

# The impacts of nature connectedness on children's well-being: Systematic literature review

Terhi Arola<sup>a,\*</sup>, Marianne Aulake<sup>a</sup>, Anna Ott<sup>a</sup>, Matti Lindholm<sup>a</sup>, Petra Kouvonen<sup>b</sup>,  
Petri Virtanen<sup>b</sup>, Riikka Paloniemi<sup>a</sup>

<sup>a</sup> Finnish Environment Institute (SYKE), Latokartanonkaari 11, 00790, Helsinki, Finland

<sup>b</sup> Iita Children's Foundation, Porkkalankatu 24, 00180, Helsinki, Finland

## ARTICLE INFO

Handling Editor: L. McCunn

### Keywords:

Children  
Agency  
Health  
Nature relationship  
Connectedness to nature

## ABSTRACT

Direct and indirect well-being benefits of children and adolescent's nature connectedness are a growing societal interest. Accordingly, they are increasingly studied and the field of research is evolving rapidly. However, the conceptualization and operationalization of nature connectedness, well-being and their interaction, as well as the empirical methods that are used to analyze them, vary remarkably. We conducted a systematic literature review on how children's nature connectedness and its well-being impacts have been studied during the past two decades and what are the key findings regarding the connection. Our analysis covered qualitative and quantitative studies, which all showed the positive effects of nature connectedness on well-being. Qualitative studies gave a voice to children in defining nature and its well-being impacts, while quantitative studies measured the connection using various nature connectedness scales. We conclude with recommendations for developing the research field in the future to fulfil current research gaps and to guide societal development to support children's well-being.

## 1. Introduction

The ever-growing evidence of the multiple benefits of nature on children's well-being is so clear that it has led pediatricians to recommend nature contact for improving children's health (Fyfe-Johnson et al., 2021; Norwood et al., 2019). Health benefits of direct nature exposure and time spent in nature have been increasingly studied from various perspectives, including how outdoor physical activity (Thompson Coon et al., 2011), microbiome exposure (Ruokolainen et al., 2015; Lehtimäki et al., 2017; Roslund et al., 2020) and air quality (Johnson et al., 2021; Prunicki et al., 2021) improve children's health directly as well as support lifelong healthy lifestyles. In addition to physical health, nature also supports psychological well-being (Mygind et al., 2019; Tillmann et al., 2018; Bowler et al., 2010; Howell & Passmore, 2011). Furthermore, during the last two years, the COVID-19 pandemic has made visible the crucial role of near-by living environments as prerequisite for health and well-being (e.g., Jackson et al., 2021; Kaplan Mintz et al., 2021; Ribeiro et al., 2021; Samuelsson et al., 2021; Tomasso et al., 2021).

In order to shed light on children's own ways of enjoying nature with

their senses, of getting actively involved in nature and their personal relationship with nature, we focus in this study on nature connectedness. Nature connectedness, also known as nature relationship or nature relatedness, refers to an individual's subjective sense of their relationship with nature (Martin et al., 2020; Pritchard et al., 2020); the concept emphasizes the notion that to feel connected to nature is more than simply spending time in nature. To measure nature connectedness quantitatively, the concept has been operationalized in various ways with adult participants, including Connectedness to Nature Scale (Mayer & Frantz, 2004) and Nature Relatedness Scale (Nisbet et al., 2009).

The well-being effects of nature connectedness have been studied from multiple points of view (e.g., Cervinka et al., 2012; Howell et al., 2011; Martin et al., 2020). Furthermore, two meta-analyses found correlation between nature connectedness and well-being (Capaldi et al., 2014; Pritchard et al., 2020). Reviews and meta-analyses about the well-being benefits of nature connectedness have focused on adult participants. An exception is Chawla (2020) who sought out to provide an overview of research on children's nature connection and the different dimensions of connectedness. Her review discusses different variables for measuring nature connectedness, as well as the benefits of

\* Corresponding author.

E-mail address: [terhi.arola@syke.fi](mailto:terhi.arola@syke.fi) (T. Arola).

<https://doi.org/10.1016/j.jenvp.2022.101913>

Received 16 May 2022; Received in revised form 27 October 2022; Accepted 14 November 2022

Available online 28 November 2022

0272-4944/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

the connection. She also included studies assessing children’s reactions to environmental change and compiled how children cope with environmental worries. Still, more research is needed to understand the mechanisms behind the relationship of children’s and adolescents’ nature connectedness and well-being (later in the text we will use the word ‘children’ to refer to underaged people, including adolescents).

Child well-being is a multifaceted concept (Fattore et al., 2019) and researching it is equally complex. It has become a central notion that children’s own subjective notions of their well-being should be the primary concern in research (Ben-Arieh et al., 2014; Raghavan & Alexandrova, 2015). Thus, in order to really understand the well-being benefits of nature for children, further attention should be paid to children’s own perceptions: how they perceive nature, their relationship with nature, and the role of that relationship in building health and well-being benefits. As we need more qualitative research that can focus on children’s perception, we also need to confirm the correlation of nature connectedness and well-being quantitatively. The way the correlation is studied should take into account children’s perceptions of the interrelationship of nature and well-being.

To this end, in this review, we explore and describe current research on the impacts of children’s nature connectedness on their well-being, focusing on one hand on children’s own perceptions and how these descriptions relate to quantitative measures and on the other hand describing the research field as a whole. We set out to create an overview of the research field itself, its recent development and current state. We ask, how have children’s nature connectedness and its well-being impacts been studied during the past two decades; how is nature connectedness found to influence children’s well-being. We analyze what children’s own perspectives on the effects of nature connectedness are and how nature connectedness and its well-being impacts have been operationalized in questionnaires and other measurements. Furthermore, we describe the current understanding regarding what aspects of nature connectedness affect various well-being effects. In addition, we will present how future research in the field could fulfill current research gaps, as proposed by the reviewed authors and based on our results.

**2. Material and methods**

In order to understand how children’s relationship to and with nature affects their well-being, we conducted a systematic literature review. Following Victor (2008), our review is systematic in a sense that it is comprehensive in the coverage of the literature, pays careful attention to the quality of the evidence, takes a clear approach to the synthesis of the data, and follows a transparent and rigorous process (see Fig. 1).

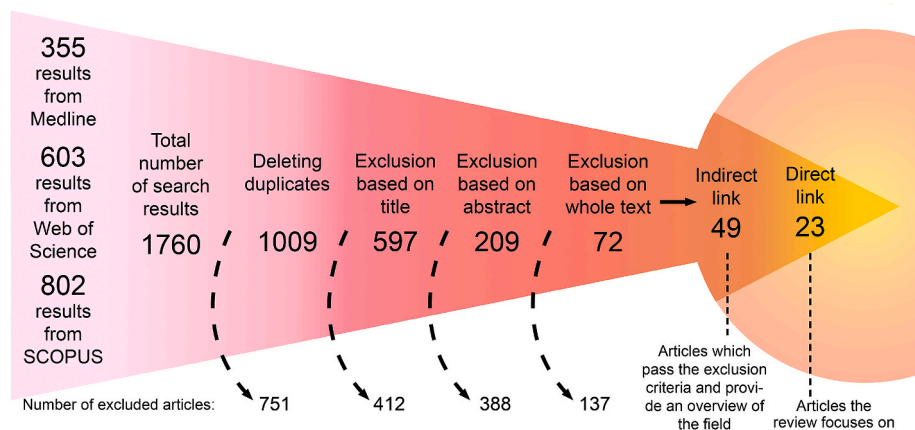
We searched two databases, Web of Science (the core collection and the U.S. National Library of Medicine Medline) and SCOPUS with search terms relating to three categories — children, nature connectedness, and

well-being — all of which needed to be in the article’s title, keywords or abstract. In Table 1, we present the final search terms used in Web of Science; the search terms used in SCOPUS differed only slightly. We performed the search query to the scientific literature published between the years 2000–2021 and limited our search to peer-reviewed articles published in English. We also included one early access article, which was officially published in 2022. The final search conducted in September 2021 resulted in a total of 1760 publications, of which 958 stemmed from Web of Science (core collection: 603; Medline: 355) and 802 from SCOPUS. After deleting duplicates, 1009 publications remained. Then, we excluded publications, which did not address the well-being effects of children’s or adolescents’ nature relationship or were not peer-reviewed articles based on the following criteria. First, an article needed to report on research involving people under the age of 20. Research that involved both children and young adults was reviewed if the results reported children separately. An article was also included if the target group was adults, but the questions were regarding the participants’ childhood. Second, for an article to be included, it needed to explore children’s relationship with nature, thus articles that only focused on nature as a physical location and did not include any measure of connectedness were excluded. Third, an article needed to present original results of how children’s or adolescents’ relationship with nature affects their well-being. We didn’t set out to define “well-being” before the initial screening process but accepted what the authors of the articles defined as well-being effects. The articles were first screened based on title only, secondly based on abstract, and in the final round the entire article was read through. The articles were divided to three researchers who conducted the screening process individually. This process resulted in 72 articles, which were included in this review.

These 72 peer-reviewed articles we analyzed in more detail based on their content, including theoretical and methodological approaches, the

**Table 1**  
Final search terms used in bibliometric analysis in databases.

<b>Terms related to children</b>	child* OR youth* OR adolesc* OR teen*
<b>Terms related to nature relationship</b>	natur* NEAR/1 relationship* OR natur* NEAR/1 experience* OR "nature relatedness" OR natur* NEAR/1 connect* OR "environmental attitude" OR "environmental concern" OR "environmental values" OR "construction* of natur*" OR "representation* of nature" OR "concept* of nature" OR "virtual nature" OR "technological nature" OR biophil*
<b>Terms related to well-being</b>	health* OR well-being OR wellbeing OR "well being" OR emotion* OR self-esteem OR self-confidence OR "quality of life" OR happiness OR stress* OR resilienc* OR illness* OR vulnerab* OR coping OR "commun*" OR "social relation**"



**Fig. 1.** Process of inclusion.

research objectives, and the children involved in the research (see online appendix for full information). In terms of nature relationship, we recorded how nature was defined in the research and what form of interaction between children and nature was studied. We further noted what type of well-being effects were studied and found and how they correlated with children’s nature relationship. Finally, we also recorded what kind of policy recommendations and future research needs were identified by a study.

While analyzing the articles, we noted that many did not focus on understanding how children’s relationship to nature affects their well-being, even though they fulfilled the pre-defined inclusion criteria. These studies, for example, may have found a correlation between children’s health and their interaction with nature without explicitly describing the relationship between the health benefits through children’s connectedness with nature, or did so in rather general terms. We therefore split the 72 articles into two groups. 23 of the articles explicitly and directly explored the impacts of children’s nature relationship on their well-being, while the other 49 studied the interrelationship indirectly (either conceptually or methodologically). All three reviewers considered the 72 articles and agreed on this split. We carried out a descriptive analysis of the 49 articles. We describe the methods and findings of these articles as a description of the research field to shed light into this evolving field and show what research gaps exist.

Our analysis of children’s nature connectedness focused on the 23 articles, which studied the direct link between connectedness and well-being. The analysis of the 23 articles was divided building on researcher triangulation: one researcher focusing on the qualitative articles, another on quantitative ones. To analyze how nature connectedness and its well-being effects were examined, we did an inductive analysis and derived common themes across the articles from the raw data. The thematic analysis began with the qualitative articles, first recognizing key themes of nature connectedness. Then, the themes were compared with the quantitative articles. Second, the well-being effects from the qualitative articles were thematized. Then the well-being themes from the quantitative articles were compared with these. Finally, we drew together a description of the research field, commenting on how the well-being effects of nature connectedness have been studied and recommend some future research directions.

### 3. Description of the studies

#### 3.1. Recent development of the research field

During the last 20 years, the studies exploring the well-being impact of children’s nature relationship have been developing both in terms of number and focus. Among the 72 analyzed articles, most of the studies (63) were published within the last 6 years (Fig. 2), and only three studies were published before 2011. Furthermore, all but one of the 23 articles at the core of the field exploring explicitly the impacts of nature connectedness on well-being, were published after 2015. These numbers indicate how recently and rapidly the interest to explore the phenomenon has been rising.

14 of all the analyzed studies were published in the UK, 13 in the US, eight in Canada, and four in Australia. 18 studies were conducted in Northern and Western Europe, of which five studies took place in Finland and four in Spain. Eight studies were from Asia, two from South America, two from Africa, two from Middle East and one from Russia. Our search results were thus focused on research conducted in the Global North, but studies from Eastern Europe were missing. All but 4 of the 23 articles at the main focus of this review were published in English speaking countries and Europe.

The 72 studies altogether covered especially 9–14-year-old children, with 11-year-olds being studied in 36 of the papers. Children younger than 6 or teens older than 17 are focused on considerably less, while six studies included also young adults (18–25-year-olds) or focused on the childhood nature experiences of adults (up to 78-year-olds). Seven articles did not specify the age of the participants. Please refer to the annex for a detailed list of the articles.

#### 3.2. An overview of concepts of nature and well-being in the field

The 49 articles, which explored the more indirect links between nature, nature connectedness and well-being represent the larger field of studying children’s health and nature relationship. In these studies, the operationalization of nature varies from themed murals in children’s hospitals (Pearson et al., 2019), and blue spaces (Ashbullby et al., 2013; Spiegel et al., 2020), to a desert (Sedawi et al., 2020). 17 of the studies focused on children’s use and access to nearby natural environments, such as school and hospital gardens (Chang et al., 2016; Reeve et al., 2017), a 5-km radius from schools to public natural spaces (Huynh &

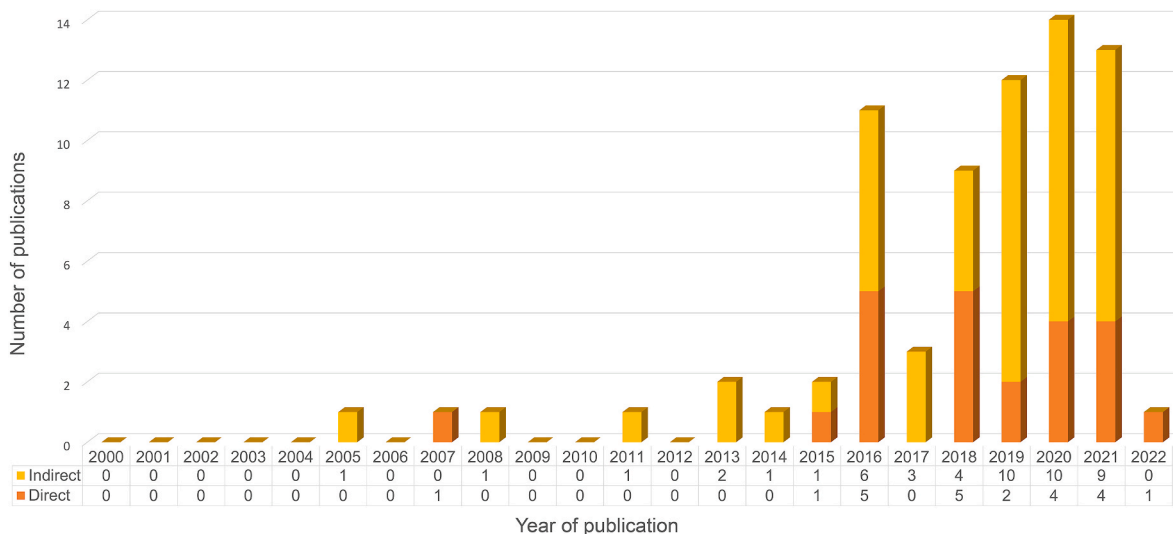


Fig. 2. Publishing years of the articles included in the review

Note. Figure shows the publishing years of both the articles that looked at the well-being effects of nature connectedness directly and that were at the core of our analysis, as well as the articles that looked at the connection indirectly, which we describe as an overview of the field. The figure includes one early access publication that was to be published in 2022.

Torquati, 2013), and “natural spaces that adolescents actually occupy” (Li et al., 2018). In these research settings, it was assumed that proximity to nature is enough to achieve well-being gains and children’s actual use of green areas and perceptions of nature were not considered. With the exception of one study (Collado et al., 2016b), all of these 17 studies were conducted in an urban setting. In 10 of the 49 articles nature was not specifically defined, or thought to encompass “all nature” (e.g. Barrera-Hernandez et al., 2020; Fretwell & Greig, 2019; Sugiyama et al., 2021). Encountering pets and animals was also studied in four articles (e.g., Bystrom et al., 2019; Moore & Lynch, 2018).

These articles document numerous impacts of nature connectedness on children’s well-being. 39 out of the 49 articles described positive effects of nature connection or time spent in nature to children’s well-being. Most of these positive well-being impacts were of psychological nature, for example, reduced stress (e.g., Ashbullby et al., 2013; Bystrom et al., 2019; Lindemann-Matthies et al., 2021), feelings of happiness and joy (e.g., Barrera-Hernandez et al., 2020; Chang et al., 2016; Fretwell & Greig, 2019), experiences of mindfulness or spirituality (Adams & Beauchamp, 2019; Sahni & Kumar, 2021), and a sense of competence, self-esteem or emotional well-being (e.g., Hinds, 2011; Pollin & Retzlaff-Furst, 2021; Readdick & Schaller, 2005). Social well-being benefits were found especially in the intervention studies (all 9 of which had positive results), where children’s social skills and competence increased during the study (e.g., Kalashnikova et al., 2016; Ward et al., 2019). Physical well-being benefits were not singled out, but some studies considered connectedness to nature as a well-being benefit in itself (e.g., Waite et al., 2016), while others focused on the sense of overall well-being (e.g., Moore & Lynch, 2018; Nagata & Liehr, 2021).

While most of the studies focused on positive well-being impacts of children’s nature, five studies explored potential negative effects and attitudes. These were the feelings of anxiety and concern related to the neighboring degrading natural environment (Strife, 2008), fear of pathogen transmission from nature (Prokop & Kubiato, 2014), perceived risks related to natural environments to vulnerable children (von Benzon, 2017), dangers of heat and sunstrokes (Sedawi et al., 2020), and disgust towards outdoor activities (Sugiyama et al., 2021). See online Annex 1.2 for more details on the articles described here, which studied the interrelationship between nature connectedness and well-being indirectly.

### 3.3. Research objectives, participants, and methods of the analyzed articles

In this section, we describe key research design, including research questions, methods, and participants of the articles, which studied children’s relationship with nature and its impacts on well-being directly (altogether 23 articles). We describe qualitative (11 articles) and quantitative studies (12) separately. The few articles that reported on mixed method research were allocated to either one of the groups based on the main method used in the study.

#### 3.3.1. Qualitative articles

The eleven qualitative articles explicitly explored the relationship between nature and children’s well-being and described children’s perceptions on the relationship. While the starting point of some articles was what constitutes children’s well-being (Barfield & Driessnack, 2018; Moula et al., 2021), others focused instead on how children understand nature (Collado, Iniguez-Rueda, & Corraliza, 2016; Tillmann et al., 2019). Most studies examined how children subjectively perceive well-being. Only in two articles, researchers and not the participating children defined ‘nature’ and assessed the effects of woodland experiences on children’s well-being (Acton & Carter, 2016; Milligan & Bingley, 2007). In these studies researchers observed and explored how children perceived nature and engaged with it in a predefined natural environment.

How children experience and connect to nature was explored in two

different ways. Most studies focused on children’s perceptions of nature and asked children to define what nature means to them, thereby providing agency to children (Barfield & Driessnack, 2018; Collado, Iniguez-Rueda, & Corraliza, 2016; Hatala et al., 2019, 2020; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016, 2019; Zamora et al., 2021). They explored how nature features in children’s drawings (Barfield & Driessnack, 2018; Moula et al., 2021), children’s descriptions of nature (Collado, Iniguez-Rueda, & Corraliza, 2016; Tillmann et al., 2019; Zamora et al., 2021), children’s photographs of close-by nature (Hatala 2020; Wiens et al., 2019), and children’s accounts of their environments (Hatala et al., 2019; Wiens et al., 2016). These studies offer insights into what nature means to children in different locations.

In these qualitative articles children or adolescents were selected to participate in the research because of a particular characteristic they share. For example, Barfield and Driessnack (2018) interviewed children with and Hatala (2019, 2020) sought out indigenous adolescents living in urban areas in Canada. Different socio-cultural backgrounds of children were presented, such as children living in rural areas of Spain, England, Canada, and Finland (Collado, Iniguez-Rueda, & Corraliza, 2016; Milligan & Bingley, 2007; Tillmann et al., 2019; Wiens et al., 2016, 2019), children from England caring for their parents (Acton & Carter, 2016), and children living in an income deprived region in England (Moula et al., 2021). Furthermore, Zamora et al. (2021) used a text message-based survey tool to ask open ended questions from a large sample of US youth. All qualitative articles were from North America or Europe.

The qualitative articles represented a wide range of theoretical and methodological backgrounds, with a variety of research methods. Semi-structured interviews and focus group discussions were the most common methods applied, but also art-based methods were used. Children were encouraged to draw their happy places (Moula et al., 2021), invited to write poems (Acton & Carter, 2016), or interviewed by a researcher using the draw-and-tell conversation approach to figure out when a child’s life was really good (Barfield & Driessnack, 2018). Hatala et al. (2020) used photovoice and invited indigenous adolescents to take pictures of different objects, people, or aspects of their lives that support their well-being. Only one article relied on a participatory workshop, which involved a woodland walk and craft sessions (Milligan & Bingley, 2007). Finally, the identified articles also include research drawing from questionnaires (Collado, Iniguez-Rueda, & Corraliza, 2016; Zamora et al., 2021).

#### 3.3.2. Quantitative articles

In the twelve quantitative articles the relationship between children’s nature connectedness and well-being was measured. Four of the studies focused on the effects of a nature intervention on children’s nature connectedness and well-being. The interventions involved an immersive wilderness camp, where children learned life skills such as leadership (Barton et al., 2016), four visits to a nature reserve (Pirchio et al., 2021), a weekly visit to a park (Sobko et al., 2020) and lessons that took place at school grounds (Harvey et al., 2020). The quantitative studies looked at correlations between certain aspects of well-being, for example, positive youth development (Bowers et al., 2021), psychosomatic symptoms (Piccininni et al., 2018) or self-esteem (Barton et al., 2016), and nature relationship. The studies also analyzed the connection between nature connectedness and well-being, for example, by controlling for social support, empathy, attention, socio-economic status and gender (Whitten et al., 2018) or by examining whether the child’s temperament mediated this connection (Cui & Yang, 2022).

All quantitative studies included a questionnaire, but the target groups and sample sizes varied greatly between the studies. Two studies were based on very large sample sizes with over 20 000 children (Whitten et al., 2018) or adolescents (Piccininni et al., 2018). Two studies asked adults to reflect on their childhood nature experiences to explain adult nature connectedness and well-being (Windhorst &

Williams, 2015; Wood & Smyth, 2020). Another two studies focused on preschool children from Hong Kong and asked parents to answer the questionnaire on behalf of their children (Sobko et al., 2018, 2020). All other quantitative studies engaged children to answer for themselves. Most studies were conducted in Europe or North America and seven of the twelve studies were from English speaking countries, however, Galli et al. (2016) surveyed Brazilian children living in urban areas, and Cui and Yang (2022) Chinese children living in urban areas. The quantitative studies focused on children from urban, middle-class families, with no medical conditions or diagnoses. The quantitative studies often assessed children as a homogenous group without paying attention to socio-economic differences within the group, as only one study focused on children living in low-income communities in the US and acknowledged the participant's ethnic backgrounds (Bowers et al., 2021).

Predefined measurement scales are feasible ways to standardize research and to increase comparability of the results across various studies. Accordingly, the analyzed quantitative studies often benefited from predefined and established questionnaire scales to measure nature connectedness. Altogether four measurement scales were used in the studies: Connectedness to Nature Scale (CNS) by Mayer and Frantz (2004); Connection to Nature Index (CNI) by Cheng and Monroe (2012); Nature Relatedness (NR-6) scale by Nisbet and Zelenski (2013) and Inclusion of Nature in Self (INS) scale by Schultz (2001). The scales and which articles used them are presented in Table 2. It is worth noticing that CNI is the only scale used in the studies that has been developed for children. All other used scales have been developed and tested for adult participants and there is only limited data on their applicability to measure children's nature connectedness.

The studies that used the predefined questionnaire scales, often adapted them to fit the local context. For example, Sobko et al. (2018) edited the CNI to work for preschoolers in Hong Kong and omitted questions that did not make sense in a big city, such as hearing sounds of

nature (because of noise pollution) or caring for wild animals (that in cities are usually pests). Furthermore, three studies created their own scales instead of using pre-existing connectedness scales (Galli et al., 2016; Piccininni et al., 2018; Whitten et al., 2018).

## 4. Results

### 4.1. Aspects of children's nature connectedness

The qualitative articles presented a holistic view on what nature means to children of different ages in different places and how interactions with nature are determined by the environmental and cultural contexts. They highlight how children described or depicted nature through living and non-living things as well as through outdoor activities. For example, Moula et al. (2015) notice the special meaning of trees, as one in three children drew a tree, while Barfield and Driessnack (2018) found that children's drawings depicted nature directly, including mountains, birds, and sunshine, as well as indirectly in outdoor activities, such as swimming, building sandcastles, or fishing.

Many studies further show how children connect to nature through their senses, thereby showing that for children, nature is not an abstract phenomenon but lived experiences (Collado, Iniguez-Rueda, & Corraliza, 2016; Hatala et al., 2019, 2020; Milligan and Bingley 2007; Wiens et al., 2016, 2018; Zamora et al., 2021). Nature is described as a process of relating with nature through touch, sight, hearing, smell, and taste. For example, Wiens et al. (2016) show how girls living in Northern Finland emphasized the greenness of the leaves, the brightness of the stars, and the smells of the swamps when describing their home landscapes. Wiens et al. (2016, 2018) further highlight how girls' understanding of nature includes and changes with the seasons. Similarly, Hatala et al. (2020) document how indigenous youth experience nature through the circularity of seasons.

From the quantitative connectedness scales, only CNI included questions that describe nature as a sensory experience or through living and non-living things, such as hearing different sounds in nature or touching animals and plants (Cheng & Monroe, 2012), similarly to how children describe nature in qualitative articles. Spending time in nature is included in both the CNI and the NR-6 scales, but they do not fully encompass the many activities children described in the qualitative studies. Some quantitative studies include a question of spending time in nature, not specifying nature in any way or describing specific activities, such as "how many hours a day do you usually spend time playing outdoors" (Piccininni et al., 2018). In intervention studies, children do not describe nature, but the studies are focused around outdoor activities, for example the wilderness expedition in Barton et al. (2016) included camping, hiking and canoeing.

Tillmann et al. (2019) explain that children's definitions of nature are often centered on outdoor activities and natural elements, but the children also highlight that nature is an interconnected system of life encompassing everything natural – an observation, which is also made by Zamora et al. (2021), Collado, Iniguez-Rueda, and Corraliza (2016) and Hatala (2019). How nature is perceived as a process of relating with nature is further apparent in the notion of care and empathy for other living things that characterize children's definition of nature (Collado, Iniguez-Rueda, & Corraliza, 2016; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016, 2018). Children voiced the need to protect and preserve nature and highlighted the dependency of humans on nature. Finally, some studies document how children perceive humans not only as dependent but as part of nature (Hatala et al., 2019, 2020; Moula et al., 2021; Wiens et al., 2019). Children expressed a sense of oneness with nature and kinship with all living things, thereby suppressing the distinction between nature and humans.

Most quantitative studies included questions about caring for nature and feelings of being part of nature, as they are often key concepts in definitions of nature connectedness. Thus, as the focus of quantitative studies is on measuring nature connectedness, many studies show that

**Table 2**  
Nature connectedness scales used in the 12 quantitative articles.

Scale	Theme	Articles
Connectedness to Nature Scale (CNS) by Mayer and Frantz (2004)	Being one with nature ("I often feel a sense of oneness with the natural world around me")	Barton et al. (2016) Pirchio et al., 2021 (adapted); Wood & Smyth, 2020;
Connection to Nature Index (CNI) by Cheng and Monroe (2012)	Enjoyment of nature ("When I feel sad, I like to go outside and enjoy nature"); Empathy for creatures ("I feel sad when wild animals are hurt"); Sense of oneness ("Humans are part of the natural world"); Sense of responsibility ("Picking up trash on the ground can help the environment")	Cui & Yang, 2022 (adapted); Harvey et al., 2020; Sobko et al., 2018 (adapted); Sobko et al., 2020 (adapted)
Nature Relatedness (NR-6) scale by Nisbet and Zelenski (2013) (which is a shorter version of the 21 item NR scale by Nisbet et al., 2009)	Enjoying nature ("My ideal vacation spot would be a remote, wilderness area"); Feeling connected to nature ("My relationship to nature is an important part of who I am")	Bowers et al., 2021; Windhorst & Williams (2015)
Inclusion of Nature in Self (INS) scale by Schultz (2001)	Scale involves one visual question that requires participant to place themselves on a spectrum: from being completely separate to being completely part of nature	Bowers et al., 2021; Windhorst & Williams (2015)

children care for nature and feel a sense of kinship and oneness with nature. However, some quantitative studies removed the questions regarding oneness with nature from their questionnaire saying children did not understand them (Cui & Yang, 2022; Sobko et al., 2018, 2020). However, several qualitative articles present evidence that children indeed understood themselves as part of nature (Hatala et al., 2019, 2020; Wiens et al., 2019). Furthermore, in those quantitative studies that included the concept of oneness, children tended to score high on nature connectedness (Barton et al., 2016; Bowers et al., 2021; Harvey et al., 2020; Pirchio et al., 2021). Therefore, it needs to be studied whether some of children’s characteristics, such as age or cultural background, determine children’s capability to see and express themselves as part of nature, or whether the wording of the questions regarding oneness with nature does not reflect children’s understanding of it.

While the studies document less or more holistic understandings of

nature, it does not seem that the older the child is, the more holistically nature is perceived. Children aged between six and 18 years participated in the reviewed qualitative articles. Our analysis reveals that children as young as six or seven can share feelings of care for nature (Collado, Iniguez-Rueda, & Corraliza, 2016; Moula et al., 2021) or embrace of sense of oneness and kinship with nature (Moula et al., 2021), while older children are reported to connect with nature mainly through outdoor activities (Acton and Carter, 2016; Barfield & Driessnack, 2018).

Table 3 summarizes the different aspects of nature connectedness found in the studies. The complexity of children’s nature connectedness is illustrated by the different aspects of nature connectedness included in studies. We recognized aspects that on one hand focus on immediate surroundings and specific concrete elements of nature, such as flowers, trees and the different smells and sounds of nature. There’s also the different activities nature enables, such as swimming and playing. These

**Table 3**  
How nature connectedness was approached in the studies.

Aspect of nature connectedness	How aspect was worded by children	Qualitative articles that included this aspect	How aspect was worded in a questionnaire	Quantitative articles that included this aspect
<b>Living and non-living things</b>	“Children (...) depicted nature directly, including mountains, lakes, beaches, blue sky, birds, grass, flowers, streams, and sunshine.” Child in Barfield and Driessnack (2018: p. 4)	<b>11/11</b> Acton and Carter, 2016; Barfield & Driessnack, 2018; Collado, Iniguez-Rueda, & Corraliza, 2016; Hatala et al., 2019; Hatala et al., 2020; Milligan & Bingley, 2007; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016; Wiens et al., 2019; Zamora et al., 2021	“I like to see wild flowers in nature.” CNI by Cheng and Monroe (2012)	<b>3/12</b> Harvey et al., 2020; Sobko et al., 2018; Sobko et al., 2020
<b>Outdoor activities and spending time in nature</b>	“Children also drew and told indirect ‘outdoor’ stories involving swimming, building sandcastles, playing, fishing, and boating.” Child in Barfield and Driessnack (2018: p. 4)	<b>11/11</b> Acton and Carter, 2016; Barfield & Driessnack, 2018; Collado, Iniguez-Rueda, & Corraliza, 2016; Hatala et al., 2019; Hatala et al., 2020; Milligan & Bingley, 2007; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016; Wiens et al., 2019; Zamora et al., 2021)	“I like to garden.” CNI by Cheng and Monroe (2012) “I spend time outdoors whenever I can.” NR-6 by Nisbet & Zelenski (2013)	<b>8/12</b> Barton et al., 2016; Bowers et al., 2021; Harvey et al., 2020; Piccininni et al., 2018; Pirchio et al., 2021; Sobko et al., 2018; Sobko et al., 2020; Wood & Smyth, 2020
<b>Sensory experience</b>	“Nature is something beautiful and marvelous, contrary to ugly buildings or nasty pollution” Child in Collado et al. (2016a: p. 725)	<b>8/11</b> Collado et al., 2016a; Hatala et al., 2019; Hatala et al., 2020; Milligan & Bingley, 2007; Moula et al., 2021; Wiens et al., 2016; Wiens et al., 2019; Zamora et al., 2021	“I like to hear different sounds in nature.” CNI by Cheng and Monroe (2012)	<b>4/12</b> Cui & Yang, 2022; Harvey et al., 2020; Sobko et al., 2018; Sobko et al., 2020
<b>Enjoyment<sup>a</sup></b>			“When I feel sad, I like to go outside and enjoy nature.” CNI by Cheng and Monroe (2012) “I enjoy being outside in nature.” NR-6 by Nisbet & Zelenski (2013)	<b>3/12</b> Bowers et al., 2021; Galli et al., 2016; Whitten et al., 2018
<b>Care for nature</b>	“I think about the countryside, river, animals, plants and that we need to look after them and preserve nature” Child in Collado et al. (2016a: p. 725)	<b>5/11</b> Collado et al., 2016a; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016; Wiens et al., 2019	“I always think about how my actions affect the environment.” NR-6 by Nisbet & Zelenski (2013) “I feel sad when wild animals are hurt.” CNI by Cheng and Monroe (2012)	<b>9/12</b> Bowers et al., 2021; Cui & Yang, 2022; Galli et al., 2016; Harvey et al., 2020; Piccininni et al., 2018; Pirchio et al., 2021; Sobko et al., 2018; Sobko et al., 2020; Windhorst & Williams, 2015
<b>Earth as a living system</b>	“I think of the earth!” Child in Zamora et al. (2019: p. 4)	<b>4/11</b> Collado et al., 2016a; Hatala et al., 2019; Tillmann et al., 2019; Zamora et al., 2021	“When I think of my life, I imagine myself to be part of a larger cyclical process of living.” CNS by Mayer & Frantz (2004)	<b>4/12</b> Barton et al., 2016; Pirchio et al., 2021; Windhorst & Williams, 2015; Wood and Smyth 2020
<b>Sense of kinship and oneness</b>	“You know this river is a part of my spirit, and that it is consistent in my life.” Child in Hatala et al. (2019: p. 126)	<b>4/11</b> Hatala et al., 2019; Hatala et al., 2020; Moula et al., 2021; Wiens et al., 2019	“I often feel a sense of oneness with the natural world around me.” CNS by Mayer & Frantz (2004) Also included in: INS, NR-6, CNI	<b>8/12</b> Barton et al., 2016; Bowers et al., 2021; Harvey et al., 2020; Piccininni et al., 2018; Pirchio et al., 2021; Whitten et al., 2018; Windhorst and Williams 2015; Wood and Smyth 2020)

Note. Table includes all 23 analyzed articles. Classification building on thematic analysis of the articles that directly focused on the effects of children’s nature connectedness on their well-being. The connectedness scales referred to in the table are Connectedness to Nature Scale (CNS), Connection to Nature Index (CNI), Nature Relatedness (NR-6) and Inclusion of Nature in Self (INS).

<sup>a</sup> Enjoyment was the only category that was not found based on the qualitative articles, which composed a basis for the categorization.

aspects show how nature is a lived experience for children. Nature was also described as a living system and children recognized themselves as part of this system. Finally, a sense of responsibility and care for living creatures and surroundings was described. From the qualitative articles, it seems that children are actively building their nature connection and are able to contemplate and articulate this connection.

The complexity of children's experience of nature means that it is difficult to measure the depth of their connectedness and different connectedness scales inevitably measure different aspects of connectedness. While quantitative studies include many of the themes raised by the qualitative studies, none of them represent all the aspects of nature children describe. From the connectedness scales used in these studies, the CNI seems to include most themes, as it includes five of the six themes identified by the qualitative studies. It can be said that the connectedness scales measure different aspects of children's relationship with nature and thus can have different results concerning the depth of that relationship and the well-being effects it might have. Further, the scales combine several aspects of nature connectedness under a single variable. They do not look at the different aspects separately, thus providing an overview of children's nature connectedness, rather than looking at what elements constitute connectedness.

One aspect that was not identified from qualitative articles was enjoyment of nature, which is included in both the NR-6 and the CNI scales. Children did, however, describe in the qualitative articles how they gained positive mood from being in nature. It could be that the wording of the scales differs from the way children describe their experiences. Children, when describing different activities they like to do and beautiful sights they like to see, are indeed describing enjoying nature - however the scales simplify this experience under one word, when children themselves describe different elements of enjoyment.

#### 4.2. Well-being effects of nature connectedness

Most qualitative studies describe how children enjoy the immediate restorative and soothing effects of connecting with nature. Processes of relating with nature are found to reduce negative emotional states, such as stress, anxiety, depression, and anger, and to promote relaxation (Collado et al., 2016a; Hatala, 2019, 2020; Milligan & Bingley, 2007; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016, 2019; Zamora et al., 2021). For example, Hatala et al. (2019, 2020) show how young indigenous Canadians could distance themselves from stressors associated with everyday life and shift towards a more calming and positive state of being when immersing in sensory nature experiences. On their side, the quantitative studies did not explore nature's restorative effects on children, although the restorative effect of nature is recognized by the CNI, which includes the statement "When I feel sad, I like to go outside and enjoy nature". It was included in studies by Whitten et al. (2018) and Harvey et al. (2020) but was excluded by other studies that used CNI. Further, three studies (Piccininni et al., 2018; Pirchio et al., 2021; Sobko et al., 2018) found correlation between nature connectedness and lessened feelings of worry and anxiety, which supports the restorative effects of nature described in the qualitative articles.

Besides allowing children to deal with negative emotions, connecting with nature is shown to also enhance other positive psychological effects. Many of the studies report children expressing that nature made them happier or improved their mood (Acton & Carter, 2016; Collado et al., 2016a; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016, 2019; Zamora et al., 2021). For example, Barfield and Driessnack (2018) reveal how engaging in outdoor activities evoked satisfaction with life in children with and Hatala et al. (2020) showed how, for example, the imagery of a tree, provided a sense of hope to indigenous youth. In quantitative studies, Cui and Yang (2022) found that nature connectedness correlated with children's self-reported happiness, and this correlation was also found in other studies (Harvey et al., 2020; Piccininni et al., 2018; Pirchio et al., 2021).

The quantitative studies also included questions about self-satisfaction, which were not described by children in the qualitative studies, but which was found to correlate with nature connectedness (Bowers et al., 2021; Harvey et al., 2020; Pirchio et al., 2021; Whitten et al., 2018). It might be that developing self-satisfaction is a slower process and children might not thus connect it with nature connectedness as easily as for example nature's mood-boosting effects. Another aspect of well-being that was not explored by the qualitative studies is social well-being. The quantitative articles found nature connectedness to correlate with empathy (Bowers et al., 2021; Pirchio et al., 2021; Sobko et al., 2018; Whitten et al., 2018) as well as good social relationships (Bowers et al., 2021; Galli et al., 2016; Harvey et al., 2020). This provides an interesting avenue for future research, where not all nature's benefits are necessarily recognized by children themselves.

Only few of the qualitative studies report that research participants themselves highlighted physical health benefits of connecting with nature (Tillmann et al., 2019; Zamora et al., 2021). More often, authors argue that it is simply the engagement in physical activities outdoors which promotes children's physical health, and not necessarily nature connectedness (Acton & Carter, 2016; Moula et al., 2021; Wiens et al., 2016). In the qualitative studies children described that nature makes them more active, which could lead to enhanced physical health. However, the correlation could also be explained by how children who are already physically healthier are also more active and spend more time in nature. Some quantitative studies also looked at physical health effects and found correlation (Galli et al., 2016; Harvey et al., 2020; Piccininni et al., 2018; Pirchio et al., 2021; Sobko et al., 2018). For example, Piccininni et al. (2018) found that nature connectedness correlated with a decrease in symptoms of depression, irritability, nervousness, or trouble falling asleep.

While the well-being impacts recognized and studied by the articles are mostly positive, in qualitative research children did, however, also highlight negative impacts of connecting with nature to both their psychological and physical well-being (Collado et al., 2016a; Hatala et al., 2020; Tillmann et al., 2019; Wiens et al., 2016, 2018; Zamora et al., 2021). For example, Wiens et al. (2016) observed that during wintertime, it seems challenging for adolescent girls to find their balance for their physical well-being as they experience fatigue and reluctance to move outdoors. Both Wiens et al. (2016, 2019) and Hatala et al. (2020) document children reflecting on the burden of wintertime darkness and weather on their mind, while Tillmann et al. (2019) and Zamora et al. (2021) argue that for some children, experiencing nature makes them feel isolated. Finally, Collado et al. (2016a) highlight how for some children, damages to nature caused by human actions affected their mental well-being negatively as they feel sad or worried about nature loss and non-human suffering. While some quantitative studies asked about negative moods and emotions, they only looked at correlation between absence of negative states and nature connectedness. The aspect of negative emotions was not explored in the quantitative articles that were included in this review. More research is still needed to explore children's negative emotional responses to nature, such as feelings of isolation and fear.

Table 4 presents the positive and negative well-being effects found in qualitative and quantitative studies respectively, organized into psychological, social and physical well-being aspects. It includes all aspects as described in the studies as well-being effects, the categories were determined by our thematic analysis. It excludes two quantitative studies conducted with adults, where they found that childhood nature experiences increase adult nature connectedness which in turn supports psychological and social well-being in adulthood (Windhorst & Williams, 2015) and lessens stress reactions (Wood & Smyth, 2020).

Five themes of well-being aspects were found from the qualitative articles, including how children find that nature soothes their stress and boosts their mood. Nature was also described as inviting different activities. It is important to note how children themselves recognize these immediate and noticeable well-being benefits, and they also actively

**Table 4**  
Nature's impact on children's well-being in both qualitative and quantitative studies.

	Nature's impact on well-being	Qualitative studies	Quantitative studies
<b>Psychological well-being</b>	<b>Restorative impacts</b> "I have anger sometimes. Like I get mad at myself or I'm mad at someone else. I go by the river and just stand beside the edge and listen, listen to nature and birds and everything around me. It cools me down." Child in Hatala et al. (2019: p. 127)	9/11 Collado et al., 2016a; Hatala et al., 2019; Hatala et al., 2020; Milligan and Bingley 2007; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016; Wiens et al., 2019; Zamora et al., 2021	
	<b>Positive mood</b> "I just think about the nature and everything that is related to it, and this gives me a positive spirit." Child in Wiens et al. (2016: p. 6) "I felt happy and in a good mood." (Pirchio et al., 2021)	9/11 Acton and Carter 2015; Barfield & Driessnack, 2018; Collado et al., 2016a; Hatala et al., 2020; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016; Wiens et al., 2019; Zamora et al., 2021	4/10 Cui & Yang, 2022; Harvey et al., 2020; Pirchio et al., 2021; Sobko et al., 2020
	<b>Negative mood</b> "Winter is a hard time for me. (...) it's a time where everything slows down, and we can become isolated and lonely sometimes." Child in Hatala et al. (2020: p. 8)	6/11 Collado et al., 2016a; Hatala et al., 2020; Tillmann et al., 2019; Wiens et al., 2016; Wiens et al., 2019; Zamora et al., 2021	
	<b>Absence of negative mood</b> "Have you felt sad?" (Harvey et al., 2020)		4/10 Harvey et al., 2020; Piccininni et al., 2018; Sobko et al., 2018; Sobko et al., 2020;
	<b>Absence of anxiety</b> "I worry about the things I have to do" (Pirchio et al., 2021)		3/10 Piccininni et al., 2018; Pirchio et al., 2021; Sobko et al., 2018
	<b>Self-satisfaction</b> "On the whole, I am satisfied with myself." (Barton et al., 2016)		5/10 Barton et al., 2016; Bowers et al., 2021; Harvey et al., 2020; Pirchio et al., 2021; Whitten et al., 2018
<b>Social well-being</b>	<b>Empathy</b> "I am helpful if someone is hurt, upset, or feeling ill." (Whitten et al., 2018)		4/10 Bowers et al., 2021; Pirchio et al., 2021; Sobko et al., 2018; Whitten et al., 2018;
	<b>Social bonds</b> "In my family I feel useful and		4/10 Bowers et al., 2021; Galli et al.,

**Table 4 (continued)**

	Nature's impact on well-being	Qualitative studies	Quantitative studies
<b>Physical well-being</b>	important" (Bowers et al., 2021)		2016; Harvey et al., 2020; Sobko et al., 2020
	<b>Being active</b> "It's good because you get fresh air, and you get active." Child in Tillmann et al. (2019: p. 712) "Satisfied with health" (Galli et al., 2016), "Have you been physically active (e. g. running, climbing, biking)?" (Harvey et al., 2020)	5/11 Acton and Carter 2015; Moula et al., 2021; Tillmann et al., 2019; Wiens et al., 2016; Zamora et al., 2021	2/10 Galli et al., 2016; Harvey et al., 2020
	<b>Being less active</b> "Well, I do not know, I am tired and just want to lie under the blanket and watch television; just too lazy to do anything." (Wiens et al., 2016, p. 6)	1/11 Wiens et al. (2016)	
	<b>Restorative sleeping</b> "I woke up feeling fresh and rested" (Pirchio et al., 2021)		2/10 Piccininni et al., 2018; Pirchio et al., 2021;
	<b>Absence of Symptoms</b> "Headache" (Sobko et al., 2018)		1/10 Sobko et al. (2018)
	<b>Absence of Irritability</b> "Irritability or bad temper" (Piccininni et al., 2018)		3/10 Cui & Yang, 2022; Piccininni et al., 2018; Sobko et al., 2018

Note. Table includes 21 of the 23 analyzes articles. The categories include what the studies described as well-being aspects of nature connectedness. Our thematic analysis grouped the aspects into psychological, social and physical well-being and includes both positive and negative effects.

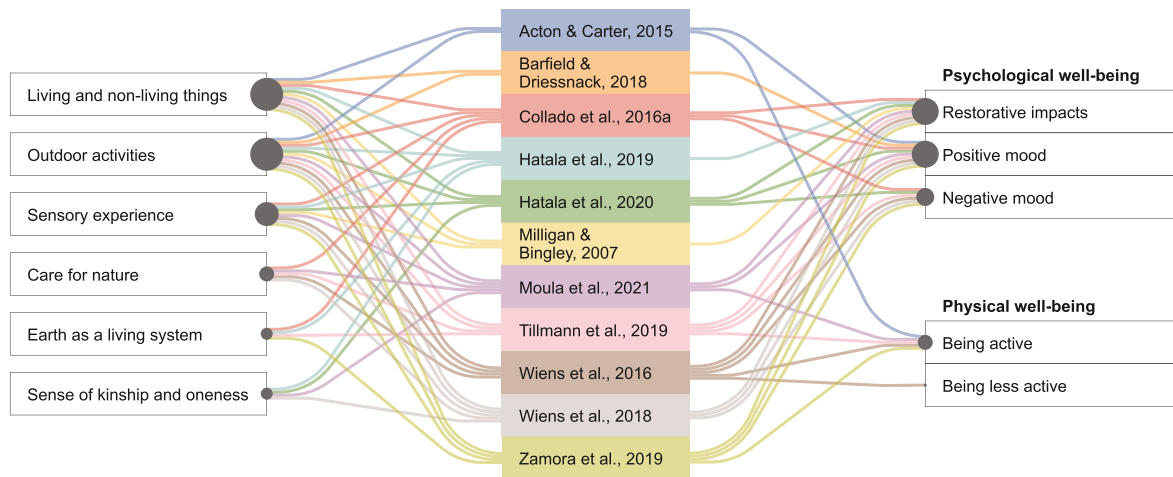
seek them out (Hatala et al., 2019, 2020; Milligan & Bingley, 2007; Wiens et al., 2016, 2018).

Quantitative articles included various measures of well-being and we found ten themes of well-being aspects from the studies. Only one theme, positive mood, was present in both qualitative and quantitative studies. However, the findings regarding well-being documented by qualitative and quantitative studies cannot be compared directly. Qualitative studies asked children to describe the effects of nature and thus children voiced immediate mood boosting effects. On the other hand, quantitative studies asked about children's well-being in general and then found correlation with nature connectedness. Thus, the quantitative findings suggest a general improvement in well-being as opposed to immediate effects of being in nature.

#### 4.3. The field of research on the well-being effects of nature connectedness

Finally, in this chapter we conclude the findings of the articles regarding the effects of nature connectedness on well-being, and more precisely what aspects of nature connectedness have been found to be related to various well-being effects. Both qualitative (Fig. 3) and





**Fig. 3.** The effects of nature connectedness on well-being in qualitative studies  
 Note. Summary of the interrelationships recognized in the analyzed qualitative studies (altogether 11 articles).

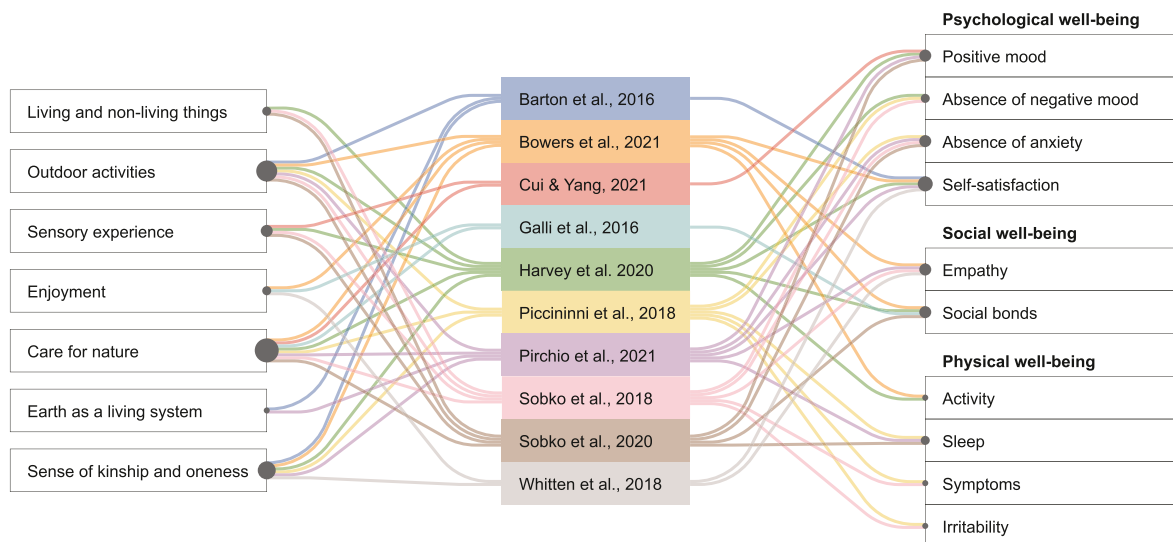
quantitative (Fig. 4) studies explored and described various effects of nature connectedness on children’s well-being.

In qualitative studies, children often described nature that increases their well-being in concrete terms, as items and entities that can be touched and smelled, but also as a system of living things that they feel being part of. In the articles it was clear that even young children were able to describe in detail their nature connection. Children voiced how nature inspires them to be physically active and how it boosts their mood. Children often emphasized how nature helps them to deal with negative emotions, as they also described how they actively utilize this well-being benefit. In many studies, children’s descriptions of well-being focused on immediate restorative effects of nature connectedness, like feeling better when spending time in nature.

In analyzed quantitative studies, various aspects of nature connectedness were found to have well-being effects. In most studies, the nature connectedness variable included care for nature, outdoor activities and a sense of oneness with nature. The different aspects of nature connectedness were found to correlate with well-being. Furthermore, a wide range of well-being effects of nature connectedness were found in quantitative studies, covering psychological, social and physical well-being effects.

The quantitative studies included many of the same nature

connectedness themes that children described in qualitative studies. However, it is worth noticing that the questionnaires focused on a specific aspect of nature connectedness at a time and, thus, they were able to cover only certain themes voiced by children. Regarding well-being effects, more themes were present in the quantitative studies than in qualitative ones. This is because the quantitative studies were investigating the effects of nature connectedness on more focused aspects of well-being. Furthermore, the quantitative studies measured different types of well-being effects, including the effects on more stable states of well-being, in addition to the immediate aspects that were recognized in the qualitative studies. For example, the quantitative studies found that children’s nature connectedness was related to their improved self-satisfaction, which would be difficult for children to describe themselves. Further, the reviewed quantitative studies did not explore the restorative effects of nature connectedness in children. However, nature’s stress relieving impacts have been studied (for example Wells et al., 2003; Corraliza et al., 2011; Shuda et al., 2020), but the studies did not emerge from our search terms, possibly because they did not specifically look at nature connectedness, but rather the more direct experience of nature or outdoor activity.



**Fig. 4.** The effects of nature connectedness on well-being in quantitative studies  
 Note. Summary of the interrelationships recognized in the analyzed quantitative studies (altogether 10 articles).

#### 4.4. Future research needs

The analyzed studies acknowledged many important future research needs. On one hand, the qualitative articles called for more voice for children to describe how nature connectedness impacts their well-being, and on the other hand, the quantitative articles called for more longitudinal studies to determine the mechanisms of health and well-being benefits of nature connection.

Building on the strength of qualitative approaches in understanding meanings and interpretations, future qualitative research should further explore how children perceive, understand, and conceptualize their nature connectedness and its well-being benefits. Such child-centered research would also importantly enable children's agency by allowing children to voice their understanding of how and why nature is beneficial to their well-being (Collado et al., 2016a; Tillmann et al., 2019).

Moreover, building on the strength of quantitative studies to measure and compare variation, for example, between various settings and population groups, future quantitative research should investigate whether there is a critical period during childhood for the strengthening of nature connection (Cui & Yang, 2022; Windhorst & Williams, 2015), how much time one needs to spend playing outdoors to achieve mental health and well-being benefits (Cui & Yang, 2022; Piccininni et al., 2018) and how important individual differences are in achieving those benefits (Harvey et al., 2020; Windhorst & Williams, 2015). In our data, most quantitative studies focused on middle-class urban families, mostly in Europe and North America, and there were no studies comparing the experiences of children in different situations. To test, verify and generalize the existing results and interpretations, the future research should be extended to children with different socioeconomic backgrounds (Bowers et al., 2021; Cui & Yang, 2022; Whitten et al., 2018; Wood & Smyth, 2020) with different genders, in good (and poor) physical condition (Piccininni et al., 2018), especially in comparative research settings. The qualitative articles suggest that children from different backgrounds experience the benefits of nature connectedness similarly, but this remains to be explored quantitatively in comparative settings. In the same vein, more research is needed on adolescents who have lower self-esteem or mental health issues, as they could have higher potential for increase in well-being from strengthening nature connectedness (Barton et al., 2016). It also remains unclear why gender differences occur (Piccininni et al., 2018) and, thus, future research is needed to explore whether children's individual experiences or different socio-psychological and cultural reasons explain the differences.

Furthermore, more research is needed to understand well-being differences and inequalities between children from different cultural and social backgrounds, such as indigenous children or children living in urban or rural areas (Hatala et al., 2019, 2020; Moula et al., 2021; Wiens et al., 2016, 2019). In order to understand what well-being effects of nature connectedness mean to children in different cultural contexts, it is essential to investigate in more detail how children perceive and experience nature, their connectedness to it and the ways it affects their well-being. This could be achieved by using qualitative research methods, such as photo-elicitation, photovoice, and 'draw and tell' and focus group discussions or observations, that would allow for more profound descriptions (Wiens et al., 2016).

The development of more holistic nature connectedness scales should be sensitive for children's own descriptions of nature perceptions, to diversity of nature in local contexts and various ages of children. Often research contexts, scales, indexes and what is meant by "nature" have largely been defined by adults. In terms of research designs, there is a call for more interdisciplinary research, for example, incorporating child psychology and environmental health, and for acknowledging diversity in the study design and test whether measures of well-being are valid for diverse groups of participants (Bowers et al., 2021). Furthermore, while the correlation between nature connectedness and well-being was clear in almost all included studies, the studies did not confirm causation. This, in turn, encourages the further

development of research designs towards, for example, longitudinal studies (Bowers et al., 2021; Cui & Yang, 2022; Windhorst & Williams, 2015) looking at causation and comparative studies testing different factors explaining the correlation.

Finally, children's agency could be further promoted in future research by applying participatory research approaches that would include children in all steps of the research process, including the formulation of the research objectives, operationalizing them and participating in data gathering. The findings of such research practices would probably better reflect the understandings, perceptions, experiences and emotions of children. Furthermore, such transdisciplinary research approaches form promising pathways to empower children and to co-create operationalizations meaningful to both children and researchers. These approaches also, accordingly, widen the understanding of complex phenomenon at the intersection of objective and subjective well-being research. An aim for better inclusion of children's voices and perspectives in research relevant for their well-being, is in line with the [UN Convention on the Rights of the Child \(1989\)](#) proclaiming that children have the right to express their views in all matters that affect them (Article 12).

## 5. Discussion

Our systematic analysis of recent scientific literature has shown that nature connectedness supports children's well-being in diverse ways. The review covered both qualitative and quantitative studies, which explored and analyzed numerous aspects relevant to nature connectedness and well-being and broadened the recognition of important and interrelated aspects of both. Thus, the review creates considerable ground for understanding this emerging research field.

The quantitative studies show how specific pre-defined aspects of nature connectedness are decreasing psychosomatic symptoms (Piccininni et al., 2018) and increasing self-satisfaction and pro-social behavior (Whitten et al., 2018) as well as positive mood (Harvey et al., 2020). In turn, in qualitative studies that did not look for the well-being effects of nature specifically, children themselves recognized how nature increases their well-being. In these studies children gave a rich view on how, for example, trees (Moula et al., 2021), mountains, birds, swimming, building sandcastles and fishing (Barfield & Driessnack, 2018), increase their happiness. And vice versa when describing nature, children spontaneously described how they feel happy in nature, and how they can capitalize on this knowledge in to increase their well-being when needed (Tillmann et al., 2019).

In other words, the qualitative research has illustrated how even young children can describe many different and essential aspects of both their nature connectedness and the benefits they gain from it. Furthermore, children are also active and capable in creating their nature connectedness and seeking out nature's benefits to them (Tillmann et al., 2019). Since children are actively forming their relationship with nature and are active in seeking the benefits of that connection, research on nature connectedness should be able to acknowledge and enable such agency. On the other hand, quantitative studies can also enrich the view of well-being impacts of nature connectedness. We found that quantitative studies measured different aspects of well-being than those that children themselves described. For example, self-satisfaction was not expressed by children in the analyzed qualitative studies, but it was found to correlate with nature connectedness in the quantitative studies (Whitten et al., 2018).

Children describe their relationship with nature as a complex phenomenon. Even though such complexity is difficult to approach in quantitative surveys, these descriptions should be better recognized also in quantitative research designs, in order to better capture how children themselves understand the connection. As Tam (2013) proposes, connection to nature is comprised of multiple dimensions and different scales emphasize different concepts. Thus, the key elements and scales of how children themselves perceive, understand and describe nature

connections should be better integrated in the pre-defined nature connectedness scales. Yet, the articles included in our review use mostly pre-defined scales that have been defined based on adults' perspective and tested with adults. One important exception here was CNI scale (Cheng & Monroe, 2012), which has been developed for children and, accordingly, it seems to better reflect children's viewpoints. It is important to consider which scale is appropriate for what ages, as children might struggle to understand the concepts included in the scales created for adults (Bragg et al., 2013). Furthermore, the usability of the scales in various social, cultural and environmental contexts need to be considered (Salazar et al., 2020).

The complexity of both nature connectedness and well-being measurements described in this article reflect the notion that the entire field of study exists in the intersection of two research traditions: On one hand, the research on various aspects of children's relationship with nature has a long history, exploring various aspects of children's nature experience, including nature connectedness, biophilia, affinity with nature and eco-awareness (Chawla, 2020). On the other hand, also children's well-being has been studied widely (Ben-Arieh et al., 2014; Fattore et al., 2019; Raghavan & Alexandrova, 2015). As a result, the research paradigms of these two traditions meet in the analyzed studies, looking at the phenomenon from different angles, contrasting and complementing each other. Thus, in order to further develop the emerging field, there is a need for more systematic conceptual and empirical research on the mechanisms and processes of how exactly nature connectedness affects well-being. We need to better understand what aspects of nature connectedness build certain types of children's well-being in order to support and cultivate both children's well-being and nature connectedness. Towards this aim, the research field would benefit from critical evaluation of methodology and systematical development of empirical studies. More longitudinal, comparative and participatory research is needed to investigate the mechanism behind the well-being effects of nature connectedness in children. Future research should aim for generalizable results and account for a broader set of variants, such as socio-economic factors, age, gender, culture and types of surrounding environment.

It is crucial that future research accounts for the complexity of children's ways to connect with nature, which also includes its possible negative aspects. Chawla (2020) argues that children's fear and worries about environmental risks and degradation also express a sense of nature connection and that nature connection has thus two facets: a positive and a painful one. From the analyzed articles, some included the negative well-being aspects nature can have, for example during wintertime (Hatala et al., 2020; Wiens et al., 2016, 2018). Still only Collado et al. (2016a) showed how degradation of nature negatively affects children's mental well-being. While children's worry over climate change (Marks et al., 2021) and the negative effects of environmental crises on children (e.g., Cunsolo & Ellis, 2018; IPCC, 2022; Kowalski 2019) are increasingly researched, more research is still needed to explore how connecting with nature relates to these issues.

The key limitations of this systematic review are related to the dominance of the Global North and Western research among the analyzed studies. Firstly, the database search included only articles written in English, which remarkably limits the geographical diversity of the included articles, and accordingly research in the Global South was almost completely missing from the articles we reviewed. In the future reviews it should be explored in more detail, whether this was a question of language barrier or if it reflects the notion that the phenomenon has been primarily emphasized in the Global North. Secondly, the analyzed articles only limitedly acknowledged and covered the various socio-demographic and cultural backgrounds of children. Thus, to provide a more diverse look into the field, future reviews could actively target different languages, cultures and socio-demographic groups. For example, children from Global South, immigrant children, refugee children, children with disabilities, children from low-income families, and children of different genders should be better acknowledged and

empowered to participate in research. A potential limitation is related to the screening process of search results, as the articles were divided between three researchers, and each implemented pre-defined and deliberated exclusion criteria individually. However, if a researcher was unclear whether to include an article or not, these cases were cross-checked by the other researchers for reliability of the process.

## 6. Conclusion

In this systematic review, we analyzed how the impacts of children's nature connectedness on their well-being have been conceptualized, operationalized, explored, and measured in the scientific articles published during the last two decades. All analyzed studies showed the positive effects of nature connectedness on well-being. The qualitative studies gave voice to children to define nature and describe their understanding of and perceptions on the impacts of nature on their well-being, and the quantitative studies measured and showed the positive effects of nature connectedness on well-being using the pre-defined nature connectedness scales. Current research has focused on investigating the correlation between specific well-being effects and nature connectedness. However, there is currently no coherent theory of the mechanism of how nature connectedness affects well-being. This is in part due to the complexity of both nature connectedness and children's well-being and especially the interaction of the two.

This review has provided a synthesis of studies describing the positive well-being effects of nature connectedness. Based on the review, it is evident that there is a correlation between nature connectedness and well-being. But as the methods used are diverse and empirical foci still limited, further research is needed especially regarding how and why children's social and cultural backgrounds, including for example, race, gender, family income, affect the impacts of nature connectedness on well-being as well as how the building of strong nature connectedness could be supported by improving the availability and accessibility of nature in children's living environments.

These findings encourage further development of the research field by diversifying research approaches through longitudinal, comparative and participatory research approaches and by enabling more systematic research in the field, for example, through development of child-centered measurement scales for nature connectedness. Finally, in future research children's agency should be strengthened, covering both research design, i.e., engaging children to describe their perspectives and perceptions on the nature connectedness, but also research impact, i.e., integrating children's perspectives into policies and programs.

## CRediT authorship contribution statement

**Terhi Arola:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Marianne Aulake:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **Anna Ott:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Matti Lindholm:** Data curation, Visualization. **Petra Kouvonen:** Conceptualization. **Petri Virtanen:** Conceptualization. **Riikka Paloniemi:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition.

## Acknowledgements

The authors disclose receipt of the following financial support for the research of this article: This work was supported by Iita Children's Foundation, Alli Paasikivi Foundation, and the HERA project (funded by Horizon 2020 [grant number 825417]). The authors declare that there is no conflict of interest. A special thanks to Simo Riikonen for help with the database searches.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jenvp.2022.101913>.

## References

Articles included in the literature review marked with an asterisk.

- \* Acton, J., & Carter, B. (2016). The impact of immersive outdoor activities in local woodlands on young carers emotional literacy and well-being. *Comprehensive Child and Adolescent Nursing-Building Evidence for Practice*, 39(2), 94–106. <https://doi.org/10.3109/01460862.2015.1115156>.
- \* Adams, D., & Beauchamp, G. (2019). Spiritual moments making music in nature. A study exploring the experiences of children making music outdoors, surrounded by nature. *International Journal of Children's Spirituality*, 24(3), 260–275. <https://doi.org/10.1080/1364436x.2019.1646220>.
- \* Ashbully, K. J., Pahl, S., Webley, P., & White, M. P. (2013). The beach as a setting for families' health promotion: A qualitative study with parents and children living in coastal regions in southwest England. *Health & Place*, 23, 138–147. <https://doi.org/10.1016/j.healthplace.2013.06.005>.
- \* Barfield, P. A., & Driessnack, M. (2018). Children with ADHD draw-and-tell about what makes their life really good. *Journal for Specialists in Pediatric Nursing*, 23(2), 7. <https://doi.org/10.1111/jspn.12210>.
- \* Barrera-Hernandez, L. F., Sotelo-Castillo, M. A., Echeverria-Castro, S. B., & Tapia-Fonllem, C. O. (2020). Connectedness to nature: Its impact on sustainable behaviors and happiness in children. *Frontiers in Psychology*, 11, 7. <https://doi.org/10.3389/fpsyg.2020.00276>.
- \* Barton, J., Bragg, R., Pretty, J., Roberts, J., & Wood, C. (2016). The wilderness expedition: An effective life course intervention to improve young people's well-being and connectedness to nature. *Journal of Experiential Education*, 39(1), 59–72. <https://doi.org/10.1177/1053825915626933>.
- Ben-Arieh, A., Casas, F., Frønes, I., & Korbin, J. E. (2014). Multifaceted concept of child well-being. In A. Ben-Arieh, F. Casas, I. Frønes, & J. Korbin (Eds.), *Handbook of child well-being*. Dordrecht: Springer. [https://doi.org/10.1007/978-90-481-9063-8\\_134](https://doi.org/10.1007/978-90-481-9063-8_134).
- \* von Benzon, N. (2017). Unruly children in unbounded spaces: School-based nature experiences for urban learning disabled young people in Greater Manchester, UK. *Journal of Rural Studies*, 51, 240–250. <https://doi.org/10.1016/j.jrurstud.2016.07.018>.
- \* Bowers, E. P., Larson, L. R., & Parry, B. J. (2021). Nature as an ecological asset for positive youth development: Empirical evidence from rural communities. *Frontiers in Psychology*, 12, 15. <https://doi.org/10.3389/fpsyg.2021.688574>.
- Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, 10(1), 456. <https://doi.org/10.1186/1471-2458-10-456>.
- Bragg, R., Wood, C., Barton, J., & Pretty, J. (2013). *Measuring connection to nature in children aged 8–12: A robust methodology for the RSPB*. Sandy, UK: RSPB. <https://www.rspb.org.uk/globalassets/downloads/documents/positions/education/measuring-connection-to-nature-in-children-aged-8-12-methodology.pdf>.
- \* Bystrom, K., Grahn, P., & Hagerhall, C. (2019). Vitality from experiences in nature and contact with animals—A way to develop joint attention and social engagement in children with autism? *International Journal of Environmental Research and Public Health*, 16(23), 36. <https://doi.org/10.3390/ijerph16234673>.
- Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: A meta-analysis. *Frontiers in Psychology*, 5. <https://doi.org/10.3389/fpsyg.2014.00976>.
- Cervinka, R., Röderer, K., & Hefler, E. (2012). Are nature lovers happy? On various indicators of well-being and connectedness with nature. *Journal of Health Psychology*, 17(3), 379–388. <https://doi.org/10.1177/1359105311416873>.
- \* Chang, Y. Y., Su, W. C., Tang, I. C., & Chang, C. Y. (2016). Exploring the benefits of school gardening for children in taiwan and identifying the factors influencing these benefits. *HortTechnology*, 26(6), 783–792. <https://doi.org/10.21273/horttech03074-16>.
- Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*, 2, 619–642. <https://doi.org/10.1002/pan3.10128>.
- Cheng, J. C.-H., & Monroe, M. C. (2012). Connection to nature: Children's affective attitude toward nature. *Environment and Behavior*, 44(1), 31–49. <https://doi.org/10.1177/0013916510385082>.
- \* Collado, S., Iniguez-Rueda, L., & Corraliza, J. A. (2016a). Experiencing nature and children's conceptualizations of the natural world. *Children's Geographies*, 14(6), 716–730. <https://doi.org/10.1080/14733285.2016.1190812>.
- \* Collado, S., Staats, H., & Sorrel, M. A. (2016b). Helping out on the land: Effects of children's role in agriculture on reported psychological restoration. *Journal of Environmental Psychology*, 45, 201–209. <https://doi.org/10.1016/j.jenvp.2016.01.005>.
- Corraliza, J. A., & Collado, S. (2011). La naturaleza cercana como moderadora del estrés infantil [Nearby nature as a moderator of stress during childhood]. *Apr Psicothema*, 23(2), 221–226. Spanish. PMID: 21504673.
- Cui, W., & Yang, Z. (2022). Association between connection to nature and children's happiness in China: Children's negative affectivity and gender as moderators. *Journal of Happiness Studies*, 23(1), 47–63. <https://doi.org/10.1007/s10902-021-00386-1>.
- Cunsolo, A., & Ellis, N. R. (2018). Ecological grief as a mental health response to climate change-related loss. *Nature Climate Change*, 8(4), 275–281. <https://doi.org/10.1038/s41558-018-0092-2>.
- Fattore, T., Fegter, S., & Hunner-Kreisel, C. (2019). Children's understandings of well-being in global and local contexts: Theoretical and methodological considerations for a multinational qualitative study. *Child Indicators Research*, 12(2), 385–407. <https://doi.org/10.1007/s12187-018-9594-8>.
- \* Fretwell, K., & Greig, A. (2019). Towards a better understanding of the relationship between individual's self-reported connection to nature, personal well-being and environmental awareness. *Sustainability*, 11(5), 21. <https://doi.org/10.3390/su11051386>.
- Fyfe-Johnson, A. L., Hazlehurst, M. F., Perrins, S. P., Bratman, G. N., Thomas, R., Garrett, K. A., ... Tandon, P. S. (2021). Nature and children's health: A systematic review. *Pediatrics*, 148(4). <https://doi.org/10.1542/peds.2020-049155>.
- \* Galli, F., Castellá-Sarriera, J., & Bedin, L. (2016). Childhood, environment and subjective well-being/Infancia, ambiente y bienestar subjetivo. *Psycology*, 7(2), 130–151. <https://doi.org/10.1080/2171976.2016.1138666>.
- \* Harvey, D. J., Montgomery, L. N., Harvey, H., Hall, F., Gange, A. C., & Watling, D. (2020). Psychological benefits of a biodiversity-focused outdoor learning program for primary school children. *Journal of Environmental Psychology*, 67, 8. <https://doi.org/10.1016/j.jenvp.2019.101381>.
- \* Hatala, A. R., Morton, D., Njeze, C., Bird-Naytowhow, K., & Pearl, T. (2019). Re-imagining miyo-wicetowin: Human-nature relations, land-making, and wellness among Indigenous youth in a Canadian urban context. *Social Science & Medicine*, 230, 122–130. <https://doi.org/10.1016/j.socscimed.2019.04.012>.
- \* Hatala, A. R., Njeze, C., Morton, D., Pearl, T., & Bird-Naytowhow, K. (2020). Land and nature as sources of health and resilience among indigenous youth in an urban Canadian context: A photovoice exploration. *BMC Public Health*, 20(1), 14. <https://doi.org/10.1186/s12889-020-08647-z>.
- \* Hinds, J. (2011). Woodland adventure for marginalized adolescents: Environmental attitudes, identity and competence. *Applied Environmental Education and Communication*, 10(4), 228–237. <https://doi.org/10.1080/1533015X.2011.669689>.
- Howell, A. J., Dopko, R. L., Passmore, H.-A., & Buro, K. (2011). Nature connectedness: Associations with well-being and mindfulness. *Personality and Individual Differences*, 51(2), 166–171. <https://doi.org/10.1016/j.paid.2011.03.037>.
- \* Huynh, Q., Craig, W., Janssen, I., & Pickett, W. (2013). Exposure to public natural space as a protective factor for emotional well-being among young people in Canada. *BMC Public Health*, 13, 14. <https://doi.org/10.1186/1471-2458-13-407>.
- Jackson, S. B., Stevenson, K. T., Larson, L. R., Peterson, M. N., & Seekamp, E. (2021). Outdoor activity participation improves adolescents' mental health and well-being during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, 18(5), 2506. <https://doi.org/10.3390/ijerph18052506>.
- Johnson, N. M., Hoffmann, A. R., Behlen, J. C., Lau, C., Pendleton, D., Harvey, N., Shore, R., Li, Y., Chen, J., Tian, Y., & Zhang, R. (2021). Air pollution and children's health—a review of adverse effects associated with prenatal exposure from fine to ultrafine particulate matter. *Environmental Health and Preventive Medicine*, 26(1), 72. <https://doi.org/10.1186/s12199-021-00995-5>.
- \* Kalashnikova, I. V., Gontar, O. B., Zhirova, V. K., & Kalashnikov, A. O. (2016). Integrated animal-assisted and plant-assisted ecotherapy for preschool children with speech disturbances: A program for the arctic. *Ecopsychology*, 8(2), 79–88. <https://doi.org/10.1089/eco.2016.0002>.
- Kaplan Mintz, K., Ayalon, O., Nathan, O., & Eshet, T. (2021). See or Be? Contact with nature and well-being during COVID-19 lockdown. *Journal of Environmental Psychology*, 78, Article 101714. <https://doi.org/10.1016/j.jenvp.2021.101714>.
- Kowalski, K. (2019). Climate change poses mental health risks to children and teens. *Health Med*. <https://www.sciencenewsforstudents.org/article/climate-change-poses-mental-health-risks-children-and-teens>.
- Lehtimäki, J., Karkman, A., Laatikainen, T., Paalanen, L., von Hertzen, L., Haahtela, T., ... Ruokolainen, L. (2017). Patterns in the skin microbiota differ in children and teenagers between rural and urban environments. *Scientific Reports*, 7(1), Article 45651. <https://doi.org/10.1038/srep45651>.
- \* Li, D. Y., Deal, B., Zhou, X. L., Slavenas, M., & Sullivan, W. C. (2018). Moving beyond the neighborhood: Daily exposure to nature and adolescents' mood. *Landscape and Urban Planning*, 173, 33–43. <https://doi.org/10.1016/j.landurbplan.2018.01.009>.
- \* Lindemann-Matthies, P., Benkowitz, D., & Hellinger, F. (2021). Associations between the naturalness of window and interior classroom views, subjective well-being of primary school children and their performance in an attention and concentration test. *Landscape and Urban Planning*, 214, 9. <https://doi.org/10.1016/j.landurbplan.2021.104146>.
- Marks, E., Hickman, C., Pihkala, P., Clayton, S., Lewandowski, E. R., Mayall, E. E., Wray, B., Mellor, C., & van Susteren, L. (2021). Young people's voices on climate anxiety, government betrayal and moral injury: A global phenomenon. <https://doi.org/10.2139/ssrn.3918955>.
- Martin, L., White, M. P., 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, Article 101389. <https://doi.org/10.1016/j.jenvp.2020.101389>.
- Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, 24(4), 503–515. <https://doi.org/10.1016/j.jenvp.2004.10.001>.
- \* Milligan, C., & Bingley, A. (2007). Restorative places or scary spaces? The impact of woodland on the mental well-being of young adults. *Health & Place*, 13(4), 799–811. <https://doi.org/10.1016/j.healthplace.2007.01.005>.
- \* Moore, A., & Lynch, H. (2018). Understanding a child's conceptualisation of well-being through an exploration of happiness: The centrality of play, people and place.

- Journal of Occupational Science*, 25(1), 124–141. <https://doi.org/10.1080/14427591.2017.1377105>.
- \* Moola, Z., Walshe, N., & Lee, E. (2021). Making nature explicit in children's drawings of wellbeing and happy spaces. *Child Indicators Research*, 14(4), 1653–1675. <https://doi.org/10.1007/s12187-021-09811-6>.
- Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bolling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for children and adolescents: A systematic review and quality assessment of the evidence. *Health & Place*, 58, Article 102136. <https://doi.org/10.1016/j.healthplace.2019.05.014>
- \* Nagata, M., & Liehr, P. (2021). Urban children's well-being factors and qualities of being and doing in natural space: Nature immersion. *Journal of Holistic Nursing*, 39(2), 174–184. <https://doi.org/10.1177/0898010120961624>.
- Nisbet, E., & Zelenski, J. (2013). The NR-6: A new brief measure of nature relatedness. *Frontiers in Psychology*, 4. <https://doi.org/10.3389/fpsyg.2013.00813>
- 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. <https://doi.org/10.1177/0013916508318748>
- Norwood, M. F., Lakhani, A., Fullagar, S., Matujean, A., Downes, M., Byrne, J., Stewart, A., Barber, B., & Kendall, E. (2019). A narrative and systematic review of the behavioural, cognitive and emotional effects of passive nature exposure on young people: Evidence for prescribing change. *Landscape and Urban Planning*, 189, 71–79. <https://doi.org/10.1016/j.landurbplan.2019.04.007>
- \* Pearson, M., Gaines, K., Pati, D., Colwell, M., Motheral, L., & Adams, N. G. (2019). The physiological impact of window murals on pediatric patients. *Herd-Health Environments Research & Design Journal*, 12(2), 116–129. <https://doi.org/10.1177/1937586718800483>.
- \* Piccininni, C., Michaelson, V., Janssen, I., & Pickett, W. (2018). Outdoor play and nature connectedness as potential correlates of internalized mental health symptoms among Canadian adolescents. *Preventive Medicine*, 112, 168–175. <https://doi.org/10.1016/j.ypmed.2018.04.020>.
- \* Pirchio, S., Passiatore, Y., Panno, A., Cipparone, M., & Carrus, G. (2021). The effects of contact with nature during outdoor environmental education on students' wellbeing, connectedness to nature and pro-sociality. *Frontiers in Psychology*, 12, 9. <https://doi.org/10.3389/fpsyg.2021.648458>.
- \* Pollin, S., & Retzlaff-Furst, C. (2021). The school garden: A social and emotional place. *Frontiers in Psychology*, 12, 11. <https://doi.org/10.3389/fpsyg.2021.567720>.
- IPCC. (2022). In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Lösche, V. Möller, A. Okem, & B. Rama (Eds.), *Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change*. Cambridge University Press (in press) <https://www.ipcc.ch/report/ar6/wg2/>.
- Pritchard, A., Richardson, M., Sheffield, D., & McEwan, K. (2020). The relationship between nature connectedness and eudaimonic well-being: A meta-analysis. *Journal of Happiness Studies*, 21(3), 1145–1167. <https://doi.org/10.1007/s10902-019-00118-6>
- \* Prokop, P., & Kubiak, M. (2014). Perceived vulnerability to disease predicts environmental attitudes. *Eurasia Journal of Mathematics, Science and Technology Education*, 10(1), 3–11. <https://doi.org/10.12973/eurasia.2014.1017a>.
- Prunicki, M., Cauwenberghs, N., Lee, J., Zhou, X., Movassagh, H., Noth, E., Lurmann, F., Hammond, S. K., Balmes, J. R., Desai, M., Wu, J. C., & Nadeau, K. C. (2021). Air pollution exposure is linked with methylation of immunoregulatory genes, altered immune cell profiles, and increased blood pressure in children. *Scientific Reports*, 11(1), 4067. <https://doi.org/10.1038/s41598-021-83577-3>
- Raghavan, R., & Alexandrova, A. (2015). Toward a theory of child well-being. *Social Indicators Research*, 121(3), 887–902. <https://doi.org/10.1007/s11205-014-0665-z>
- \* Readdick, C. A., & Schaller, G. R. (2005). Summer camp and self-esteem of school-age inner-city children. *Perceptual & Motor Skills*, 101(1), 121–130. <https://doi.org/10.2466/pms.101.5.121-130>.
- \* Reeve, A., Nieberler-Walker, K., & Desha, C. (2017). Healing gardens in children's hospitals: Reflections on benefits, preferences and design from visitors' books. *Urban Forestry and Urban Greening*, 26, 48–56. <https://doi.org/10.1016/j.ufug.2017.05.013>.
- Ribeiro, A. I., Triguero-Mas, M., Jardim Santos, C., Gómez-Nieto, A., Cole, H., Angelovski, I., Silva, F. M., & Baró, F. (2021). Exposure to nature and mental health outcomes during COVID-19 lockdown. A comparison between Portugal and Spain. *Environment International*, 154, Article 106664. <https://doi.org/10.1016/j.envint.2021.106664>
- Roslund, M. I., Puhakka, R., Grönroos, M., Nurminen, N., Oikarinen, S., Gazali, A. M., Cinek, O., Kramná, L., Siter, N., Vari, H. K., Soininen, L., Parajuli, A., Rajaniemi, J., Kinnunen, T., Laitinen, O. H., Hyöty, H., & Sinkkonen, A. (2020). Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. *Science Advances*, 6(42). <https://doi.org/10.1126/sciadv.aba2578>
- Ruokolainen, L., von Hertzen, L., Fyhrquist, N., Laatikainen, T., Lehtomäki, J., Auvinen, P., Karvonen, A. M., Hyvärinen, A., Tillmann, V., Niemelä, O., Knip, M., Haahtela, T., Pekkanen, J., & Hanski, I. (2015). Green areas around homes reduce atopic sensitization in children. *Allergy*, 70(2), 195–202. <https://doi.org/10.1111/all.12545>
- \* Sahni, P., & Kumar, J. (2021). Exploring the relationship of human-nature interaction and mindfulness: A cross-sectional study. *Mental Health, Religion & Culture*, 24(5), 450–462. <https://doi.org/10.1080/13674676.2021.1890704>.
- Salazar, G., Kunkle, K., & Monroe, M. C. (2020). *Practitioner guide to assessing connection to nature*. Washington, DC: North American Association for Environmental Education.
- Samuelsson, K., Barthel, S., Giusti, M., & Hartig, T. (2021). Visiting nearby natural settings supported wellbeing during Sweden's "soft-touch" pandemic restrictions. *Landscape and Urban Planning*, 214, Article 104176. <https://doi.org/10.1016/j.landurbplan.2021.104176>
- Schultz, P. (2001). The structure of environmental concern: Concern for self, other people, and the biosphere. *Journal of Environmental Psychology*, 21, 327–339. <https://doi.org/10.1006/jevp.2001.0227>
- \* Sedawi, W., Assaraf, O. B., & Reiss, M. J. (2020). Indigenous children's connectedness to nature: The potential influence of culture, gender and exposure to a contaminated environment. *Cultural Studies of Science Education*, 15(4), 955–989. <https://doi.org/10.1007/s11422-020-09982-8>.
- Shuda, Q., Bougoulas, M. E., & Kass, R. (2020). Effect of nature exposure on perceived and physiologic stress: A systematic review. *Complementary Therapies in Medicine*, 53. <https://doi.org/10.1016/j.ctim.2020.102514>
- \* Sobko, T., Jia, Z., & Brown, G. (2018). Measuring connectedness to nature in preschool children in an urban setting and its relation to psychological functioning. *PLoS One*, 13(11), Article e0207057. <https://doi.org/10.1371/journal.pone.0207057>.
- \* 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). <https://doi.org/10.1038/s41598-020-78642-2>.
- \* Spiegel, S. J., Thomas, S., O'Neill, K., Brondgeest, C., Thomas, J., Beltran, J., Hunt, T., & Yassi, A. (2020). Visual storytelling, intergenerational environmental justice and indigenous sovereignty: Exploring images and stories amid a contested oil pipeline project. *International Journal of Environmental Research and Public Health*, 17(7), 20. <https://doi.org/10.3390/ijerph17072362>.
- \* Strife, S. (2008). Growing up in an environmental justice context: Children's environmental concerns. *Environmental Justice*, 1(4), 217–224. <https://doi.org/10.1089/env.2008.0520>.
- \* Sugiyama, N., Hosaka, T., Takagi, E., & Numata, S. (2021). How do childhood nature experiences and negative emotions towards nature influence preferences for outdoor activity among young adults?. *Landscape and Urban Planning*, 205, 7. <https://doi.org/10.1016/j.landurbplan.2020.103971>.
- Tam, K.-P. (2013). Concepts and measures related to connection to nature: Similarities and differences. *Journal of Environmental Psychology*, 34, 64–78. <https://doi.org/10.1016/j.jenvp.2013.01.004>
- Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environment Science Technology*, 45(5), 1761–1772. <https://doi.org/10.1021/es102947t>
- \* Tillmann, S., Button, B., Coen, S. E., & Gilliland, J. A. (2019). 'Nature makes people happy, that's what it sort of means': children's definitions and perceptions of nature in rural Northwestern Ontario. *Children's Geographies*, 17(6), 705–718. <https://doi.org/10.1080/14733285.2018.1550572>.
- Tillmann, S., Tobin, D., Avison, W., & Gilliland, J. (2018). Mental health benefits of interactions with nature in children and teenagers: A systematic review. *Journal of Epidemiology & Community Health*, 72(10), 958–966. <https://doi.org/10.1136/jech-2018-210436>
- Tomasso, L. P., Yin, J., Cedeño Laurent, J. G., Chen, J. T., Catalano, P. J., & Spengler, J. D. (2021). The relationship between nature deprivation and individual wellbeing across urban gradients under COVID-19. *International Journal of Environmental Research and Public Health*, 18(4), 1511. <https://doi.org/10.3390/ijerph18041511>
- UN Convention on the Rights of the Child. (1989). Nov. 20 <https://www.ohchr.org/en/professionalinterest/pages/crc.aspx>.
- Victor, L. (2008). Systematic reviewing in the social sciences: Outcomes and explanation. *Enquire*, 1(1), 1–12. <https://www.nottingham.ac.uk/sociology/documents/enquire/volume-1-issue-1-victor.pdf>.
- \* Waite, S., Goodenough, A., Norris, V., & Puttick, N. (2016). From little acorns.: Environmental action as a source of well-being for schoolchildren. *Pastoral Care in Education*, 34(1), 43–61. <https://doi.org/10.1080/02643944.2015.1119879>.
- \* Ward, T., Goldingay, S., & Parson, J. (2019). Evaluating a supported nature play programme, parents' perspectives. *Early Child Development and Care*, 189(2), 270–283. <https://doi.org/10.1080/03004430.2017.1317764>.
- Wells, N. M., & Evans, G. W. (2003). Nearby nature: A buffer of life stress among rural children. *Environment and Behavior*, 35(3), 311–330. <https://doi.org/10.1177/0013916503035003001>
- \* Whitten, T., Stevens, R., Ructtinger, L., Tzoumakis, S., Green, M. J., Laurens, K. R., Holbrook, A., & Carr, V. J. (2018). Connection to the natural environment and well-being in middle childhood. *Ecopsychology*, 10(4), 270–279. <https://doi.org/10.1089/eco.2018.0010>.
- \* Wiens, V., Kyngäs, H., & Pölkki, T. (2016). The meaning of seasonal changes, nature, and animals for adolescent girls' wellbeing in northern Finland: A qualitative descriptive study. *International Journal of Qualitative Studies on Health and Well-Being*, 11(1), Article 30160. <https://doi.org/10.3402/qhw.v11.30160>.
- \* Wiens, V., Kyngäs, H., & Pölkki, T. (2019). Insight from focus group interviews: Adolescent girls' well-being in relation to experiences of winter, nature and seasonal changes in northern Finland. *Scandinavian Journal of Caring Sciences*, 33(4), 969–977. <https://doi.org/10.1111/scs.12695>.

- \* Windhorst, E., & Williams, A. (2015). Growing up, naturally: The mental health legacy of early nature affiliation. *Ecopsychology*, 7(3), 115–125. <https://doi.org/10.1089/eco.2015.0040>.
- \* 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>.
- \* Zamora, A. N., Waselewski, M. E., Frank, A. J., Nawrocki, J. R., Hanson, A. R., & Chang, T. (2021). Exploring the beliefs and perceptions of spending time in nature among US youth. *BMC Public Health*, 21(1), 8. <https://doi.org/10.1186/s12889-021-11622-x>.