



# Mindfulness and connectedness to nature: A meta-analytic investigation

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## ABSTRACT

The traits of mindfulness and connectedness to nature may have a reciprocal relationship. Mindfulness, which consists of non-evaluative awareness, may allow individuals to feel more connected to nature, and connection to natural environments may help foster mindfulness. A number of studies have investigated the association between trait mindfulness and connectedness with nature. The current meta-analytic investigation consolidated the findings from these studies. Across 12 samples, which included 2435 individuals, there was a significant relationship between mindfulness and connectedness to nature, with a weighted effect size of  $r = 0.25$ . Moderator analyses indicated that studies with older participants and studies with community participants rather than students found significantly stronger associations between mindfulness and connectedness to nature. Associations between mindfulness and connectedness with nature varied significantly depending on measures of mindfulness used. These meta-analytic findings provide a foundation for (1) future intervention programs aimed at drawing on nature exposure to increase mindfulness and (2) intervention programs intended to enhance connectedness to nature through mindfulness.

## 1. Introduction

### 1.1. Mindfulness

Mindfulness consists of a focus on the present moment in a state of non-judgmental awareness (Brown & Ryan, 2003; Kohls, Sauer, & Walach, 2009). Mindfulness can be a relatively stable individual-difference characteristic or trait as well as a transitory state (Brown & Ryan, 2003; Kohls et al., 2009). Trait and state mindfulness may interact. A higher level of trait mindfulness may translate into more frequent mindful states. Practices that lead to mindful states may result over time in increased dispositional or trait mindfulness (Grossman, Niemann, Schmidt, & Walach, 2004).

A higher level of trait mindfulness is associated with a variety of beneficial characteristics. These characteristics include more positive affect, less negative affect, greater life satisfaction, and greater autonomy and competence (Brown & Ryan, 2003; Giluk, 2009). Meta-analyses of mindfulness interventions have found that increases in mindfulness are associated with a variety of beneficial well-being outcomes (Grossman et al., 2004; Khoury et al., 2013). Mindfulness interventions can also ameliorate distress, such as symptoms of post-traumatic stress (Hopwood & Schutte, 2017).

### 1.2. Connectedness to nature

Humans may have an intrinsic tendency, shaped by evolution, to want connections to nature and to benefit from these connections (Kahn, 2011; Wilson, 1984). As well as being a universal tendency, desire for nature connectedness may be stronger in some individuals than others and can comprise a relatively stable individual-difference characteristic (Tam, 2013).

Connectedness to nature has beneficial psychological and health effects (Capaldi, Dopko, & Zelenski, 2014; McMahan & Estes, 2015; Richardson, Maspero, Golightly, Sheffield, & Staples, 2017). For example, in a meta-analysis of findings from 30 samples, Capaldi et al. (2014) found that a higher level of connectedness to nature was associated with more positive affect, greater vitality, and higher life satisfaction.

The non-judgmental awareness and presence that is central to mindfulness may facilitate the development of a sense of connectedness to nature. Such awareness may allow individuals to engage with nature experiences more fully, resulting in the building of a sense of connection to or oneness with nature. In a reciprocal relationship, contact with natural environments may restore attention capability (Passmore & Holder, 2016) and may allow an effortless sense of presence in an environment to which humans are adapted through evolution (Kahn, 2011; Wilson, 1984). Thus, a cycle of interaction between nature and mindfulness may result in an association between the traits of

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mindfulness and connectedness to nature.

A number of studies have examined the association between mindfulness and connection to nature. These studies have varied in that they examined this association in different populations, such as students (e.g., Wolsko & Lindberg, 2013) and community members (e.g., Unsworth, Palicki, & Lustig, 2016), in samples with older (e.g., Richardson & Sheffield, 2015) and younger (e.g., Tipsord, 2009) mean ages, and in samples with different proportions of women and men. These studies have also varied in approach to assessment of mindfulness through use of different measures such as the Five Facet Mindfulness Questionnaire (Baer et al., 2008) or the Mindful Attention Awareness Scale (MacKillop & Anderson, 2007) and assessment of connection to nature through use of different measures such as the Connectedness to Nature Scale (Mayer & Frantz, 2004) or the Allo Inclusive Nature Scale (Leary, Tipsord, & Tate, 2008). Finally, these studies found varying effect sizes for the association between mindfulness and connectedness to nature. Because the magnitude of the effect size of the association between mindfulness and connectedness to nature has varied between studies, the overall effect size of the association is unknown. A meta-analysis can provide useful information regarding such an overall effect size.

### 1.3. Purpose of the investigation

The purpose of the present meta-analytic investigation was to consolidate the results of studies investigating the association between mindfulness and connection to nature. The meta-analysis tested the hypothesis that across studies a higher level of mindfulness would be associated with more connectedness to nature. Exploratory meta-analytic moderator analyses investigated features of studies that might relate to the strength of the association between mindfulness and connectedness to nature.

## 2. Materials and methods

### 2.1. Identification of studies and extraction of data

The inclusion criteria for studies were that they (a) measured both level of mindfulness and level of connectedness to nature and (b) provided sufficient statistical results to allow the calculation of an association effect size suitable for meta-analysis. We searched the data bases Embase, Cochrane, Clinical Key, CINAHL Complete, Pubmed, Psyc INFO, Proceedings of the National Academy of Sciences and Google Scholar using the terms mindful, mindfulness and nature. We also searched the reference lists of articles relating to mindfulness and connection to nature for possible other studies for inclusion. Fig. 1 shows the search process and the number of resulting samples.

Two raters independently coded the studies included in the meta-analysis on (1) the effect size for the association between mindfulness and connection to nature, (2) *N*, (3) mean age of the sample, (4) percent of females in the sample, (5) nature of the population comprising the sample (university students, community, or mixed), (6) the mindfulness scale used in the study, and (7) the connectedness to nature scale used in the study. Effect sizes for all studies were based on cross-sectional designs, convenience samples, and reliable and valid measures of mindfulness and connectedness to nature; thus, study quality was similar for studies and was not coded. Inter-rater agreement for coding was 97%. The ratings on which there was not initial agreement were discussed and consensus reached on the final rating.

### 2.2. Data analyses

The meta-analysis used *r* as the effect size. When more than one effect size for the association between mindfulness and connectedness to nature was reported for the same sample, the effect sizes were averaged. Comprehensive Meta-Analysis Version 3.3 (CMA; Borenstein,

Hedges, Higgins, & Rothstein, 2014) was used to calculate the overall weighted effect size for the association between mindfulness and connectedness to nature. The CMA software was also used to perform meta-regressions and moderator analyses for these effects. According to Borenstein, Hedges, Higgins, and Rothstein (2009), a random effects model should be used when one cannot assume that the true effect will remain stable across studies. Because the sample populations differed and the effect sizes were expected to vary, we used a random effects model.

## 3. Results

### 3.1. Overall effect size for the association between mindfulness and connectedness to nature

To test the hypothesis that across studies a higher level of mindfulness would be associated with greater connectedness to nature, a mean effect size was calculated for all samples included in the meta-analysis ( $k = 12$ ), which comprised a total of 2435 individuals. Table 1 shows the effect sizes for each study (reported as *r*). The overall mean weighted effect size was  $r = 0.25$ , 95% CI [0.17, 0.33],  $p < 0.001$ , indicating that across samples higher mindfulness was associated with greater connectedness to nature. Fig. 2 shows the forest plot of effect sizes for studies.

### 3.2. Publication bias

A classic fail-safe *N* test, Orwin's fail-safe *N* and Duval and Tweedie's trim and fill procedure with funnel plot tested publication bias. The fail-safe *N* of 407 indicated that 407 studies finding no association between mindfulness and connectedness to nature would be needed to bring the meta-analytic effect size to a non-significant result. Orwin's fail-safe *N* suggested that 16 studies with a 0.00 correlation would be need to bring the meta-analysis *r* to a small correlation of 0.1. The funnel plot was slightly asymmetrical, and Duval and Tweedie's trim and fill, which produces an unbiased adjusted effect size through trimming and imputing to create a symmetrical funnel plot, resulted in an adjusted *r* of 0.24.

### 3.3. Heterogeneity analysis

Heterogeneity statistics showed a significant Q-Statistic,  $Q(11) = 45.6$ , 95% CI (18, 0.35),  $p < 0.001$  and an  $I^2$  index of 76. These results indicate heterogeneity, with the effect sizes across studies varying significantly. The  $I^2$  index indicates that 76% of the dispersion of effect sizes is due to difference between the true effects, rather than sampling error. The results indicate that across studies effect sizes varied adequately to warrant moderator analyses.

### 3.4. Moderator analyses

#### 3.4.1. Meta-regression analyses

Method of moments meta-regression assessed the moderating effect of the continuous variables of mean age of samples and percent of female participants in samples on the association between mindfulness and connectedness to nature. Samples in which participants had a higher mean age showed significantly greater effect sizes (slope = 0.012,  $SE = 0.003$ , 95% CI [0.006, 0.018],  $p = 0.0001$ ). The percentage of females in samples was not significantly associated with the effect size (slope =  $-0.001$ ,  $SE = 0.004$ , 95% CI [ $-0.009$ , 0.006],  $p = 0.74$ ).

#### 3.4.2. Categorical moderator analyses

Categorical moderator analyses examined the impact of type of population comprising samples, the scale used to assess mindfulness, and the scale used to assess connectedness with nature on the

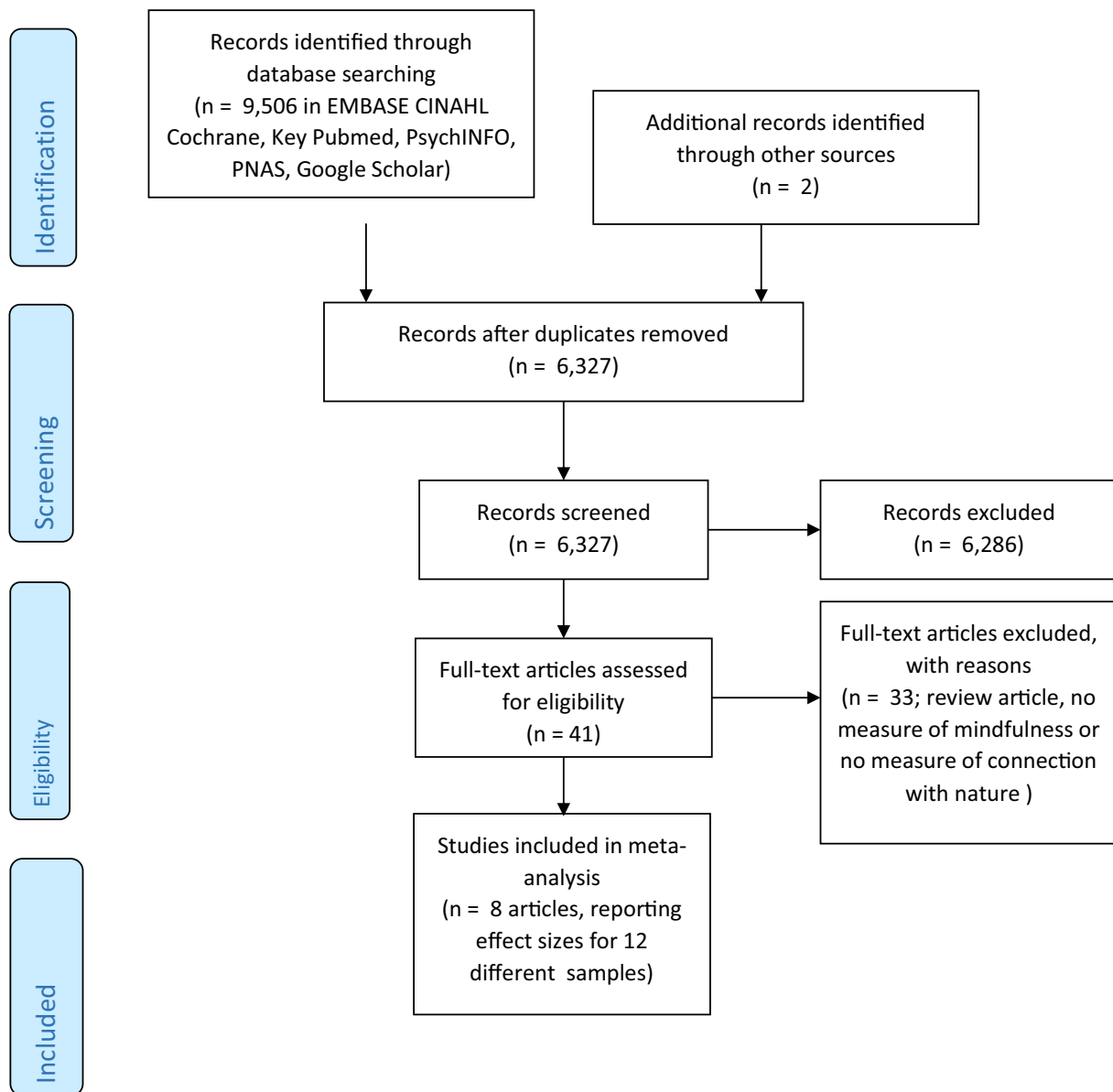


Fig. 1. PRISMA flow chart showing process of identifying, screening, excluding, and including studies for the meta-analysis.

Table 1  
Characteristics of studies.

Study sample	N	Mean age	% female	Population	mindfulness scale	Nature scale	Effect size (r)
Barbaro and Pickett (2016) sample one	342	20	68	Students	FFMQ	CNS	0.28
Barbaro and Pickett (2016) sample two	296	38	60	Community	FFMQ	CNS	0.42
Hamann and Ivtzan (2016)	62	40	74	Mixed	Freiburg	CNS	0.46
Howell, Dopko, Passmore, and Buro (2011) sample one	452	22	69	Students	MAAS	CNS	0.30
Howell et al. (2011) sample two	263	20	68	Students	Multiple	Multiple	0.18
Nisbet (2011)	207	28	78	Mixed	Other	Multiple	0.26
Richardson and Sheffield (2015)	137	35	77	Students	MAAS	CNS	0.34
Tipsord (2009) sample one	140	19	67	Students	MAAS	AIN	0.20
Tipsord (2009) sample two	50	NR	NR	Students	FFMQ	AIN	0.29
Unsworth et al. (2016)	25	31	68	Community	Freiburg	INS	0.52
Wolsko and Lindberg (2013) sample one	265	30	63	Students	MAAS	CNS	0.15
Wolsko and Lindberg (2013) sample two	223	33	61	Students	MAAS	CNS	0.16

Note: NR = not reported; FFMQ = Five Facet Mindfulness Questionnaire; Freiburg = Freiburg Mindfulness Inventory; MAAS = Mindful Attention Awareness Scale; CNS = Connectedness to Nature Scale; AIN = Allo Inclusive Nature Scale; INS = Inclusion of Nature in Self Scale.

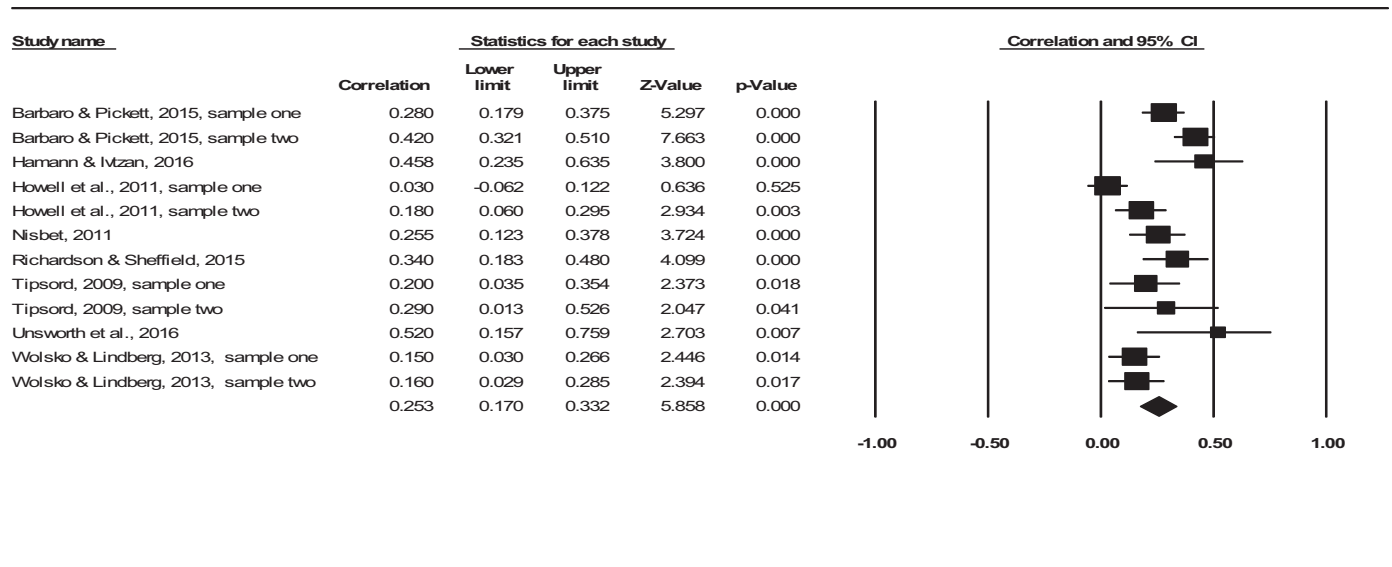


Fig. 2. Random-effects model forest plot showing relative weights for effects of the association between mindfulness and connectedness to nature.

Table 2  
Categorical moderator analyses.

Category	r	95% CI	Z	p	k
Population type, $Q(2) = 14.78, p = 0.001$					
Community	0.43	[0.33, 0.51]	8.11	0.001	2
Mixed	0.34	[0.13, 0.52]	3.08	0.002	2
Students	0.19	[0.12, 0.27]	4.79	0.001	8
Mindfulness measure, $Q(2) = 8.29, p = 0.02$					
FFMQ	0.31	[0.20, 0.41]	5.51	0.001	4
Freiburg	0.46	[0.29, 0.63]	4.65	0.001	2
MAAS	0.18	[0.07, 0.28]	3.25	0.001	5
Nature measure, $Q(1) = 0.13, p = 0.72$					
AIN	0.22	[0.08, 0.36]	3.08	0.023	2
CNS	0.26	[0.13, 0.37]	4.00	0.000	7

Note.  $r$  = point estimate of the effect size; CI = the 95% lower and upper limits of  $r$ ;  $Z = z$  test to test statistically significance of effects within each category;  $p$  = significance level;  $k$  = the number of outcomes;  $Q$  = test statistic determining whether the effect varies significantly between the subcategories of the moderator variable (random effects model used); FFMQ = Five Facet Mindfulness Questionnaire; Freiburg = Freiburg Mindfulness Inventory; MAAS = Mindful Attention Awareness Scale; CNS = Connectedness to Nature Scale; AIN = Allo Inclusive Nature Scale.

association between mindfulness and connectedness to nature. Meta-analytic moderator analyses require at least two effect sizes in each category in order to have variance in the category. Table 2 shows the categorical moderator analysis results.

The type of study sample and the mindfulness measure used in studies were significant moderators. Studies with participants drawn from the general community had a larger effect size than studies with student samples. Studies using the Freiburg Inventory to assess mindfulness had larger effect sizes, while studies using the Mindful Attention Awareness Scale had smaller effect sizes. There was no significant difference between studies using different measures of connectedness to nature.

#### 4. Discussion

The meta-analysis consolidated findings of the association between the traits of mindfulness and connectedness to nature from 12 samples. A total of 2435 individuals participated in these studies. Across studies there was a significant meta-analytic association between greater mindfulness and more connectedness to nature. The overall weighted

effect size was  $r = 0.25$ .

The meta-analytic finding that greater mindfulness is associated with feeling more connected to nature supports theoretical assumptions regarding mindfulness and nature. Non-judgemental awareness and presence features of mindfulness (Brown & Ryan, 2003) may encourage individuals to more fully engage with nature experiences and develop a sense of connectedness to nature. Contact with natural environments may restore attention capability (Passmore & Holder, 2016) and allow relatively effortless attention and processing in an environment to which humans are evolutionarily adapted (Kahn, 2011; Wilson, 1984). A cycle of interaction between nature and mindfulness may result in strengthening associations between mindfulness and connectedness to nature.

Some preliminary experimental research also supports the notion of a reciprocal, bi-directional relationship between connectedness to nature and mindfulness. For example, Hamann and Ivztan (2016) found that participants who were randomly assigned to a nature intervention consisting of spending at least 30 min a day in nature for 30 days showed significant increases in mindfulness compared to participants in a control condition. In relation to mindfulness increasing connection to nature, Aspy and Proeve (2017) found that participants assigned to a mindful meditation intervention reported greater connection to nature compared to participants in a control condition.

The meta-analysis found that studies with older participants and with community rather than student participants found significantly stronger associations than other studies. These moderation findings can be viewed in the context of a proposed reciprocal relationship between mindfulness and connectedness to nature. Older individuals are likely to have had more opportunities to engage with nature and to experience mindfulness-enhancing qualities of nature. Thus, older individuals may have experienced more of the proposed reciprocal relationships between nature and mindfulness. Community participants in the studies providing results for the meta-analysis tended to be older than student participants; thus the same reciprocal effect between contact with nature and mindfulness may be an explanation for the moderation finding regarding community versus student participants.

The meta-analysis found a significant difference in the effect sizes of studies using different measures of mindfulness. It may be that some mindfulness measures, such as the Freiburg Mindfulness Inventory (Kohls et al., 2009) capture aspects of mindfulness especially relevant to connectedness with nature. All of the measures of mindfulness used in the studies included in the meta-analysis have sound psychometric

properties (Park, Reilly-Spong, & Gross, 2013). Some, such as the Freiburg Mindfulness Inventory, assess dimensions of mindfulness such as non-evaluation of experience as well as present moment awareness, and it may be that capturing multiple dimensions of mindfulness contributes to finding a stronger association between mindfulness and connectedness to nature. Only two of the studies used the Freiburg measure, so caution is warranted in interpreting this moderator result. There was no difference in the association between mindfulness and connectedness to nature between studies using different measures of connection to nature.

The finding across studies of a significant association between mindfulness and connection to nature adds to previous findings regarding the correlates of connection to nature. For example, Capaldi et al. (2014) found meta-analytic effect sizes for the association between connectedness to nature and vitality at  $r = 0.24$ , connectedness to nature and positive affect at  $r = 0.24$ , and life satisfaction at  $r = 0.17$ . The  $r$  of 0.25 for the association between connection to nature and mindfulness found in the present meta-analysis is similar to the effect size for other positive characteristics. Thus, mindfulness can be added to the set of positive characteristics that have been found to be associated with connectedness to nature across studies. The meta-analytic findings also add to previous findings regarding the connection between mindfulness and other characteristics, such as positive affect, life satisfaction, autonomy, and competence (Brown & Ryan, 2003; Giluk, 2009).

Some cautions should be kept in mind when considering the results of the present meta-analysis. First, the overall weighted effect size for the association between mindfulness and connection to nature was based on studies available at present. Second, the correlational results do not show causation. Third, the moderator results are quasi-experimental as there was no random assignment across studies of types of participants or measures. Fourth, because the studies included in the meta-analysis had similar designs and used reliable and valid measures, it was not feasible to examine study quality as a moderator.

Future research might further investigate aspects of mindfulness and connectedness to nature that are especially relevant to the interaction between these characteristics. Programs intended to increase mindfulness and programs intended to enhance connectedness to nature may benefit from drawing on findings relating to the bond between these characteristics, and it would be useful for future research to investigate optimal approaches to drawing on this bond. Research investigating the effect of a cycle of reciprocal interactions between connection to nature and mindfulness might shed further light on the development of these beneficial characteristics and approaches to enhancing them.

## 5. Conclusions

Across studies there is a significant association between connection to nature and mindfulness. This relationship confirms theoretical assumptions regarding both connection to nature and mindfulness. The bond between connection to nature and mindfulness may also inform programs intended to increase mindfulness and programs intended to increase connection to nature.

## Conflict of interest

The authors declare no conflict of interest.

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<sup>1</sup> Note: articles reporting studies included in the meta-analysis are marked with an \*.