this review is the categorization of nature-based activities, which helps to identify literature gaps and could serve as a guide for future research. Based on this literature review, "noticing-nature" activities seem to have received some attention and could be among the most cost-effective interventions, as they can be self-guided, individualized, and applied to different settings. As for meditation or mindful interventions, previous literature has demonstrated their positive effect in nature connectedness when delivered online or in an urban setting [89-90], however, with available studies summarized in this review, there is still no clear answer to whether mindfulness interventions performed in nature have a greater effect in promoting nature connectedness and health benefits compared to mindfulness programs in non-natural settings. Although no studies of NBA in a work environment met the inclusion criteria for this review, some recent studies suggest that nature-based programs implemented in a work environment could lead to reduced levels of stress, improved cognitive performance, and increased work engagement [91-92], making it interesting to explore in the future if nature connectedness acts a mediator for these effects. Similarly, many studies on environmental education programs in nature have been researched in school and higher education students, with a general tendency to show positive effects in promoting nature connectedness [93-98]. However, they all correlate this increased connectedness to nature with ecological behaviours, and there are still no studies analyzing if these positive results also apply to health outcomes. Although nature-based social prescriptions have received certain attention, especially for people carrying chronic health conditions, they still face many challenges before they are more routinely integrated into the health practice [99-100]. Based on



initial findings from this review, it would be interesting to further explore if a variety of NBA could be tested in the context of social prescribing, with a focus on nature connectedness as a mediator for health outcomes.

Regarding the setting, as it is the case for general literature in urban natural areas, few studies researching nature connectedness in the context of blue spaces have been found. Some interesting interventions, either as a variety of activities in coastal areas (such as walking, rock pooling, or beach cleaning), or a surf therapy program, have proven benefits for mental health, social connectedness, and/or pro-environmental behaviours. However, these studies do not place attention to the underlying mechanisms and do not report measurements on nature connectedness [101-102]. Nevertheless, blue spaces might have qualities related to sensory stimulus (wave sounds, visual openness, fluidity of the water and light reflections) that could be linked to increased nature connectedness in a very unique way. Therefore, more research on activities in urban blue spaces should be encouraged.

The secondary purpose of this literature review was to find some trends on what specific subgroups of the population could benefit the most from these interventions, to increase their nature connectedness and gain greater health benefits. Available evidence is no conclusive, and more research in vulnerable groups should be encouraged, with a focus on those who generally have less access to urban nature and could gain more benefit, for example ethnic minorities or low-mobility populations. Nevertheless, although no strong recommendation can yet be given, an interesting preliminary finding is the association of both trait and post-intervention levels of nature connectedness with health benefits. Some previous literature has suggested trait nature connectedness as the mediating effect of nature exposure on health benefits [103]. In this regard, although observational data have a greater risk of bias and no causal relationship can be determined, since people frequently engaging in NBA could do so because they already have greater trait levels of nature connectedness, evidence from the cross-sectional studies presented in this literature review introduce some findings that should be taken into



consideration. An alternative hypothesis could be that benefits obtained from nature exposure can be greater for those who already have a strong sense of nature connectedness and greater intrinsic motivation to spend time in nature. Therefore, along with considering psychological differences, these interventions might be more beneficial the earlier they are applied, for an earlier acquisition of nature connectedness. Thus, the focus for future research should be placed on different key stages of life, specifically childhood. One study presented in this review supports this hypothesis (Wood & Smith 2020) [61], as well as two other studies not included in this literature review for not meeting the inclusion criteria [104-105]. Overall, they all correlate increased participation in nature activities during childhood (both in green and blue spaces) to increased contact with nature during adulthood, and possibly, with health benefits mediated by increased nature connectedness.

### **Limitations**

This review has many limitations. The lack of consensus on nature connectedness terminology made it difficult to find all studies assessing the original research question. The search depended on a non-predefined protocol and inclusion criteria of studies relied on researcher's experience. Therefore, this review was susceptible to selection bias. Moreover, the classification of NBA is arbitrary and some interventions may belong to more than one category. Although initially the idea was to include only studies that conducted NBA in urban environments, a few studies combine interventions with wild outdoor environments. They were still included since they were considered relevant to answer the question of how NBA can increase nature connectedness and linked to health outcomes. Studies covered in this review use various methodologies for assessing nature connectedness, including qualitative methods, as there is still no agreed standardize measure for nature contact in research, nor instruments sufficiently validated to quantitatively measure human-nature connection at different life stages [106-107]. Up to date, different scales for measuring nature connectedness or nature relatedness have been reported in





the literature. The most widely used in the studies included in this literature review are the "connectedness to nature scale" by Mayer and Frantz (2004) and the "nature-relatedness questionnaire" by Nisbet et al. (2007) [108-109]. Overall, evidence is low quality. Most of the quantitative studies were quasi-experimental, with their derived limitations, such, as lack of randomization or blinding. Many studies did not show statistically significant effects, possibly due a low number of participants. Some articles presented results on small pilot studies designed to test feasibility of interventions, therefore, bigger randomised controlled trials are required to see if they can be translated into more significant results. Some other studies mentioned as a limitation the short duration of their interventions, and they suggest a longer follow-up to test if their beneficial effects were sustained.

### **Future directions**

This review can help to create awareness and include nature connectedness into the research framework of NBA in urban natural spaces. There are, however, some identified gaps in the literature and some clear directions for future research:

- Analyse the effect of NBA in nature connectedness as a driver for physical health outcomes.
- Conduct research to clarify which characteristics of NBA lead to increased nature connectedness, including:
  - o Duration, frequency, intensity.
  - o Setting: develop more studies in urban blue spaces.
  - o Compare the differentiated effect of:
    - non-demanding activities versus physically active or mentally challenged.
    - Passive interactions versus activities that involve taking care of nature.
    - Solitary activities versus those focused on interacting with other people.



- Measure the impact of individual or subgroup differences in the effect of NBA, considering:
  - a. Psychological factors.
  - b. Life-stage.
  - c. Socio-cultural status and gender-based differences.
  - d. Presence of chronic diseases. Research NBA as part of nature-based social prescribing programs.
- Identify how NBA in urban natural spaces compares to virtual exposure to nature (watching videos or viewing pictures of nature).

## **CONCLUSIONS**

Findings from this review add to previous literature and highlights the fact that nature connectedness has become relevant not only to promote pro-environmental behaviours, but also as a mechanism for human health. Although the available evidence does not allow to give conclusions on the optimal characteristics of NBA, activities conducted in direct contact with urban nature could be the key element uncovering the potential of green and blue spaces to promote nature connectedness, becoming an effective way of increasing well-being as part of a healthy urban living. It is necessary to develop conceptual frameworks, find agreement on terminology, and prioritize measuring nature connectedness as a mediator of health outcomes in research conducted in urban nature. This evidence might help clarify what characteristics of nature-based activities can be more beneficial and amplify the understanding for a broader variety of health outcomes. Further research is needed to better understand the possibilities and results of different NBA to incorporate them as community-based interventions and how to successfully engage people with urban nature using cost-effective individualized interventions. Understanding the drivers for nature connectedness at different key life stages might contribute to future policy making and increased societal benefits.



## REFERENCES

1. Jimenez, M. P., DeVille, N. V., Elliott, E. G., Schiff, J. E., Wilt, G. E., Hart, J. E., & James, P. (2021). Associations between Nature Exposure and Health: A Review of the Evidence. *International journal of environmental research and public health*, *18*(9), 4790. <https://doi.org/10.3390/ijerph18094790>.
2. Nieuwenhuijsen, M. J., Khreis, H., Triguero-Mas, M., Gascon, M., & Davvand, P. (2017). Fifty Shades of Green: Pathway to Healthy Urban Living. *Epidemiology (Cambridge, Mass.)*, *28*(1), 63–71. <https://doi.org/10.1097/EDE.0000000000000549>
3. Gascon, M., Zijlema, W., Vert, C., White, M.P., Nieuwenhuijsen, M.J. (2017). Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *Int J Hyg Envir Heal* 4. doi:10.1016/j.ijheh.2017.08.004
4. Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental research*, *166*, 628–637. <https://doi.org/10.1016/j.envres.2018.06.030>
5. Rojas-Rueda, D., Nieuwenhuijsen, M. J., Gascon, M., Perez-Leon, D., & Mudu, P. (2019). Green spaces and mortality: a systematic review and meta-analysis of cohort studies. *The Lancet. Planetary health*, *3*(11), e469–e477. [https://doi.org/10.1016/S2542-5196\(19\)30215-3](https://doi.org/10.1016/S2542-5196(19)30215-3)
6. Porcherie, M., Linn, N., Le Gall, A. R., Thomas, M. F., Faure, E., Rican, S., Simos, J., Cantoreggi, N., Vaillant, Z., Cambon, L., & Regnaud, J. P. (2021). Relationship between Urban Green Spaces and Cancer: A Scoping Review. *International journal of environmental research and public health*, *18*(4), 1751. <https://doi.org/10.3390/ijerph18041751>
7. Ewa Jarosz (2022) Direct Exposure to Green and Blue Spaces is Associated with Greater Mental Wellbeing in Older Adults, *Journal of Aging and Environment*, DOI: [10.1080/26892618.2022.2109792](https://doi.org/10.1080/26892618.2022.2109792)
8. GBD 2019 Diseases and Injuries Collaborators (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet (London, England)*, *396*(10258), 1204–1222. [https://doi.org/10.1016/S0140-6736\(20\)30925-9](https://doi.org/10.1016/S0140-6736(20)30925-9)
9. Weinstein N., Balmford A., DeHaan C., Gladwell V., Bradbury R., Amano T. (2015). Seeing Community for the Trees: The Links among Contact with Natural Environments, Community Cohesion, and Crime, *BioScience*, *65*(12), 1141–1153. <https://doi.org/10.1093/biosci/biv151>
10. Brown S. Environment Agency (2020). The social benefits of Blue Space: a systematic review. Available online: <https://www.gov.uk/government/publications/the-social-benefits-of-blue-space-a-systematic-review> [Accessed on 10 December 2022]
11. Rosa, C. D., Collado, S. (2019). Experiences in Nature and Environmental Attitudes and Behaviors: Setting the Ground for Future Research. *Frontiers in psychology*, *10*, 763. <https://doi.org/10.3389/fpsyg.2019.00763>



12. Martin, L., White, M., Hunt, A., Richardson, M., Pahl, S., Burt, J. (2020). Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours. *Journal of Environmental Psychology*. 68. 101389. [10.1016/j.jenvp.2020.101389](https://doi.org/10.1016/j.jenvp.2020.101389).
13. World Bank based on World Population Prospects - Department of Economic and Social Affairs, UN Population Division (2018). The World's Cities in 2018—Data Booklet (ST/ESA/SER.A/417) Available online: <http://data.worldbank.org/data-catalog/world-development-indicators> [Accessed on 10 December 2022]
14. Song, S., Wang, S., Shi, M., Hu, S., & Xu, D. (2022). Urban blue-green space landscape ecological health assessment based on the integration of pattern, process, function and sustainability. *Scientific reports*, 12(1), 7707. <https://doi.org/10.1038/s41598-022-11960-9>
15. Kessel, A., Green, J., Pinder, R., Wilkinson, P., Grundy, C., & Lachowycz, K. (2009). Multidisciplinary research in public health: a case study of research on access to green space. *Public health*, 123(1), 32–38. <https://doi.org/10.1016/j.puhe.2008.08.005>
16. Carter, M., Horwitz, P. (2014). Beyond Proximity: The Importance of Green Space Useability to Self-Reported Health. *EcoHealth*. 11. [10.1007/s10393-014-0952-9](https://doi.org/10.1007/s10393-014-0952-9).
17. Shanahan, D. F., Astell-Burt, T., Barber, E. A., Brymer, E., Cox, D. T. C., Dean, J., Depledge, M., Fuller, R. A., Hartig, T., Irvine, K. N., Jones, A., Kikillus, H., Lovell, R., Mitchell, R., Niemelä, J., Nieuwenhuijsen, M., Pretty, J., Townsend, M., van Heezik, Y., Warber, S., ... Gaston, K. J. (2019). Nature-Based Interventions for Improving Health and Wellbeing: The Purpose, the People and the Outcomes. *Sports (Basel, Switzerland)*, 7(6), 141. <https://doi.org/10.3390/sports7060141>
18. Cohen, D. A., Marsh, T., Williamson, S., Derose, K. P., Martinez, H., Setodji, C., & McKenzie, T. L. (2010). Parks and physical activity: why are some parks used more than others?. *Preventive medicine*, 50 Suppl 1(Suppl 1), S9–S12. <https://doi.org/10.1016/j.ypmed.2009.08.020>
19. Roberts, Hannah & McEachan, RRC & Margary, Tamsin & Conner, Mark & Kellar, Ian. (2016). Identifying Effective Behavior Change Techniques in Built Environment Interventions to Increase Use of Green Space: A Systematic Review. *Environment and Behavior*.
20. Zhang, R., Wulff, H., Duan, Y., & Wagner, P. (2019). Associations between the physical environment and park-based physical activity: A systematic review. *Journal of sport and health science*, 8(5), 412–421. <https://doi.org/10.1016/j.jshs.2018.11.002>
21. Ferrari, G., Werneck, A. O., Silva, D. R., Kovalskys, I., Gómez, G., Rigotti, A., Cortés, L. Y., García, M., Liria-Domínguez, M. R., Herrera-Cuenca, M., Pratt, M., Marques, A., Van Dyck, D., Leme, A., & Fisberg, M. (2022). Perceived Urban Environment Attributes and Device-Measured Physical Activity in Latin America: An 8-Nation Study. *American journal of preventive medicine*, 62(4), 635–645. <https://doi.org/10.1016/j.amepre.2021.09.006>



22. White, M. P., Wheeler, B. W., Herbert, S., Alcock, I., & Depledge, M. H. (2014). Coastal proximity and physical activity: Is the coast an under-appreciated public health resource?. *Preventive medicine*, 69, 135–140. <https://doi.org/10.1016/j.ypmed.2014.09.016>
23. Wood, S. L., Demougin, P. R., Higgins, S., Husk, K., Wheeler, B. W., & White, M. (2016). Exploring the relationship between childhood obesity and proximity to the coast: A rural/urban perspective. *Health & place*, 40, 129–136. <https://doi.org/10.1016/j.healthplace.2016.05.010>
24. Houlden, V., Weich, S., Porto de Albuquerque, J., Jarvis, S., & Rees, K. (2018). The relationship between greenspace and the mental wellbeing of adults: A systematic review. *PloS one*, 13(9), e0203000. <https://doi.org/10.1371/journal.pone.0203000>
25. Carthy, P., Lyons, S., & Nolan, A. (2020). Characterising urban green space density and footpath-accessibility in models of BMI. *BMC public health*, 20(1), 760. <https://doi.org/10.1186/s12889-020-08853-9>
26. Alejandre, J. C., & Lynch, M. (2020). "Kids Get in Shape with Nature": A Systematic Review Exploring the Impact of Green Spaces on Childhood Obesity. *Journal of nutritional science and vitaminology*, 66(Supplement), S129–S133. <https://doi.org/10.3177/jnsv.66.S129>
27. Pierpaolo, Mudu & Dorota, Jarosinska & Kendrovski, Vladimir & Braubach, Matthias & de Vries, Sjerp & Lammel, Annamaria & Andreucci, Maria. (2021). Green and Blue Openspaces and Mental Health: New Evidence and Perspectives for Action.
28. Qu, P., Luo, M., Wu, Y., Zhang, F., Vos, H., Gu, X., Mi, Y., Luo, X., & Jia, P. (2021). Association between neighborhood aesthetics and childhood obesity. *Obesity reviews: an official journal of the International Association for the Study of Obesity*, 22 Suppl 1(Suppl 1), e13079. <https://doi.org/10.1111/obr.13079>
29. Teixeira, A., Gabriel, R., Quaresma, L., Alencão, A., Martinho, J., & Moreira, H. (2021). Obesity and Natural Spaces in Adults and Older People: A Systematic Review. *Journal of physical activity & health*, 18(6), 714–727. <https://doi.org/10.1123/jpah.2020-0589>
30. Malacarne, D., Handakas, E., Robinson, O., Pineda, E., Saez, M., Chatzi, L., & Fecht, D. (2022). The built environment as determinant of childhood obesity: A systematic literature review. *Obesity reviews : an official journal of the International Association for the Study of Obesity*, 23 Suppl 1, e13385. <https://doi.org/10.1111/obr.13385>
31. Wray, A., Martin, G., Ostermeier, E., Medeiros, A., Little, M., Reilly, K., & Gilliland, J. (2020). Physical activity and social connectedness interventions in outdoor spaces among children and youth: a rapid review. Interventions pour favoriser l'activité physique et l'appartenance sociale chez les enfants et les jeunes dans des espaces extérieurs : revue rapide de la littérature. *Health promotion and chronic disease prevention in Canada : research, policy and practice*, 40(4), 104–115. <https://doi.org/10.24095/hpcdp.40.4.02>
32. Gladwell, V. F., Brown, D. K., Wood, C., Sandercock, G. R., & Barton, J. L. (2013). The great outdoors: how a green exercise environment can benefit all. *Extreme physiology & medicine*, 2(1), 3. <https://doi.org/10.1186/2046-7648-2-3>



33. Lahart, I., Darcy, P., Gidlow, C., & Calogiuri, G. (2019). The Effects of Green Exercise on Physical and Mental Wellbeing: A Systematic Review. *International journal of environmental research and public health*, 16(8), 1352. <https://doi.org/10.3390/ijerph16081352>
34. Bragg, R. and Atkins, G. (2016) A Review of Nature-Based Interventions for Mental Health Care. Natural England Commissioned Reports, Number 204.
35. Bragg, R. and Leck, C. (2017). Good practice in social prescribing for mental health: The role of nature-based interventions. Natural England Commissioned Reports, Number 228. York.
36. Marini, S., Mauro, M., Grigoletto, A., Toselli, S., & Maietta Latessa, P. (2022). The Effect of Physical Activity Interventions Carried Out in Outdoor Natural Blue and Green Spaces on Health Outcomes: A Systematic Review. *International journal of environmental research and public health*, 19(19), 12482. <https://doi.org/10.3390/ijerph191912482>
37. Cohen, D. A., Han, B., Derosé, K. P., Williamson, S., Marsh, T., Raaen, L., & McKenzie, T. L. (2017). Promoting physical activity in high-poverty neighborhood parks: A cluster randomized controlled trial. *Social science & medicine (1982)*, 186, 130–138. <https://doi.org/10.1016/j.socscimed.2017.06.001>
38. Britton, E., Kindermann, G., Domegan, C., & Carlin, C. (2020). Blue care: a systematic review of blue space interventions for health and wellbeing. *Health promotion international*, 35(1), 50–69. <https://doi.org/10.1093/heapro/day103>
39. Olszewska-Guizzo, Agnieszka & Andreucci, Maria & Beute, Femke & de Vries, Sjerp & Glanville, Julie & Keune, Hans & Lammel, Annamaria & Livoreil, Barbara & Marselle, Melissa & O'Brien, Liz & Russo, Alessio & Remmen, Roy & Davies, Zoe & Tan, Amos. (2019). Types and Components of Urban Blue Spaces that have a Positive Impact on Mental Health and Well-being: a Systematic Review. 10.13140/RG.2.2.31795.25121.
40. Coventry, P. A., Brown, J. E., Pervin, J., Brabyn, S., Pateman, R., Breedvelt, J., Gilbody, S., Stancliffe, R., McEachan, R., & White, P. L. (2021). Nature-based outdoor activities for mental and physical health: Systematic review and meta-analysis. *SSM - population health*, 16, 100934. <https://doi.org/10.1016/j.ssmph.2021.100934>
41. Fairbrass, A. J., Chatterjee, H., Jones, K. E., & Osborn, D. (2022). Human responses to nature- and culture-based non-clinical interventions: a systematised review. *Perspectives in public health*, 142(3), 149–157. <https://doi.org/10.1177/1757913920967036>
42. Taylor, E. M., Robertson, N., Lightfoot, C. J., Smith, A. C., & Jones, C. R. (2022). Nature-Based Interventions for Psychological Wellbeing in Long-Term Conditions: A Systematic Review. *International journal of environmental research and public health*, 19(6), 3214. <https://doi.org/10.3390/ijerph19063214>
43. Johansson, G., Juuso, P., Engström, Å. (2022). Nature-based interventions to promote health for people with stress-related illness: An integrative review. *Scandinavian journal of caring sciences*, 36(4), 910–925. <https://doi.org/10.1111/scs.13089>



44. Park, B. J., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M., & Miyazaki, Y. (2007). Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest)--using salivary cortisol and cerebral activity as indicators. *Journal of physiological anthropology*, 26(2), 123–128. <https://doi.org/10.2114/jpa2.26.123>
45. Plano, S. A., Casiraghi, L. P., García Moro, P., Paladino, N., Golombek, D. A., & Chiesa, J. J. (2017). Circadian and Metabolic Effects of Light: Implications in Weight Homeostasis and Health. *Frontiers in neurology*, 8, 558. <https://doi.org/10.3389/fneur.2017.00558>
46. Kabisch, N., van den Bosch, M., & Laforzezza, R. (2017). The health benefits of nature-based solutions to urbanization challenges for children and the elderly - A systematic review. *Environmental research*, 159, 362–373. <https://doi.org/10.1016/j.envres.2017.08.004>.
47. Sudimac, S., Sale, V. & Kühn, S. How nature nurtures: Amygdala activity decreases as the result of a one-hour walk in nature. *Mol Psychiatry* (2022). <https://doi.org/10.1038/s41380-022-01720-6>
48. Georgiou, M., Morison, G., Smith, N., Tiegies, Z., & Chastin, S. (2021). Mechanisms of Impact of Blue Spaces on Human Health: A Systematic Literature Review and Meta-Analysis. *International journal of environmental research and public health*, 18(5), 2486. <https://doi.org/10.3390/ijerph18052486>
49. Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: a meta-analysis. *Frontiers in psychology*, 5, 976. <https://doi.org/10.3389/fpsyg.2014.00976>
50. Lovell R. (2016). Natural England Access to Evidence Information Note EIN015. Connection to Nature: evidence briefing, European Centre for Environment and Human Health and University of Exeter Medical School. DOI:10.13140/RG.2.2.11320.55045.
51. Pritchard, Alison & Richardson, Miles & Sheffield, David & Mcewan, Kirsten. (2020). The Relationship Between Nature Connectedness and Eudaimonic Well-Being: A Meta-analysis. *Journal of Happiness Studies*. 21. 10.1007/s10902-019-00118-6.
52. White, M.P., Elliott, L.R., Grellier, J. *et al.* (2021). Associations between green/blue spaces and mental health across 18 countries. *Sci Rep* **11**, 8903. <https://doi.org/10.1038/s41598-021-87675-0>
53. White, M. P., Elliott, L. R., Gascon, M., Roberts, B., & Fleming, L. E. (2020). Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental research*, 191, 110169. <https://doi.org/10.1016/j.envres.2020.110169>
54. Richardson, M., Passmore, H., Lumber, R., Thomas, R., Hunt, A. (2021). Moments, not minutes: The nature-wellbeing relationship. *International Journal of Wellbeing*. 11. 8-33. 10.5502/ijw.v11i1.1267.
55. Oh, R., Fielding, K. S., Chang, C. C., Nghiem, L., Tan, C., Quazi, S. A., Shanahan, D. F., Gaston, K. J., Carrasco, R. L., & Fuller, R. A. (2021). Health and Wellbeing Benefits from



- Nature Experiences in Tropical Settings Depend on Strength of Connection to Nature. *International journal of environmental research and public health*, 18(19), 10149. <https://doi.org/10.3390/ijerph181910149>
56. Milliron, B. J., Ward, D., Granche, J., Mensinger, J., Stott, D., Chenault, C., Montalto, F., & Ellis, E. V. (2022). Nature Relatedness Is Positively Associated With Dietary Diversity and Fruit and Vegetable Intake in an Urban Population. *American journal of health promotion: AJHP*, 36(6), 1019–1024. <https://doi.org/10.1177/08901171221086941>
57. Barragan-Jason, G., de Mazancourt, C., Parmesan, C., Singer, M. C., & Loreau, M. (2022). Human-nature connectedness as a pathway to sustainability: A global meta-analysis. *Conservation letters*, 15(1), e12852. <https://doi.org/10.1111/conl.12852>
58. Zylstra, M.J., Knight, A.T., Esler, K.J. et al. (2014). Connectedness as a Core Conservation Concern: An Interdisciplinary Review of Theory and a Call for Practice. *Springer Science Reviews* 2, 119–143. <https://doi.org/10.1007/s40362-014-0021-3>
59. Giusti, M., Svane, U., Raymond, C. M., & Beery, T. H. (2018). A Framework to Assess Where and How Children Connect to Nature. *Frontiers in psychology*, 8, 2283. <https://doi.org/10.3389/fpsyg.2017.02283>
60. Lengieza, M. L., & Swim, J. K. (2021). The Paths to Connectedness: A Review of the Antecedents of Connectedness to Nature. *Frontiers in psychology*, 12, 763231. <https://doi.org/10.3389/fpsyg.2021.763231>
61. Wood, C. J., Smyth, N. (2020). The health impact of nature exposure and green exercise across the life course: a pilot study. *International journal of environmental health research*, 30(2), 226–235. <https://doi.org/10.1080/09603123.2019.1593327>
62. Calogiuri, G., Nordtug, H., & Weydahl, A. (2015). The potential of using exercise in nature as an intervention to enhance exercise behavior: results from a pilot study. *Perceptual and motor skills*, 121(2), 350–370. <https://doi.org/10.2466/06.PMS.121c17x0>
63. Sundgot-Borgen, C., Trangsrud, L. K. J., Otterbring, T., & Bratland-Sanda, S. (2022). Hiking, indoor biking, and body liking: a cross-sectional study examining the link between physical activity arenas and adults' body appreciation. *Journal of eating disorders*, 10(1), 183. <https://doi.org/10.1186/s40337-022-00705-8>
64. Cox, D. T., Gaston, K. J. (2016). Urban Bird Feeding: Connecting People with Nature. *PloS one*, 11(7), e0158717. <https://doi.org/10.1371/journal.pone.0158717>
65. Tharrey, M., Sachs, A., Perignon, M., Simon, C., Mejean, C., Litt, J., & Darmon, N. (2020). Improving lifestyles sustainability through community gardening: results and lessons learnt from the JArDinS quasi-experimental study. *BMC public health*, 20(1), 1798. <https://doi.org/10.1186/s12889-020-09836-6>
66. Song, M. K., Bang, K. S., Kim, S., Lee, G., & Jeong, Y. (2020). Effects of an Urban Forest-Based Health Promotion Program on Children Living in Group Homes. *Journal of psychosocial*





- nursing and mental health services*, 58(6), 18–29. <https://doi.org/10.3928/02793695-20200406-01>
67. Johnson, S. A., Snow, S., Lawrence, M. A., & Rainham, D. G. C. (2019). Quasi-Randomized Trial of Contact With Nature and Effects on Attention in Children. *Frontiers in psychology*, 10, 2652. <https://doi.org/10.3389/fpsyg.2019.02652>
68. Down, M. J. A., Chivers, P., Kirsch, P., & Picknoll, D. (2022). Wellbeing and nature connectedness for emerging adult undergraduates after a short expedition: A small pilot study. *Health promotion journal of Australia : official journal of Australian Association of Health Promotion Professionals*, 33(3), 912–919. <https://doi.org/10.1002/hpja.555>
69. Garza-Terán, G., Tapia-Fonllem, C., Fraijo-Sing, B., Borbón-Mendivil, D., & Poggio, L. (2022). Impact of Contact With Nature on the Wellbeing and Nature Connectedness Indicators After a Desertic Outdoor Experience on Isla Del Tiburon. *Frontiers in psychology*, 13, 864836. <https://doi.org/10.3389/fpsyg.2022.864836>
70. Nisbet, Elizabeth & Zelenski, John & Grandpierre, Zsuzsa. (2019). Mindfulness in Nature Enhances Connectedness and Mood. *Ecopsychology*. 11. 10.1089/eco.2018.0061.
71. Djernis, D., O'Toole, M. S., Fjorback, L. O., Svenningsen, H., Mehlsen, M. Y., Stigsdotter, U. K., & Dahlgaard, J. (2021). A Short Mindfulness Retreat for Students to Reduce Stress and Promote Self-Compassion: Pilot Randomised Controlled Trial Exploring Both an Indoor and a Natural Outdoor Retreat Setting. *Healthcare (Basel, Switzerland)*, 9(7), 910. <https://doi.org/10.3390/healthcare9070910>
72. Ma, J., Williams, J., Morris, P. G., & Chan, P. S. W. Y. (2022). Effectiveness of mindful walking intervention in nature on sleep quality and mood among university student during Covid-19: A randomised control study. *Explore (New York, N.Y.)*, S1550-8307(22)00125-2. Advance online publication. <https://doi.org/10.1016/j.explore.2022.08.004>
73. Passmore, Holli-Anne & Holder, Mark. (2016). Noticing nature: Individual and social benefits of a two-week intervention. *The Journal of Positive Psychology*. 12. 10.1080/17439760.2016.1221126.
74. Passmore, H. A., Yargeau, A., Blench, J. (2022). Wellbeing in Winter: Testing the Noticing Nature Intervention During Winter Months. *Frontiers in psychology*, 13, 840273. <https://doi.org/10.3389/fpsyg.2022.840273>
75. McEwan, K., Richardson, M., Sheffield, D., Ferguson, F. J., & Brindley, P. (2019). A Smartphone App for Improving Mental Health through Connecting with Urban Nature. *International journal of environmental research and public health*, 16(18), 3373. <https://doi.org/10.3390/ijerph16183373>
76. Denton H., Aranda K. (2020) The wellbeing benefits of sea swimming. Is it time to revisit the sea cure?, *Qualitative Research in Sport, Exercise and Health*, 12:5, 647-663, DOI: [10.1080/2159676X.2019.1649714](https://doi.org/10.1080/2159676X.2019.1649714)



77. McDougall, C., Foley, R., Hanley, N., Quilliam, R., Oliver, D. (2022). Freshwater Wild Swimming, Health and Well-Being: Understanding the Importance of Place and Risk. Sustainability. 14. 6364. [10.3390/su14106364](https://doi.org/10.3390/su14106364).
78. Pirchio S, Passiatore Y, Panno A, Cipparone M and Carrus G (2021) The Effects of Contact With Nature During Outdoor Environmental Education on Students' Wellbeing, Connectedness to Nature and Pro-sociality. *Front. Psychol.* 12:648458. doi: [10.3389/fpsyg.2021.648458](https://doi.org/10.3389/fpsyg.2021.648458)
79. Moula, Z., Palmer, K., & Walshe, N. (2022). A Systematic Review of Arts-Based Interventions Delivered to Children and Young People in Nature or Outdoor Spaces: Impact on Nature Connectedness, Health and Wellbeing. *Frontiers in psychology*, 13, 858781. <https://doi.org/10.3389/fpsyg.2022.858781>
80. Schwarzmüller-Erber, G., Stummer, H., Maier, M., & Kundi, M. (2020). Nature Relatedness of Recreational Horseback Riders and Its Association with Mood and Wellbeing. *International journal of environmental research and public health*, 17(11), 4136. <https://doi.org/10.3390/ijerph17114136>
81. Forestry Commission Scotland. Woods in and Around Towns (WIAT) Programme 2010. Available online: <http://www.forestry.gov.uk/wiat> [Accessed on 16 December 2022].
82. Ward Thompson, C., Silveirinha de Oliveira, E., Tilley, S., Elizalde, A., Botha, W., Briggs, A., Cummins, S., Leyland, A. H., Roe, J. J., Aspinall, P., Brookfield, K., & Mitchell, R. (2019). *Health impacts of environmental and social interventions designed to increase deprived communities' access to urban woodlands: a mixed-methods study*. NIHR Journals Library.
83. Sobko, T., Jia, Z., Kaplan, M., Lee, A., & Tseng, C. H. (2017). Promoting healthy eating and active playtime by connecting to nature families with preschool children: evaluation of pilot study "Play&Grow". *Pediatric research*, 81(4), 572–581. <https://doi.org/10.1038/pr.2016.251>
84. Sobko, T., Liang, S., Cheng, W. H. G., & Tun, H. M. (2020). Impact of outdoor nature-related activities on gut microbiota, fecal serotonin, and perceived stress in preschool children: the Play&Grow randomized controlled trial. *Scientific reports*, 10(1), 21993. <https://doi.org/10.1038/s41598-020-78642-2>
85. Sobko T., Tse, M., Kaplan, M. (2016). A randomized controlled trial for families with preschool children - Promoting healthy eating and active playtime by connecting to nature. *BMC Public Health*. 16. [10.1186/s12889-016-3111-0](https://doi.org/10.1186/s12889-016-3111-0).
86. Sachs, A. L., Coringrato, E., Sprague, N., Turbyfill, A., Tillema, S., & Litt, J. (2022). Rationale, Feasibility, and Acceptability of the Meeting in Nature Together (MINT) Program: A Novel Nature-Based Social Intervention for Loneliness Reduction with Teen Parents and Their Peers. *International journal of environmental research and public health*, 19(17), 11059. <https://doi.org/10.3390/ijerph191711059>



87. Salonen, K., Hyvönen, K., Paakkolanvaara, J. V., & Korpela, K. (2022). Flow With Nature Treatment for Depression: Participants' Experiences. *Frontiers in psychology, 12*, 768372. <https://doi.org/10.3389/fpsyg.2021.768372>
88. Richardson M and McEwan K (2018) 30 Days Wild and the Relationships Between Engagement With Nature's Beauty, Nature Connectedness and Well-Being. *Front. Psychol. 9*:1500. doi: 10.3389/fpsyg.2018.01500
89. Aspy, D. J., & Proeve, M. (2017). Mindfulness and Loving-Kindness Meditation: Effects on Connectedness to Humanity and to the Natural World. *Psychological Reports, 120*(1), 102–117. <https://doi.org/10.1177/0033294116685867>
90. Wang, X., Geng, L., Zhou, K., Ye, L., Ma, Y., & Zhang, S. (2016). Mindful learning can promote connectedness to nature: Implicit and explicit evidence. *Consciousness and cognition, 44*, 1–7. <https://doi.org/10.1016/j.concog.2016.06.006>
91. Ho, P. L., Li, T. W., Liu, H., Yeung, T. F., & Hou, W. K. (2022). Testing a New Protocol of Nature-Based Intervention to Enhance Well-Being: A Randomized Control Trial. *International journal of environmental research and public health, 19*(7), 3931. <https://doi.org/10.3390/ijerph19073931>
92. Daniels, S., Clemente, D. B. P., Desart, S., Saenen, N., Sleurs, H., Nawrot, T. S., Malina, R., & Plusquin, M. (2022). Introducing nature at the work floor: A nature-based intervention to reduce stress and improve cognitive performance. *International journal of hygiene and environmental health, 240*, 113884. <https://doi.org/10.1016/j.ijheh.2021.113884>
93. Tina Braun & Paul Dierkes (2017) Connecting students to nature – how intensity of nature experience and student age influence the success of outdoor education programs, *Environmental Education Research, 23*:7, 937-949, DOI: [10.1080/13504622.2016.1214866](https://doi.org/10.1080/13504622.2016.1214866)
94. Crawford, M. R., Holder, M. D., & O'Connor, B. P. (2017). Using Mobile Technology to Engage Children With Nature. *Environment and Behavior, 49*(9), 959–984. <https://doi.org/10.1177/0013916516673870>
95. Otto, S., & Pensini, P.M. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change-human and Policy Dimensions, 47*, 88-94.
96. Yoori Cho & Dowon Lee (2018) 'Love honey, hate honey bees': reviving biophilia of elementary school students through environmental education program, *Environmental Education Research, 24*:3, 445-460, DOI: [10.1080/13504622.2017.1279277](https://doi.org/10.1080/13504622.2017.1279277)
97. Greg R. Lankenau (2018) Fostering connectedness to nature in higher education, *Environmental Education Research, 24*:2, 230-244, DOI: [10.1080/13504622.2016.1225674](https://doi.org/10.1080/13504622.2016.1225674)



98. Dopko, Raelyne & Capaldi, Colin & Zelenski, John. (2019). The psychological and social benefits of a nature experience for children: A preliminary investigation. *Journal of Environmental Psychology*. 10.1016/j.jenvp.2019.05.002.
99. Kiely, B., Croke, A., O'Shea, M., Boland, F., O'Shea, E., Connolly, D., & Smith, S. M. (2022). Effect of social prescribing link workers on health outcomes and costs for adults in primary care and community settings: a systematic review. *BMJ open*, 12(10), e062951. <https://doi.org/10.1136/bmjopen-2022-062951>
100. Alexandre, J. C., Chastin, S., Irvine, K. N., Georgiou, M., Khanna, P., Tiegues, Z., Smith, N., Chong, Y. Y., Onagan, F. C., Price, L., Pflieger, S., Helliwell, R., Singleton, J., Estandarte, A., Smith, E. S., Curran, S., & Helwig, K. (2022). Investigating the contextual factors and mechanisms associated with implementing Blue Prescription Programmes in health and social care settings: a systematic review using realist synthesis. *The Lancet. Planetary health*, 6 Suppl 1, S9. [https://doi.org/10.1016/S2542-5196\(22\)00271-6](https://doi.org/10.1016/S2542-5196(22)00271-6)
101. Wyles, K. J., Pahl, S., Holland, M., & Thompson, R. C. (2017). Can Beach Cleans Do More Than Clean-Up Litter? Comparing Beach Cleans to Other Coastal Activities. *Environment and behavior*, 49(5), 509–535. <https://doi.org/10.1177/0013916516649412>
102. McKenzie RJ, Chambers TP, Nicholson-Perry K, Pilgrim J and Ward PB (2021) "Feels Good to Get Wet": The Unique Affordances of Surf Therapy Among Australian Youth. *Front. Psychol.* 12:721238. doi: 10.3389/fpsyg.2021.721238
103. McMahan, E., Estes, D., Murfin, J. S., & Bryan, C. M. (2018). Nature Connectedness Moderates the Effect of Nature Exposure on Explicit and Implicit Measures of Emotion. *Journal of Positive Psychology and Wellbeing*. Retrieved from [https://digitalcommons.wou.edu/fac\\_pubs/45](https://digitalcommons.wou.edu/fac_pubs/45)
104. Rosa, C. D., Profice, C. C., & Collado, S. (2018). Nature Experiences and Adults' Self-Reported Pro-environmental Behaviors: The Role of Connectedness to Nature and Childhood Nature Experiences. *Frontiers in psychology*, 9, 1055. <https://doi.org/10.3389/fpsyg.2018.01055>
105. Vitale, V., Martin, L., White, M.P., Elliott, L.R., Wyles, K.J., Browning, M.H.E.M., Pahl, S., Stehl, P., Bell, S., Bratman, G.N., Gascon, M., Grellier, J., Lima, M.L., Löhmus, M., Nieuwenhuijsen, M., Ojala, A., Taylor, J., van den Bosch, M., Weinstein, N., Fleming, L.E. (2022). Mechanisms underlying childhood exposure to blue spaces and adult subjective well-being: An 18-country analysis, *Journal of Environmental Psychology*, doi: <https://doi.org/10.1016/j.jenvp.2022.101876>.
106. Holland, I., DeVille, N. V., Browning, M., Buehler, R. M., Hart, J. E., Hipp, J. A., Mitchell, R., Rakow, D. A., Schiff, J. E., White, M. P., Yin, J., & James, P. (2021). Measuring Nature



Contact: A Narrative Review. *International journal of environmental research and public health*, 18(8), 4092. <https://doi.org/10.3390/ijerph18084092>

107. Keaulana, S., Kahili-Heede, M., Riley, L., Park, M., Makua, K. L., Vegas, J. K., Antonio, M. (2021). A Scoping Review of Nature, Land, and Environmental Connectedness and Relatedness. *International journal of environmental research and public health*, 18(11), 5897. <https://doi.org/10.3390/ijerph18115897>
108. Mayer F. S., Frantz C. M. (2004). The connectedness to nature scale: a measure of individuals' feeling in community with nature. *J. Environ. Psychol.* 24 503–515. 10.1016/j.jenvp.2004.10.001
109. Nisbet, E. K., Zelenski, J. M., Murphy, S. A. (2009). The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. *Environment and behavior*, 41(5), 715-740.