Educational Psychology Review (2023) 35:29
https://doi.org/10.1007/s10648-023-09750-4

REVIEW ARTICLE

Psychological Benefits of Attending Forest School for Preschool Children: a Systematic Review

Enrico Sella[1] · Monica Bolognesi[1] · Emma Bergamini[1] · Lucia Mason[2] · Francesca Pazzaglia[1,3]

Accepted: 10 February 2023 / Published online: 6 March 2023

Abstract

Forest school is a form of outdoor learning that takes children into regular and repeated learning experiences in natural settings. Being based on a comprehensive experience with nature, it is assumed to be beneficial for learning and to promote restorative effects on cognitive and emotional function in preschool children. This review aimed to examine the available evidence on the benefits of forest school compared to indoor school activities in children aged 3 to 6 years. We searched for studies on forest school for preschool children in PsycInfo, JSTOR, and Scopus, with no restriction on publication year. The risk of bias was assessed using Joanna Briggs's criteria for quasi-experimental design. Of the 190 articles identified, 16 studies were reviewed ($N = 1560$). Higher benefits were found in children attending forest school compared to those attending indoor school in various areas of child development: cognitive function, motor coordination and balance, connectedness to nature, and health and well-being outcomes. There is, however, still a shortage of empirical evidence, and the methodological quality of most studies was limited. The literature on forest schools for preschool children in general supports positive effects in a wide range of variables that promote child health and development, but more evidence is needed to assess their effectiveness. Due to the methodological weaknesses of the reviewed studies, one should interpret their findings with caution.

Keywords Forest school · Kindergartner · Outdoor education · Preschool · Child development

The benefits of contact with nature have been recognized in numerous studies conducted in recent decades (see, e.g., Menardo et al., 2021; Ohly et al., 2016; and

✉ Enrico Sella
enrico.sella@unipd.it

✉ Francesca Pazzaglia
francesca.pazzaglia@unipd.it

Extended author information available on the last page of the article

Wendelboe-Nelson et al., 2019, for recent reviews and meta-analyses). Indeed, prolonged experiences in natural contexts (Gascon et al., 2015), as well as short exposure to real and virtual nature (Kasap et al., 2021), do improve people's psychophysical well-being and quality of life (Howell et al., 2011; Mayer & Frantz, 2004; Nisbet & Zelenski, 2013). Two dominant theories explain the restorative mechanisms underlying the positive effects derived from interaction with nature: stress reduction theory (SRT; Ulrich et al., 1991), mainly focused on psychophysiological and affective processes, and attention restoration theory (ART; Kaplan, 1995), specifically centered on restoration of attentive functions.

It is also acknowledged that exposure to nature leads to improvements in health and well-being in children (e.g., Mason et al., 2022; Tillman et al., 2018; Vella-Brodrick & Gilowska, 2022). Children experiencing nature for a long period can reap benefits to their well-being, as well as social and academic performance and physical and psychological competencies (Becker et al., 2017; Cooper, 2015; Dabaja, 2021; Harris, 2017). Despite the known benefits of being in contact with nature and outdoor learning/play activities for children's health, there are some concerns about the increasing tendency of children not to spend time outdoors in the natural environment. Several factors, such as lifestyle changes due to urbanization (Cox et al., 2018) and changes in social and educational practices, have led to reduced opportunities for interacting with nature (Hartig et al., 2014), even in childhood.

Prolonged contact with a natural outdoor environment has been implemented in various educational practices (Bilton, 2010), showing that exposure to nature at school leads to benefits in physical activity (motor function and competencies) and child behaviors (cooperative play, prosocial behavior) in children from preschool to primary school (Dankiw et al., 2020) and adolescents (Gill, 2014). A nature-based school, where a natural space is specifically designed to promote children's physical and learning activities (Cooper, 2015), seems to produce more health and psychological benefits for children attending it (e.g. Dabaja, 2021; Johnstone et al., 2022; Mann et al., 2021; Vella-Brodrick & Gilowska, 2022) than indoor school.

The importance of preschool education in promoting good health, cognitive and emotional skills, and sustained learning and academic achievement are established from an early age and continue across a child's life and school course (Pearce et al., 2019). Preschool education is typically defined as pre-primary education programs designed for children from 3 years of age to the start of primary school (International Standard Classification of Education (ISCED), 2011; UNESCO, 2012). Within the preschool landscape, learning and educational activities are characterized by interaction with peers and teachers, providing children organized and structured instruction outside of the family context (e.g., Pianta et al., 2009). In general, preschool is intended to improve children's use of language and social skills; start to develop crucial cognitive (e.g., logical and reasoning), physical (e.g., gross and motor), and emotional skills; allow children to explore their surrounding world and environment; and promote social interactions with peers and teachers to develop social skills, autonomy, and school readiness (Mahoney et al., 2020; Reynolds et al., 2011).

While primary education has multiple benefits in child development and well-being, it should be noted that traditional preschool learning contexts are

constructed and artificial. From the age of 3, children begin to spend more time in such contexts that are organized environments and structures (e.g., swings, slides), where educational and learning practices take place indoors rather than outdoors. Alongside traditional indoor preschools, there are nature-based preschools (or nature-based early childhood education; see Johnstone et al., 2022), which provide a unique educational opportunity to reconnect children to nature through allowing them to spend the majority of their time outdoors.

Among nature-based learning programs (Harwood et al., 2020), forest schools (which originated in the 1950s in Scandinavia; Harris, 2017) are characterized by the fact that all school activities are conducted outdoors in completely natural contexts with forests, trees, or large green spaces, guided by professional forest practitioners, and inspired by a child-oriented learning approach with activities freely conducted in the natural environment (Cooper, 2015). The forest school approach integrates nature into its philosophy, curriculum, and/or overall environment, and children typically spend the majority of their day outdoors in immersive nature experiences. In particular, forest schools aim to provide an alternative learning process to a traditional school based on constant contact with nature through regular sessions, rather than one-off or infrequent visits; encourage children' nature connectedness in a woodland or natural environment to create a relationship between the learner and the natural world using learner-centered processes; and promote holistic development to foster self-esteem, confidence, independency, and creativity (Cooper, 2015; Dabaja, 2021; Harris, 2017). Surprisingly, to our knowledge, no reviews have been conducted to examine whether these forest school programs could be beneficial for preschool children.

There is evidence that children aged 3 to 6 attending forest schools have some advantages over their peers attending indoor schools, with benefits in cognitive function (Zamzow & Ernst, 2018), creative thinking (Wojciehowski & Ernst, 2018), social skills (Agostini et al., 2018), and nature connectedness (Barrable & Booth, 2020a, 2020b). However, a review of the literature that includes the methods adopted and the degree of exposure to nature in addition to the benefits obtained is still lacking.

We aimed to cover this gap and review studies on the forest school approach for children aged 3 to 6, considering its benefits on cognitive and affective function, physical activity and motor function, child behaviors, and nature connectedness, compared to a traditional indoor school. Such a complete review has both theoretical and practical significance. The former is related to understanding the various factors that characterize the effectiveness of forest school for preschool children's development. The practical significance is related to guiding the planning and implementation of school innovations based on exposure to natural environments.

The following are the questions we intend to answer through this review:

1. Does attending forest schools lead to improvements in cognitive function, affect, and other areas of child development (such as motor function and competences) compared to indoor education?

Existing evidence extensively supports the associations between nature and children's health and development, having been evaluated at various degrees of exposure to nature, including in nature-based schools or outdoor educational programs (e.g., Johnstone et al., 2022). A growing body of research shows that forest school, compared to indoor educational programs, has a positive influence on various health and well-being domains for preschool children. To our knowledge, this is the first review that systematically provides a comprehensive summary of the benefits of attending forest school for preschool children aged 3 to 6 years.

2. How are the effects of the forest school programs measured, and which methods and instruments are used?

The literature appears highly heterogeneous in terms of the methods (e.g., self-reported measures, table for observation, or objective measurements for cognitive/affective and physical outcomes) used to assess benefits of contact with nature in preschool children attending forest schools. Considering the outdoor educational context—different from the typical indoor context in which children were evaluated—it is also necessary to examine how evidence about such benefits was collected, such as through teachers or parents' perceptions or through tasks proposed to children. As stressed above, to date, no systematic reviews have produced a complete picture of the methods and instruments used to assess the benefits of attending forest school in preschool children.

3. What is the quality of the evidence about forest school programs for preschool children?

The growing interest in examining nature's effects on child health and development has led to empirical studies, but most of them adopted correlational designs with several methodological weaknesses (see risk-of-bias assessment). It is therefore necessary to determine the quality of the evidence and the features of the study design that could give misleading results on this topic.

Therefore, in the studies reviewed, we considered the types of activities in the forest environment (compared to those in an indoor school), whether and how they improved psychological outcomes and other aspects of child development (e.g., motor function and competences), teaching methods used in forest school, and the quality of the evidence.

Method

Study Eligibility Criteria

The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (Moher et al., 2009; Page et al., 2021). A systematic literature search was conducted to identify studies that focus

on forest school for preschool children. To systematically frame our research questions (Schardt et al., 2007), the inclusion/exclusion criteria were defined using the PI(E)CO framework: (a) population: children aged 3–6 years attending forest preschools who have not yet started primary school (according to ISCED, 2011; UNESCO, 2012). We excluded all studies including children with diseases or health conditions, such as attention deficit hyperactivity disorder or autism spectrum disorder, and children over 7 years of age who did not attend preschool education. (b) Intervention/exposure: forest or nature-based preschool adopting the forest school approach (e.g. Cooper, 2015; Sobel, 2014), in which children spend all or most of their school time in a natural environment. Studies were excluded if the preschool setting was artificial/indoor, children spent more time with indoor activities, or nature-based education was not clearly integrated into the preschool education. (c) Comparison: we compared the forest school approach to typical indoor preschools in which learning and educational activities are predominantly carried out on indoor playgrounds (including man-made and artificial structures), and children spend a small amount of time on outdoor activities. (d) Outcome: we studied outcomes related to cognitive, affective, and child development areas (e.g., motor and gross activity, play, and social behaviors). Outcomes that did not relate to children's health and well-being (e.g., those related to educators, parents, or teachers) were excluded. (e) Study design: we included quasi-experimental or randomized controlled trials published in regular papers, conference abstracts, and official reports published in peer-reviewed journals at any time, in English. We excluded articles published in languages other than English, single animal studies, single case studies, qualitative studies, books, commentaries, meta-analyses, and reviews.

Search Strategy for Study Identification

We conducted electronic searches for the present review in January 2021 using Scopus (one of the largest abstract and citation databases of research literature and quality web sources), JSTOR (a database targeting educational and pedagogical sciences), and PsycInfo (a resource devoted to peer-reviewed literature in behavioral science and mental health). In addition, bibliographies from previous reviews on forest school and retrieved articles were hand searched (e.g., Dabaja, 2021; and, as recommended, Horsley et al., 2011). Two authors (FP and EB) first constructed the search strategy and then refined it with the other authors. The choice of search terms was based on the target intervention/treatment of interest (i.e., forest school for preschool children) and the outcomes of interest (i.e., cognitive, affective, and other child development areas). We did not limit the initial date of publication so as to include as many articles as possible. We used the following terms: ("forest school" OR "nature school" OR "forest kindergarten" OR "nature preschool" OR "forest preschool" OR "outdoor preschool") AND ("outcomes" OR "cognitive effects" OR "affective effects" OR "childhood development") AND ("children" OR "school children"). All these keywords were used for each database, using an appropriate database-specific indexing syntax. The complete search algorithm with the keywords for each database is available from the authors on request. All potential references were organized and deduplicated by one author (ES) using Zotero software (Roy

Rosenzweig Center for History & New Media, 2016). Three author—reviewers (EB, ES, MB)—independently screened the titles and abstracts of the articles retrieved for eligibility. Any disagreements over which articles to retain were resolved by consensus, consulting another author (FP) if necessary.

Synthesis of the Findings

Data extracted from the included studies were the characteristics of the sample (age, gender, sample size), the type of preschool activity for forest preschools and indoor preschools (if present), measures of interest (see also Supplementary Material), and the main findings (Table S1, Supplementary Material). A meta-analysis was not conducted due to the heterogeneity of the studies, measures, and outcomes. Therefore, we decided to group the results of the studies at the outcome level (Table 1). Three authors (EB, ES, MB), in agreement with the other authors (FP, LM), discussed the outcomes relevant to the effects of preschool on child development (e.g., Lee et al., 2021; Miller et al., 2021; Vella-Brodrick & Gilowska, 2022). We grouped the included studies into the following categories: cognitive function, creativity, child development and motor function, behavior, connectedness to nature and attitudes/behaviors towards nature, and other subjective outcomes (i.e., outcomes not included in the previous categories; see Table 1). Finally, we organized a summary of the evidence at the outcome level, including the study design, the methodological quality of the study (see below for the risk of bias assessment), the type of informant (child, parent, teacher, or independent observer), directionality of the effects, and a summary of the findings and quality of evidence (see Table 1).

Evaluation of the Risk of Bias of the Reviewed Studies

The methodological quality of each eligible study was assessed using the Joanna Briggs Institute (JBI) critical appraisal checklist for quasi-experimental design (Munn et al., 2020). The following sources of bias were examined: presence of a control group, selection bias, bias in measurement of outcomes, presence of follow-ups, appropriateness of statistical analyses, and overall methodological bias. Two authors (ES, MB) rated each reviewed study, classifying each item as having a high, moderate, or low risk of significant bias. When they disagreed, a third reviewer (FP) rated the study in question.

Results of the Literature Search

The PRISMA diagram shows that 166 records remained after removing duplicates. Screening titles and abstracts identified 50 eligible studies. A Cohen's k of 0.88 (98% agreement) indicated almost perfect agreement between the reviewers in this phase. The fourth reviewer was consulted to exclude four articles. Finally, 16 studies met our inclusion/exclusion criteria. The PRISMA 2020 diagram for study inclusion is presented in Fig. 1.

Table 1 Qualitative synthesis of the findings grouped by outcomes of interest

Outcomes of interest	Studies	Study design	Risk of bias*	Type of informant	Effect direction	Summary of the findings and quality of evidence
Cognitive function	Agostini et al., 2018	Quasi-experimental (pre-post)	High	Teacher report/rating	⇑	The evidence was inconsistent, as only one study reported improvements in cognitive functioning in children attending forest preschools (albeit with a large effect size), while the other three studies reported nonsignificant benefits (with low effect size). Certainty of evidence was considered low due to the high risk of bias, the weak study design, and the mixed methods adopted in terms of measurements and type of informant
	Müller et al., 2017	Quasi-experimental (pre-post)	High	Teacher report/rating	⇔	
	Zamzow & Ernst, 2018	Quasi-experimental (pre-post)	High	Task for children	⇔	
	Ernst & Burcak, 2019	Quasi-experimental (pre-post)	High	Task for children	⇔	
Creativity	Wojciehowski & Ernst, 2018	Quasi-experimental (pre-post)	Moderate	Task for children	⇑	Improvements in creativity were more common among children attending forest preschools compared to indoor preschools. Measurements of this outcome were consistent. However, this evidence was affected by the lack of certainty (low effect size), weak study design, and methodological weaknesses (moderate-to-high risk of bias)
	Ernst & Burcak, 2019	Quasi-experimental (pre-post)	High	Task for children	⇑	

Table 1 (continued)

Outcomes of interest	Studies	Study design	Risk of bias*	Type of informant	Effect direction	Summary of the findings and quality of evidence
Child development and motor function	Agostini et al., 2018	Quasi-experimental (pre-post)	High	Teacher report/rating	⇑	Ideally, teachers and children reported evidence on improvements in various areas of child development (with small-to-large effect size). However, nonsignificant changes in physical activity were directly observed by independent raters. The directionality of the effects, the weak study design, and the moderate-to-high risk of bias demonstrated low certainty of evidence
	Fjørtoft & Sageie, 2000	Quasi-experimental (pre-post)	Moderate	Teacher report/rating and direct observation	⇑	
	Fjørtoft, 2001	Quasi-experimental (pre-post)	Moderate	Task for children	⇑	
	Fjørtoft, 2004	Quasi-experimental (pre-post)	Moderate	Task for children	⇑	
	Fyfe-Johnson et al., 2019	Quasi-experimental (cross-sectional)	High	Direct observation	⇔	
	Müller et al., 2017	Quasi-experimental (pre-post)	High	Direct observation	⇔	
Behavior	Fyfe-Johnson et al., 2019	Quasi-experimental (cross-sectional)	High	Child report	⇔	Evidence on social behaviors was untrustworthy. Some studies reported improvements in behavior among children attending forest preschools, whereas other studies found nonsignificant effects. The inconsistency of the effects, the heterogeneity of the type of informant, and the weak study quality (i.e., moderate-to-high risk of bias) demonstrated low evidence certainty
	Cordiano et al., 2019	Quasi-experimental (pre-post)	Moderate	Parent and teacher report/rating	⇔ ⇑⇓	
	Müller et al., 2017	Quasi-experimental (pre-post)	High	Parent and teacher report/rating	⇑	
	Mårtensson et al., 2009	Quasi-experimental (cross-sectional)	High	Teacher report/rating	⇑	
	Lerstrup et al., 2017	Quasi-experimental (cross-sectional)	High	Direct observation	⇔	

Table 1 (continued)

Outcomes of interest	Studies	Study design	Risk of bias*	Type of informant	Effect direction	Summary of the findings and quality of evidence
Connectedness to nature and attitudes/behaviors towards nature	Barrable & Booth, 2020a, 2020b	Quasi-experimental (cross-sectional)	Moderate	Parent report/rating	⇑	Improvements were reported in connectedness to nature among children attending forest preschools compared to indoor preschools (with a small effect size), with no significant changes in environmentally responsible behaviors. Certainty of evidence was low due to the moderate-to-high risk of bias and weak study design
	Elliot et al., 2014	Quasi-experimental (pre-post)	High	Child report	⇑	
	Cordiano et al., 2019	Quasi-experimental (pre-post)	Moderate	Child report	⇓	
	Müller et al., 2017	Quasi-experimental (pre-post)	High	Child report	⇓	
Other subjective outcomes						The few and mixed studies that emerged on subjective variables reflect the possible benefits of forest/nature kindergarten in various areas of development and quality of life among children attending school in the forest compared to indoor preschool Due to the paucity of evidence, the weak study design, and the moderate-to-high risk of bias of all studies, the overall certainty of evidence was considered low for all subjective outcomes

Table 1 (continued)

Outcomes of interest	Studies	Study design	Risk of bias*	Type of informant	Effect direction	Summary of the findings and quality of evidence
- Readiness skills	Cordiano et al., 2019	Quasi-experimental (pre-post)	Moderate	Teacher report / rating, Child report	⇔	No improvements in children's academic readiness skills
- Curiosity	Ernst & Burcak., 2019	Quasi-experimental (pre-post)	High	Child report	⇑	Increased curiosity level
- Psychological resilience	Ernst & Burcak, 2019	Quasi-experimental (pre-post)	High	Parent report/rating	⇑	Increased psychological resilience
- Sleep	Choi et al., 2014	Quasi-experimental (pre-post)	High	Parent report/rating	⇑	Improvements in sleep–wake patterns
- Illness and Injury	Frenkel et al., 2019	Quasi-experimental (cross-sectional)	Moderate	Teacher report/ rating	⇔	No changes in the incidence of illness and injury

Effect direction: ⇑ = positive association with forest preschool program; ⇓ = negative association with forest preschool program; ⇔ = no significant association with forest preschool program; ⇑⇓ = conflicting findings. *See Supplementary Material for further details of risk bias assessment

Participants and Study Design

Table S1 (Supplementary Material) provides details of the 16 studies included in the review, which concerned 1560 children in all (sample sizes ranged from 26 to 216), with 917 children attending forest school and 642 in the control groups (i.e., indoor preschools). All studies were quasi-experimental, 11 with a pre-post design and 5 with a cross-sectional design. The studies were conducted in several countries: 8 in American countries, 7 in European countries, and 1 in South Korea. As for the years of publication, studies were conducted from 2000 onwards, with a higher frequency between 2014 and 2020, a distribution that demonstrates how interest in this area has developed recently.

Findings Grouped by Outcomes of Interest

Most of the reviewed studies reported improvements in different areas of the development of children attending forest schools compared to indoor ones. There is also evidence of some mixed results that may even be due to the considerable variety of the outcomes examined, the measurements, and the activities adopted. Therefore, these findings were grouped by outcomes of interest and the measures used.

Cognitive Function

In total, four studies examined cognitive function in children attending forest school compared to indoor preschool. The results are mixed and heterogeneous.

Agostini et al. (2018) examined the benefits of outdoor learning activities in nature, exploring teachers' perceptions of children's development. Forty-one children attending an outdoor kindergarten and 52 children attending an indoor kindergarten were evaluated using the Kuno Beller Developmental Tables (Mantovani, 1995) and an ad hoc instrument for examining outdoor activities (i.e., outdoor activities/trip diary). The results showed that teachers' assessments of the global cognitive function of children in the outdoor kindergarten were significantly better than in the indoor kindergarten after 2 consecutive school years ($p < 0.001$, $\eta_p^2 = 0.51$).

Müller et al. (2017) measured children's cognitive function in nature preschool and compared their performance in different areas of cognitive function as measured at the beginning and end of the school year. Forty-one children attending a nature kindergarten and 45 children attending an indoor kindergarten were asked to complete the following cognitive tests: the boxes task (Kerns & McInerney, 2007) for assessing working memory (i.e., a touch-screen operated, self-ordered search task in which children were instructed to find a jack-in-the-box while continuously keeping in mind boxes they had already searched), the Continuous Performance Test (CPT; Kerns & McInerney, 2007) for examining attention performance (i.e., children were required to respond to the appearance of a target stimulus by touching this animal on the touchscreen computer and to refrain from responding to a number of different, non-target stimuli), and the Head-Shoulders-Knees-Toes task (HSKT; Ponitz et al., 2008) for assessing inhibition (i.e., children were asked to follow the experimenter's

commands, and then to do the opposite of what the experiment said: children were told to touch their head when the experimenter told them to touch their feet, for instance). There were no significant differences in improvements in all cognitive measures compared to children in indoor preschool (working memory: $p = 0.19$, $\eta_p^2 = 0.02$; attention: $p = 0.51$, $\eta_p^2 = 0.01$; inhibition: $p = 0.76$, $\eta_p^2 = 0.00$).

Zamzow and Ernst (2018) compared 78 children from four forest preschools that integrated learning and play activities in nature and 44 children from two non-nature preschools on executive functions as measured with the Minnesota Executive Function Scale (MEFS; Carlson & Zelazo, 2014). A child-directed approach was used in all four of these nature preschools to support development and learning in all domains using a combination of natural settings for nature play, including unmaintained ("wild") natural settings, natural spaces that were minimally managed for nature play, and natural playscapes designed specifically for nature play. Both non-nature preschools emphasized child-directed play to support cognitive, social, emotional, and physical development, with most of the time spent indoors in free or loosely guided play. The results showed that both children in nature preschools and those not in nature preschools showed significant improvements in executive functions from pretests to posttests (after 8 months; $p < 0.001$, $\eta_p^2 = 0.38$), while no significant differences between the two preschools emerged at the posttest ($p = 0.60$, $\eta_p^2 < 0.01$).

Similarly, Ernst and Burcak (2019) compared 78 children attending a forest preschool that integrated learning and play activities in nature and 44 children in an indoor preschool on executive function skills as assessed with the MEFS (Carlson & Zelazo, 2014) and found no significant differences between the two preschools ($p = 0.60$, $\eta_p^2 < 0.01$).

Creativity

Only two studies considered the influence of nature preschool activities on creative thinking in preschool children.

The study by Wojciehowski and Ernst (2018) involved 75 children in preschools adopting a forest school approach and 11 children in non-nature preschools. Participants' creative thinking levels were assessed using Thinking Creatively in Action and Movement (TCAM; Torrance, 1981). At the posttest, participants in forest preschools demonstrated significantly higher scores compared to the pretest for all the creative dimensions assessed (fluency, originality, and imagination; $p < 0.001$ for all dimensions), while those in indoor preschools did not. In addition, Ernst and Burcak (2019) assessed creative thinking in nature and non-nature preschools using TCAM (Torrance, 1981) and found that only the former reported significant improvements in all three creative dimensions (fluency, originality, and imagination; $p < 0.001$ for all dimensions) at the posttest assessment.

Child Development and Motor Function

Six studies examined whether and how child movement and physical activity in nature can promote child development, behavior, and motor function in children in nature preschools compared to those in indoor, non-nature preschools.

In the abovementioned study of Agostini et al. (2018), child development was assessed with the Kuno Beller Developmental Tables (Mantovani, 1995) in both nature and non-nature preschools. Significant improvements were found in different areas of development (body function: $p=0.010$, $\eta_p^2=0.27$; awareness of the surrounding environment: $p=0.004$, $\eta_p^2=0.30$; social and emotional development: $p=<0.001$, $\eta_p^2=0.38$; play: $p<0.001$, $\eta_p^2=0.41$; gross and fine motor skills: $p=0.021$, $\eta_p^2=0.51$; $p<0.001$, $\eta_p^2=0.15$) compared to children attending indoor education activities. Teachers also reported that children attending outdoor activities, compared to indoor ones, showed significant differences in terms of outdoor activities: The forest preschool group reported a higher frequency of outdoor activities, such as physical education and structured exploration, over 2 years of teachers' observation ($\chi^2=55.02$, $p<0.001$).

Three studies examined motor development in 46 children attending a forest preschool that integrated learning and play activities in nature compared to 29 children in traditional preschool (Fjørtoft & Sageie, 2000; Fjørtoft, 2001; Fjørtoft, 2004). The nature preschool group used a small forest as a supplement to the traditional outdoor playground and engaged in different play activities: functional play (i.e., gross motor activities and basic skills implemented in games like tag, chase and catch, leapfrog, hide and seek, catch a tree, making angels in the snow, and other games involving basic movements), construction play (i.e., building shelters, dens, and other constructions, such as a pirate ship, and building with cones and sticks and other moveable things), and symbolic play (socio-dramatic play as role play and fantasy play, such as playing house, playing pirates, and making a play farm with cones and sticks). Those in the comparison group engaged in traditional outdoor playground activities 1–2 h per day and visited natural sites only occasionally. After 9 months, the motor function of both groups of children was evaluated using the European Test of Physical Fitness (EUROFIT; Adam et al., 1998), and the findings showed that the children in nature preschool showed significant improvements in balance ($p<0.001$) and coordination skills ($p<0.01$).

Finally, two studies (Fyfe-Johnson et al., 2019; Müller et al., 2017) measured moderate to vigorous physical activity (MVPA) using accelerometers, a non-invasive method for assessing circadian rhythms and movements, for 5 consecutive days. There were, however, no significant differences between the outdoor and indoor groups.

Behavior

Five studies assessed child behaviors in forest preschools and non-nature preschools, showing a different pattern of results. In the study of Fyfe-Johnson et al. (2019), parents' reports of child behavior, assessed with the Strengths and Difficulties Questionnaire (Goodman, 1997), were evaluated in 20 children attending preschools that integrated learning and play activities in the nature in comparison with parents' reports of 13 children in non-nature preschools. Five behavioral and psychological dimensions were examined (emotional problems, behavior problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior), but no differences between the two groups emerged ($p>0.05$).

Cordiano et al. (2019) examined behaviors of children who interacted with their environment. Twelve children attending preschools in nature and 14 children in non-nature kindergartens were observed by their parents and teachers, who rated their behavior during the school year. One parent of each child completed several rating forms in September and again the following May. The teachers of each class completed rating forms for each child in September, January, and May. Children's peer play behaviors were assessed across the dimensions of play interaction, play disruption, and play disconnection using the Penn Interactive Peer Play Scale (PIPPS; McWayne et al., 2002) and a pretend play rating with five ad hoc questions about children's imagination in play, use of make-believe, enjoyment of play, amount of emotion expressed in play, and use of make-believe in dramatic play, while social skills and problem behavior

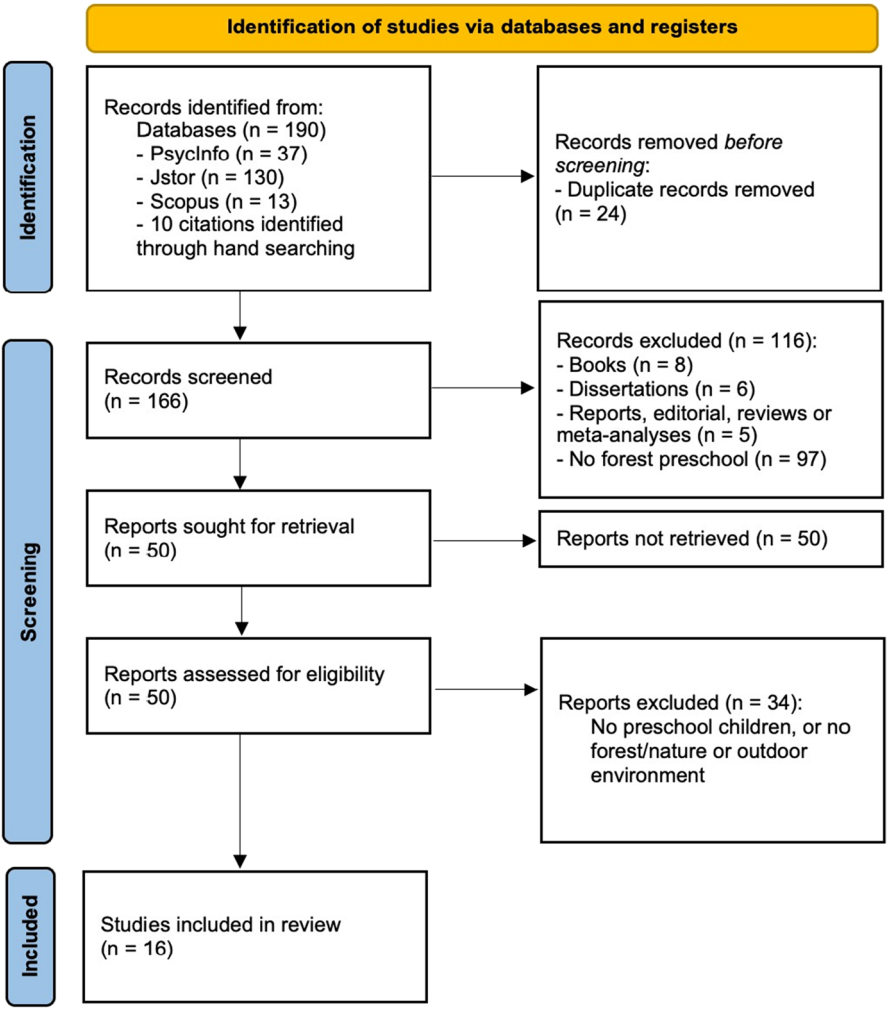

Fig. 1 PRISMA 2020 flow diagram of the study selection procedure

were evaluated using the Preschool and Kindergarten Behavior Scales (PKBS; Merrell, 2002). Parents' reports did not significantly differ between outdoor and indoor groups in all play behaviors (play interaction: $p > 0.05$, $\eta_p^2 = 0.00$; pretend play: $p > 0.05$, $\eta_p^2 = 0.02$; play disruption: $p > 0.05$, $\eta_p^2 = 0.03$; play disconnection: $p > 0.05$, $\eta_p^2 = 0.06$), while teachers reported that children in the outdoor preschool had more play disruption and disconnection ($p < 0.001$, $\eta_p^2 = 0.27$), and higher levels of behavioral problems ($p > 0.05$, $\eta_p^2 = 0.06$). Interestingly, teachers also reported that children in the outdoor education program significantly increased their ability to pretend play, while those in the indoor preschool did not ($p < 0.01$, $\eta_p^2 = 0.58$).

In the study of Müller et al. (2017), parents and teachers were asked to assess child social behavior using the Social Skills Rating Scale (SSRS; Gresham & Elliott, 1990), which assesses the social skills domains of cooperation, assertion, responsibility (parent form only), empathy (student form only), and self-control, and a self-reported measure for assessing the presence of externalizing (aggression, hyperactivity) or internalizing problems (anxiety, sadness). Although there were no significant differences between parental ratings of children attending nature and indoor preschools for the SSRS domains (assertiveness: $p = 0.01$, $\eta_p^2 = 0.13$; social responsibility: $p = 0.03$, $\eta_p^2 = 0.11$; cooperation: $p = 0.06$, $\eta_p^2 = 0.08$; self-control: $p = 0.29$, $\eta_p^2 = 0.02$; externalizing behavior: $p = 0.25$, $\eta_p^2 = 0.03$; internalizing behavior: $p = 0.68$, $\eta_p^2 = 0.00$), teachers' ratings reported that children in nature preschool showed higher scores in the cooperation ($p = < 0.001$, $\eta_p^2 = 0.20$) and self-control ($p = < 0.001$, $\eta_p^2 = 0.32$) domains.

In the study by Mårtensson et al. (2009), the association between forest kindergarten environments and attention and impulsivity was examined in eleven preschools in Sweden where the playgrounds varied in the amounts of trees, shrubbery, hilly terrain, and vegetation around play structures; in three of them, the children spent 91–97% of the preschool day outdoors during the school period. The Early Childhood Attention Deficit Disorders Evaluation Scale (ECADDES, School version; McCarney, 1995) was applied to detect behavior characteristics within two main domains of attention: inattention and hyperactivity/impulsivity. Children who played in large and integrated natural areas showed significantly less inattention ($p < 0.05$), with lower measures of impulsivity that bordered on significance ($p = 0.069$).

Finally, Lerstrup et al. (2017) conducted an observational study involving two groups of children enrolled in forest preschools using several natural sites in a nearby forest and an indoor preschool using a playground. Based on observations of preschoolers in playground and forest settings for 2 months in winter/early spring, the functional taxonomy of children's outdoor environments by Heft (1988) was adapted in this study. The result was a classification of outdoor features for preschool children into ten categories: open ground, sloping terrain, shielded places, rigid fixtures, moving fixtures, loose objects, loose material, water, creatures, and fire. Each class was categorized by key activities based on the analysis of the observations. The key activities were the activities observed to be distinctive for the class and attractive for children in preschool. Children in both the indoor and natural contexts seemed to demonstrate similar play activities related to some specific environmental characteristics (such as walking or running on a flat, relatively smooth surface or sheltering in hidden places).

Connectedness to Nature and Attitudes/Behaviors Towards Nature

Mixed results of four studies that assessed connectedness to nature emerged. Barrable and Booth (2020a, 2020b) compared 132 children attending forest nurseries and 84 attending indoor nurseries in nature connectedness (NC) as measured through parents' reports using the Connectedness to Nature Index for parents of preschool children (CNI-PPC; Soboko et al., 2018) This index assesses the construct of connectedness to nature in its four dimensions: enjoyment, empathy, responsibility, and awareness. The outdoor group demonstrated higher scores on the dimensions of enjoyment ($\beta = 0.59$, $p < 001$) and awareness ($\beta = 0.76$, $p < 001$), while the two groups did not show significant differences on the other dimensions of connectedness to nature (empathy and responsibility). In addition, the predictive relationship between the time spent attending school in nature and NC was also confirmed. Parents' NC levels, measured with the Inclusion of Nature in the Self Scale (INS; Schultz, 2002), were significantly related to the CNI-PPC dimensions of the children ($\beta = 0.42$, $p < 0.001$).

In the abovementioned study, Cordiano et al. (2019) created the Children's Attitudes Toward Nature (CATN) scale to assess children's feelings about nature in both forest and non-nature preschools. A series of nature activities were read to the child, who responded to each by pointing to a face on a card that reflects the child's attitude towards the activity. There were no significant differences between the two preschool groups ($p > 0.05$, $\eta_p^2 = 0.11$).

Elliot et al. (2014) compared 21 children attending a kindergarten that integrated learning and play activities in nature and 22 children in an indoor kindergarten on nature connectedness using the Nature Relatedness and Environmentally Responsible Behavior tool (Evans et al., 2007), in which the child had to express preferences with respect to different nature options proposed by the examiner and related to connectedness with the natural world. Children in nature kindergarten showed higher levels of nature relatedness compared to those of indoor preschools ($p < 0.05$). In contrast, Müller et al. (2017) did not find significant differences between outdoor and indoor schools with regard to nature relatedness ($p = 0.22$, $\eta_p^2 = 0.02$). Both of these studies (Elliot et al., 2014; Müller et al., 2017) found no significant differences in environmentally responsible behavior between children in nature preschools and indoor preschools.

Other Subjective Outcomes

In some of the reviewed studies, other outcome variables were taken into account when comparing preschools that integrated learning and play activities in indoor natural and non-natural schools. Preschool is an important venue for teaching, encouraging, and practicing behavioral regulation skills, as they are associated with academic readiness in kindergarten and appropriate behavior in the classroom setting. Cordiano et al. (2019) compared a pre-primary program that integrated activities in nature and an indoor one in different areas of play behaviors (as mentioned above), including the teacher report of children's academic kindergarten readiness skills. These skills (i.e., letter and number recognition, sorting and classifying

information, counting, rhyming, and recognizing one's name in print) were rated at the beginning and ending of the school year. Furthermore, children's attitudes toward school were evaluated through the Children's Attitudes Toward School questionnaire (CATS; Henry et al., 2007), a self-reported questionnaire administered to each child in which they responded how they enjoyed a range of school activities. However, there were no significant differences in school readiness ratings and children's enjoyment of school between nature and non-nature schools (readiness: $p > 0.05$, $\eta_p^2 = 0.16$; school enjoyment: $p > 0.42$, $\eta_p^2 = 0.30$).

Environmental learning also includes opportunities to explore and investigate topics of young children's own choosing, as well as opportunities to make decisions about their own activities. Ernst & Burcak (2019) assessed children's curiosity using the Curiosity Drawer Box task (Henderson & Moore, 1979), a measure of object curiosity or the desire to know and explore how things work and function, in which the child is invited to play with the box and the observer/researcher records the number of toys the child takes out/explores. Children in the forest preschool played with toys related to nature more than those in indoor preschools ($p = 0.01$, $\eta_p^2 = 0.09$).

Psychological resilience is also considered a relevant protective factor in child development, particularly since many children face daily or ongoing threats to their healthy development. In another pilot study conducted by Ernst and Burcak (2019), psychological resilience, as measured by the Early Childhood Assessment for Preschoolers, second edition (DECA-P2; LeBuffe & Naglieri, 201), was examined by comparing children in nature preschools with those in indoor preschools. The results suggested that children in forest preschools, compared to indoor preschools, showed positive development in their psychological resilience as reported by both teachers and parents, specifically in the resilience dimensions of initiative and self-regulation (teacher report for initiative: $p < 0.001$; teacher report for self-regulation: $p = 0.002$; parent report for initiative: $p < 0.001$; parent report for self-regulation: $p = 0.002$).

Only one study investigated the effects of forest/nature kindergarten on sleep (Choi et al., 2014). The parents of a group of 18 children who participated in a forest kindergarten program and a group of 19 children who participated in a regular kindergarten program completed the Children's Sleep Habits Questionnaire (Owens et al., 2000). After 8 months, children in the forest kindergarten showed significant improvements in overall subjective sleep quality (i.e., fewer sleep disturbances); in particular, fewer children experienced sleep disordered breathing ($p = 0.04$) and daytime sleepiness levels ($p < 0.001$) compared to children attending the regular kindergarten.

Frenkel et al. (2019) recorded the weekly incidence of illness and injury in 71 children in a forest preschool and 70 children in an indoor preschool. The authors designed a log based on nine key interviews with preschool teachers and other school health professionals. Teachers recorded daily illnesses (i.e., when a child was absent for at least 1 day due to illness) and injuries (i.e., when a child required first-aid attention from teachers) for 11 to 15 weeks from mid-September, when nature preschools started their school year, to the start of winter break in mid-December 2014. There were no significant differences between nature and indoor preschools (IRR: 0.93, 95% CI = [0.64, 1.34]). The only difference was that girls at nature preschool had a significantly higher incidence of minor injury compared to those in indoor preschool (IRR: 5.91, 95% CI = [1.98, 17.7], $p < 0.01$).

Assessment Measures

The reviewed studies used a variety of instruments and measures to evaluate the benefits of forest preschools for children: seven studies include self-reported questionnaires, seven studies used cognitive and behavioral tasks, four studies included ad hoc measurements, and four studies adopted observational scales of child behaviors (see Supplementary Material, Part 2). Only two studies used objective methods (i.e., accelerometers) to assess children's physical activities (Müller et al., 2017; Fyfe-Johnson et al., 2019). Most of the studies (11 studies: Cordiano et al., 2019; Elliot et al., 2014; Ernst & Burcak, 2019; Fjørtoft & Sageie, 2000; Fjørtoft, 2001; Fjørtoft, 2004; Fyfe-Johnson et al., 2019; Lerstrup et al., 2017; Müller et al., 2017; Wojciehowski & Ernst, 2018; Zamzow & Ernst, 2018) examined the outcomes of interest through the administration of questionnaires and tasks to the children. There are also studies that investigated the differences between children attending forest schooling and indoor schooling through reports from parents (4 studies: Barrable & Booth, 2020b; Choi et al., 2014; Cordiano et al., 2019; Müller et al., 2017) and teachers (7 studies: Agostini et al., 2018; Cordiano et al., 2019; Ernst & Burcak, 2019; Frenkel et al., 2019; Fyfe-Johnson et al., 2019; Mårtensson et al., 2009; Müller et al., 2017). These studies adopted mixed methods and instruments to assess such varied outcomes of interest, which is also the reason for the listed number of different results (see Table S1, Supplementary Material).

Risk of Bias in the Studies Reviewed

Each study was assessed for its methodological quality (i.e., risk of bias; see Supplementary Material, Part 1). Scores obtained with the JBI Critical Appraisal checklist ranged from 0 to 9 (mean 4). The overall quality of the studies was poor. Nine studies (53%; mean 3.22) were judged to be at high risk of bias, and the other 7 (47%; mean 5) were judged to be at moderate risk. The most common sources of bias were lack of details on other exposures or interventions that occurred at the same time as the intervention of interest, lack of pre- and posttest assessment and follow-up, low measurement reliability, and high statistical inference bias.

Most studies included a control group (87.5%), and 75% clearly defined variables of interest. However, only one study clearly provided information on whether participants in the two groups (experimental and control) were receiving other exposures or interventions similar to those of interest at the same time as the measurement (Fyfe-Johnson et al., 2019). There were also other biases that potentially threaten the internal validity of a study exploring causal relationships: Only 37.5% paid attention to both pre- and posttest assessment, and no studies included a follow-up beyond the posttest assessment to evaluate how long the effects of forest exposure persisted. Adequate information about reliability of outcome measurements (i.e., the number of raters, training of raters, intrater reliability, and interrater reliability within the study) was reported in 37.5% of cases. In 87.5% of the studies, the statistical procedure was inadequate (no power analysis or sample size justification, no reported effect sizes or post hoc adjustments for multiple comparison (see Fig. 2).

Discussion

In this review, we aimed to summarize the available evidence on the effects of forest preschool in preschool children. In particular, we evaluated the reviewed studies considering whether preschool children attending forest schools showed improvements in child development areas (as categorized here; see below) compared to children attending indoor preschools. In addition, we also considered which methods and procedures are commonly used to assess the benefits of forest schools for preschool children and the quality of evidence on this topic.

In the 16 studies examined, children attending forest school were in most cases exposed to nature settings every day of the week from 1–2 h to 5 h per day (see Table S1, Supplementary Material). In line with the forest school approach (Cooper, 2015; Dabaja, 2021; Harris, 2017), the sessions dedicated to outdoor learning included a child-oriented approach to play, and children freely carried out play and learning activities in an unstructured natural environment characterized by nature (forests, trees, or large green spaces), whereas children who attended indoor preschool activities mainly spent their time indoors or on the playground or were exposed to a natural setting for a few hours during the week. These studies also appeared to be in line with the forest school approach behind outdoor learning programs for primary school children developed in England (Waite & Goodenough, 2018) and *udeskole* in Denmark (Waite et al., 2016), providing preschool children with opportunities to move and play freely in a natural environment. In fact, the reviewed studies included nature-based activities (like free play activities in open spaces with trees and rocks) in a natural setting in which children and practitioners/teachers had relative autonomy and freedom in what they do away from the confines of a more "structured" formal school setting (Harris, 2017).

This review was guided by some research questions for a more comprehensive overview of the benefits of forest kindergartens. Our first research questions asked whether forest preschool program attendance leads to improvements in preschool children. The results suggest that the benefits of forest preschools varied considerably, so the types of benefit were grouped into a few main categories: cognitive function, creativity, child development and child behavior, connectedness to nature and attitudes toward nature, and other subjective outcomes. Regarding cognitive function, four studies showed mixed results: children attending outdoor learning activities showed improved global cognitive performance compared to those involved in indoor school activities (Agostini et al., 2018), while no significant improvements emerged in executive functions (Müller et al., 2017; Zamzow & Ernst, 2018; Ernst & Burcak, 2019) and working memory (Müller et al., 2017). Outdoor learning activities appeared to be associated with child global cognitive function, and this could be related to the child-oriented approach of outdoor learning in which the learner often participates in various stimulating activities requiring various abilities (cognitive, motor, and socio-emotional skills), whereas executive functions and working memory are complex and demanding cognitive abilities (i.e., executive function and working memory) that could benefit from more cognitive-directed learning rather than a general

child-directed approach adopted in early childhood education. The inconsistent results found here might lead to different cognitive resources needed to perform the cognitive tasks assessed by some studies (Zamzow & Ernst, 2018; Ernst & Burcak, 2019). The ART argued that the restorative benefits of nature are based in its capacity to restore directed attention and concentration, in turn reducing the demand on executive-based attention (i.e., soft fascination). It is plausible that demanding cognitive tasks in terms of cognitive resources, such as working memory, inhibition, and executive functions, do not directly benefit from exposure/interaction with nature. Therefore, the benefits of nature might be better detected in preschool children's cognition in tasks involving more general (sustained and voluntary) cognitive and attentional resources/mechanisms (in line with the soft fascinations principles of ART; Kaplan, 1995), in which nature automatically captures attention while simultaneously eliciting feelings of pleasure in children attending forest preschools (Pearson & Craig, 2014). It is also plausible that the cognitive development measures were designed from the perspective of traditional/indoor education. The inconsistent results derived from studies that used cognitive tasks requiring children to complete several specific actions (e.g., follow and touch the target on a screen) through the use of an electronic device (e.g., computer) were administered in a typical experimental (indoor) setting. The only study reporting positive benefits in cognitive development used a more ecological tool, which required observing children in their natural learning context (Agostini et al., 2018) without testing them in an artificial experimental setting that was different from their usual learning environment. Therefore, future studies should involve new tools and methods for assessing the effects of forest school learning in preschool.

In two other studies, improvements in creativity were reported (Ernst & Burcak, 2019; Wojciehowski & Ernst, 2018), and this is in line with previous literature (Luchs & Fikus, 2013; McArdle et al., 2013) and consistent with the assumptions of forest school, in which learners are encouraged to play/interact with the natural environment freely and actively, requiring them to make choices and decisions, find new ways of doing unstructured activities, or try something brand new in their play.

Regarding child behavior, teachers reported significant improvements in play and social behavior in children attending forest school compared to those engaged in traditional indoor activities (Agostini et al., 2018; Cordiano et al., 2019; Müller et al., 2017), but when the children's behavior was assessed by parents, there were no significant differences between the two groups (Cordiano et al., 2019; Müller et al., 2017). It should be noted that teachers play a primary role in outdoor learning activities, as they are actively engaged in the child-oriented approach and take part in the child–nature interaction. This could then influence teachers' perception of children's behavior, as they perceive improvements in child behavior in the forest school activities, while parents do not perceive such differences (because they observe child behavior only when they are outside the outdoor school space). This is also in line with the idea that the forest school approach can offer a unique opportunity for interactions not only between nature and children, but also between children and teachers, enabling the latter to detect child development more effectively than a simple rating of behavioral difficulties/problems or strengths in the traditional

school setting. These teacher's observations would also include the child's play activities in nature. Improvements were also observed in motor abilities as assessed through observational self-reported measurements of child behavior (Agostini et al., 2018) and a battery of tests focused on motor function (Fjørtoft & Sageie, 2000; Fjørtoft, 2001; Fjørtoft, 2004). There were no significant changes in objectively measured motor activity using actigraphy (Fyfe-Johnson et al., 2019; Müller et al., 2017). This might be due to the fact that the children in the comparison group could spend hours in an outdoor enrichment class offered via a traditional school activity. It is possible that these children had higher physical activity than those attending forest preschools. Future studies should consider both the quantitative (as measured by accelerometers) and qualitative assessment of physical activity (e.g., in terms of pleasure in doing physical activity) to gain a more comprehensive picture of children's behavior.

Two other studies reported improvements in nature connectedness (Barrable & Booth, 2020a, 2020b; Elliot et al., 2014), and this is consistent with previous literature on nature-based schools (Barrable & Booth, 2020b; Johnstone et al., 2022) and with the literature assessing benefits to children from exposure to nature (Gill, 2014), suggesting that preschool children actively involved in learning activities in nature appeared to increase their feelings and connectedness to the natural world. In contrast, other studies showed no differences in attitudes/behaviors towards nature (Cordiano et al., 2019; Müller et al., 2017). This could be because nature-based education improves environmentally responsible behavior only over longer time spans. Another explanation might lie in the ways environmentally responsible behavior was assessed. Several standardized scales have been developed for adults and children, but not for preschool children, especially those in the outdoor education setting. The way pro-environment behaviors were measured might not capture individual differences in nature-oriented behaviors among children attending forest preschools. Future researchers should try to develop more precise measures.

Furthermore, improvements in other subjective outcomes were detected: children attending forest school demonstrated greater curiosity (Ernst & Burcak, 2019), improved sleep quality as assessed by parents (Choi et al., 2014), and greater psychological resilience as assessed by both parents and teachers (Ernst & Burcak, 2019). There were no significant differences in the attitude towards school (Cordiano et al., 2019) and in physical health with regard to illness and injuries (Frenkel et al., 2019). In general, although some factors suggested other benefits of attending forest school, having only one study for each subjective outcome and those studies' design issues (e.g., small sample size, weak study design) means that we should be cautious when inferring causality.

Our second research question asked how forest preschool experiences were evaluated. This review identified a marked heterogeneity in the methods and tools used to assess the benefits of forest preschools for children (see Table S4 in the Supplementary Material for details). Outcomes of interest were primarily measured by self-reported scales or cognitive and behavioral tasks, and only two studies used objective measures to assess motor activity. Most studies (64%) collected evidence of forest preschool experiences from child perceptions, 42% also included teacher perceptions, and only 24% considered parents' perceptions of the outcomes considered

here. In general, the assessment of such different areas of child development and the use of different tools and methods to assess children's experience in school indicates interest in examining the effects of forest preschools' educational approach. It is important to point out, however, that the lack of adequate methodological procedures makes it difficult to capture the causal effects of the forest preschool experience in preschool children. Future studies should collect more evidence on the same outcomes of interest using the same method and tools to replicate the benefits found in the studies reviewed here.

We also examined the methodological quality of each study. Although the present review suggests that various children attending forest preschools reported some advantage, caution is necessary given that this literature revealed various methodological weaknesses (overall judgement ranging from moderate-to-high risk of bias). Some methodological weaknesses were, in fact, often identified, such as inadequate pre-post assessment (often only a single measurement of the outcome of interest), no follow-up measurements, unreliable outcome measurements (e.g., due to the absence of independent raters or interrater reliability), and suboptimal statistical methods (e.g., sample sizes too small for an adequate statistical power). Future studies should adopt a rigorous and preferably preregistered study design to confirm and extend the findings summarized here. They should also examine whether forest preschool

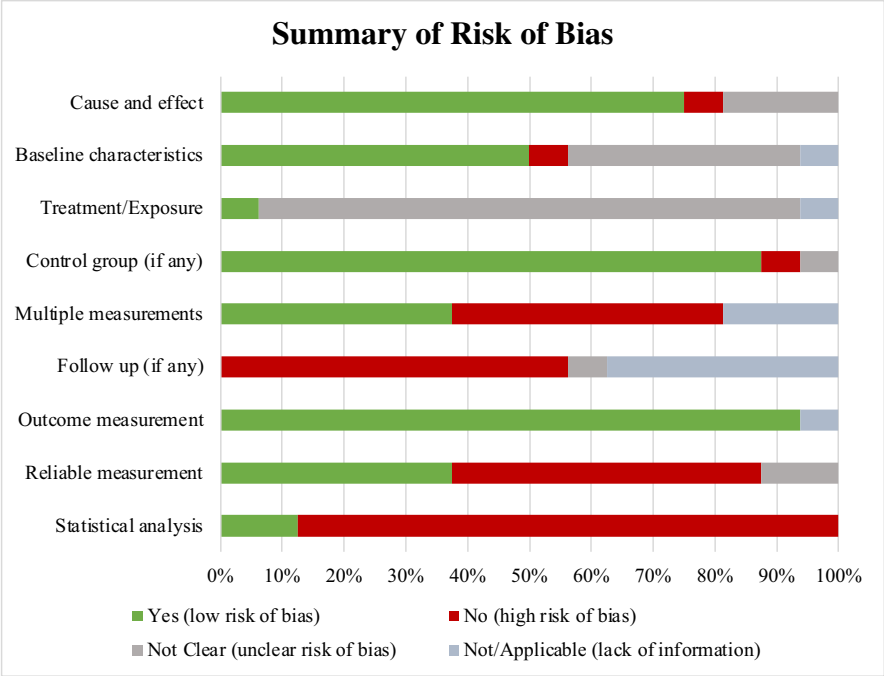

Fig. 2 Stacked bar graph shows summary of authors' judgements results in percentage (%) for each criterion of the Joanna Briggs Institute (JBI) Critical Assessment checklist for quasi-experimental design (Munn et al., 2020)

activities have long-lasting effects on children's development and how they might influence other child domains (e.g., emotional and academic skills).

Some limitations of this review should be acknowledged. The inclusion of methodologically heterogeneous studies and the heterogeneity of outcomes made a meta-analysis of the results infeasible. Future studies should make efforts to accumulate more evidence on this topic and then perform both a systematic review and a meta-analysis, along with a preregistration protocol (as this was not done here) to qualitatively and quantitatively confirm the effects of forest preschool as found in the present review. We also summarized the characteristics of the setting and type of school activities of the forest preschools at study and outcome levels (Table 1; see also Table S1, Supplementary Material). A thematic/qualitative analysis examining the different school activities in nature would be useful to establish practical suggestions and implications for replicating such a forest preschool approach in future studies. In addition, our review included all articles that emerged in the selected databases. Future reviews should focus on other databases, not only those relevant to psychological research, to broaden the search for evidence. In the future, it would be interesting to include samples of children with chronic health problems or specific learning disabilities (like deficits in language and speech development) to investigate the effects of nature on their health and well-being.

Noteworthy, the present systematic review examined the available evidence on preschools adopting the forest school approach. Despite their promising results regarding the benefits of forest school attendance on different psychological outcomes (albeit with varying degrees of uncertainty; see Table 1) for preschool children, there were differences between the nature-based education programs considered here. There were studies that included forest preschools or kindergartens (e.g., Choi et al., 2014; Elliot et al., 2014; Fjørtoft & Sageie, 2000; Fjørtoft, 2001, 2004) and studies that included nature-based preschools—though called with different names (e.g., kindergarten in nature: Müller et al., 2017; or nature nurseries; Barrable & Booth, 2020a, 2020b; nature-based pre-primary program: Cordiano et al., 2019). Although these studies have nature as an educational setting in common—which is interconnected into the philosophy and educational practices, and children spend most of their day outdoors in immersive nature experiences—, the forest preschool or kindergarten learning programs typically focus on a child/learner-oriented approach integrated in play and learning activities in nature (e.g., Sobel, 2014; Waite & Goodenough, 2018).

Furthermore, these nature-based learning programs also varied for the characteristics of the proposed outdoor learning activities and for the types and modalities of exposure to nature in the learning programs (see Table S1, Supplementary Material). The different degree of exposure to nature in outdoor learning activities during the day might be not sufficient to influence or lead to psychological benefits in all learning programs that adopt the forest school approach (including forest preschool, forest kindergarten, nature nursery, nature kindergarten, or outdoor learning programs). Future studies should then make an effort to implement and design forest school programs with more emphasis on forest school principles and pedagogical features (see the key principles provided by the Forest School Association, FSA, 2017; see also Waite & Goodenough, 2018), along with more methodologically sound procedures (i.e., valid tools and instruments, and methodologies) to examine

the effectiveness of forest preschools on psychological and educational outcomes in children, as a potential means of supporting preschool children to engage with learning and education, and promote more psychological benefits through the contact with nature during their learning experiences.

In conclusion, this review shows a prevalence of positive effects in children attending forest preschools; in particular, improvements were detected in motor and physical development, creative thinking, psychological resilience and curiosity, connectedness to nature, and sleep quality. More controversial results emerged for cognitive function and generic areas of child development; therefore, these should be further investigated. The methods and instruments used in the reviewed studies are manifold: Both cross-sectional and longitudinal designs were used, and the information was collected either through a teacher's or parent's perceptions or directly by children's responses. The growing interest in early childhood education with nature-based outdoor learning and the promising results summarized here suggest the importance of continuing to adopt a forest preschool approach for preschool children.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10648-023-09750-4.

Funding Open access funding provided by Università degli Studi di Padova within the CRUI-CARE Agreement.

Data Availability The data that support the findings of this study are available from the corresponding author, ES, upon reasonable request.

Declarations

Conflict of Interest The authors declare no competing interests.

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Authors and Affiliations

Enrico Sella[1] · Monica Bolognesi[1] · Emma Bergamini[1] · Lucia Mason[2] · Francesca Pazzaglia[1,3]

Monica Bolognesi
monica.bolognesi@studenti.unipd.it

Emma Bergamini
emma.bergamini.work@gmail.com

Lucia Mason
lucia.mason@unipd.it

[1] Department of General Psychology, University of Padova, Via Venezia, 8, 35131 Padova, Italy

[2] Department of Developmental Psychology and Socialization, University of Padova, Via Venezia 8, 35131 Padova, Italy

[3] Interuniversity Research Centre in Environmental Psychology (CIRPA), University of Rome "La Sapienza", Via Dei Marsi 78, 00185 Rome, Italy