**Literature Review**

A Systematic Review of the Key Mechanisms Underpinning Psychological Change Following Nature Exposure in an Adolescent Population.

**Empirical Paper**

Contact with Nature in Adolescents Experiencing Depressive Symptomology. A Pilot, Two-Week, Psychoeducation Intervention.

Submitted by Megan Alison Rowley, to the University of Exeter as a thesis for the degree of Doctor of Clinical Psychology, March 2022.

## Contents

# A Systematic Review of the Key Mechanisms Underpinning Psychological Change Following Nature Exposure in an Adolescent Population.

Megan Alison Rowley

**Primary Research Supervisor:** Dr Matthew Owens-Solari

**Secondary Research Supervisor:** Dr Raluca Topciu

**Nominated Journal:** Journal of Adolescent Health

This manuscript has been submitted in partial fulfilment of a Doctoral degree in Clinical Psychology.

**Abstract**

This systematic review aimed to identify mechanisms of psychological change following exposure to nature within an adolescent population. Keyword searches within Scopus, PsychINFO and Web of Science were carried out to include articles that were published by 14th September, 2021. Records were reviewed in line with inclusion criteria: adolescents with an average age of 24 and under, inclusion of exposure to nature compared to a control condition using an experimental or quasi-experimental design and outcomes relating to mental health and psychological status. The systematic review resulted in the inclusion of 27 papers that were assessed for methodological quality and manually searched for the inclusion of mediation analyses. A range of psychological outcomes were identified and grouped into 10 categories: Mood and Affect, Mental Health, Wellbeing, Perceived Restoration, Stress, Energy, Cognitive Functioning, Resilience, Self-Concept and Pro-Social Behaviour. Only one formal mediation analysis was reported, highlighting a mediating role of belonging in increases in resilience. Limitations include the majority use of undergraduate samples and over half of the papers being of low methodological quality. No firm conclusions on key mechanisms in an adolescent population were made due to insufficient evidence of mediating variables. The development of methodologically rigorous experimental studies with the inclusion of statistical pathway modelling is needed to test and specify plausible mechanisms.

Keywords: nature exposure, mechanisms, adolescence, systematic review, mental health, prevention.

Adolescence presents a key developmental window for the prevention of mental health disorders, highlighting it as a critical time to intervene (Muñoz et al., 2010). Exposure to nature is a modifiable lifestyle behaviour that shows promise in supporting the prevention of mental health difficulties given its benefits to health and wellbeing (Hartig et al., 2014; Hossain et al., 2020). A central aspect of health research is to identify mechanisms that account for the observed benefits, which is invaluable to the design and testing of strategies to promote the beneficial effects of nature exposure (Frumkin et al., 2017). As such, there is a need to understand why nature exposure leads to psychological benefits in an adolescent population. Specifying and investigating these key underlying mechanisms of change will be imperative in developing effective nature-based interventions for mental health and wellbeing in this period of development. Furthermore, it is particularly important to identify any key mechanisms that may also be implicated in the development and maintenance of mental health difficulties to enable the best chance of mitigating against the risk factors for the development of disorders. Whilst previous reviews have aimed to explore psychological outcomes following nature contact in children and adolescents (Roberts et al., 2020; Tillmann et al., 2018), further investigation is needed specifically in an adolescent population, with a consideration of suggested mechanisms of change.

Adolescence presents a period of significant vulnerability to mental health problems with 75% of adult mental health disorders emerging before 25 years of age (Blakemore, 2019; Jones, 2013; Kessler et al., 2007). The experience of mental ill health in adolescence, such as depression, has significant consequences on health in young adulthood and places increased burden on society through associated direct and indirect costs (Keenan-Miller et al., 2007). As such, adolescence highlights a key developmental window for the intervention of mental health difficulties, aimed at averting their course (Muñoz et al., 2010; 2012).

Given the heightened potential for prevention in adolescence as a period of development, targeting lifestyle behaviours as modifiable factors associated with common mental health disorders has been suggested as a key intervention strategy (Jacka et al., 2012). Lifestyle psychiatry is an approach that aims to facilitate the management of mental health disorders via a holistic approach to health (Noordsy, 2019). Whilst this has traditionally focused on areas such as physical activity, diet and nutrition, adequate sleep, and stress management, it also offers the opportunity for immersion in nature. With a growing evidence base for the impact of nature on health and wellbeing (Hartig et al., 2014; Hossain et al., 2020), and a sound evidence base for the emotional benefits of exposure to nature (Capaldi et al., 2015), there has been a call to focus on nature as a key, targetable lifestyle factor in clinical practice (Piotrowski et al., 2021).

Nature can be defined as "areas containing elements of living systems that include plants and nonhuman animals across a range of scales and degrees of human management" (Bratman et al., 2012, p. 120). The connection between nature and health and mental wellbeing is underpinned by a suggested affinity to nature as outlined in E.O. Wilson's Biophilia Hypothesis (Wilson, 1984). Biophilia, literally meaning a 'love of life', states that humans have a connection to nature that is both adaptive in response to evolving in natural environments and innate in origin (Kellert & Wilson, 1995).

Nature has been found to directly promote multiple aspects of health, including mental health and wellbeing (Hartig et al., 2014; Hossain et al., 2020). The psychological benefits associated with exposure to nature have been particularly highlighted and encompass emotional and cognitive functioning, wellbeing and other dimensions of mental health, such as depressive symptoms, anxiety, affect and stress (Capaldi et al., 2015; Hossain et al., 2020). More specifically, in children and adolescents, nature exposure has been found to lead to improvements in mental health outcomes including mood, emotional wellbeing, resilience

and stress, alongside beneficial improvements in attention and memory (McCormick, 2017; Mygind et al., 2019; Norwood et al., 2019; Tillmann et al., 2018; Vanaken & Danckaerts, 2018; Zhang et al., 2020).

Vanaken and Danckaerts (2018), for example, found credible support for a confounder-adjusted (demographic and socio-economic) relationship between green space exposure and general mental health, as indicated by research using the Strengths and Difficulties Questionnaire, supporting the association between nature and mental health independent of cofounders that may also predict mental health. In another review, Mygind et al. (2019) found that, when focusing specifically on studies that compared immersive nature experiences with a control group, outcomes such as self-esteem and resillience were enhanced compared to comparison conditions. However, they concluded that these findings only conditionally provide recommendations for practice due to the low quality of evidence. With possible benefits highlighted, developing nature-based interventions aimed at supporting wellbeing and other dimensions of mental health has the potential to prevent the burden associated with mental ill health that develops in adolescence. Whilst the specific psychological mechanisms are less than clear, there has been a number of suggested theories through which nature has positive effects via psychological and psychophysiological recovery.

**Stress Reduction Theory (SRT; Ulrich et al., 1991)**

SRT suggests that nature promotes psychophysiological restoration through a reduction in stress and negative affect, alongside a shift to a more positively-toned emotional state. Believed to be grounded in the psycho-evolutionary theory of biophilia, exposure to unthreatening natural environments is posited to lead to stress-reducing psychophysiological responses, as a result of positive and pre-cognitive responses to nature (Bratman et al., 2021;

Capaldi et al., 2015). More specifically, unthreatening natural settings are believed to trigger an initial positive affective response. This, combined with the mobilisation of the parasympathetic nervous system, leads to higher levels of positive feelings, reduced negatively-toned feelings and a maintenance or restoration of attention and energy, which are adaptive to survival (Ulrich, 1981; Ulrich, 1983). Evidence for SRT following nature exposure is supported by the positive effects on various physiological and emotional parameters associated with stress recovery (Corazon et al., 2019; Largo-Wight et al., 2011). These outcomes have been particularly highlighted in the forest-bathing (or 'shinrin-yoku' in Japanese) literature (Antonelli et al., 2021).

**Attention Restoration Theory (ART; Kaplan & Kaplan, 1989)**

ART suggests that directed attention resources are replenished when in nature due to our involuntary attention resources engaging with intrinsically fascinating stimuli in the environment. More specifically, nature can be considered a restorative environment as it enables: 1) a sense of being away and thus a shift away from mental activity that requires directed attention, 2) soft fascination which is attentionally effortless, 3) a sense of extent, which enables the mind to be engaged with seeing and experiencing nature and 4) a high compatibility between the environment and an individual's purpose (Kaplan, 1995). Posited to lead to cognitive clarity and reduced mental fatigue (Hartig et al., 1991), research also supports restoration in cognitive domains, such as cognitive flexibility, working memory and attentional control, enabling greater effectiveness (Stevenson et al., 2018).

**Affect Regulation**

More recently, an evolutionary model of affect regulation and neurophysiology of emotion has been posited, in which nature-based wellbeing benefits are experienced through

an emotional state balance (Bratman, Young et al., 2021; Richardson et al., 2016). The model outlines how nature exposure brings emotional balance through activating certain aspects of our nervous system (Richardson, 2019). Furthermore, nature plays a role in increasing adaptive emotional regulation strategies and decreasing maladaptive ones, depending on the characteristics of and cues in the environment (Bratman, Olvera-Alvarez et al., 2021). Support for a model of affect regulation comes from evidence of individuals seeking natural environments to support their emotional regulation (Johnsen & Rydstedt, 2013; Korpela et al., 2018) and rumination reduction following nature contact, with evidence of this mediating the relationship between nature and negative affect (Bratman, Daily et al., 2015; Bratman, Hamilton, et al., 2015; Bratman, Young, et al., 2021; Mcewan et al., 2021).

As over-arching theories, SRT, ART and affect regulation provide candidates for key mechanisms of psychological change following nature contact. Research also suggests that there are additional constructs that may interact with or be independent of these theories. These include the perceived restorativeness (Han, 2018; Han, 2003; Hartig et al., 1997), specifically, a measure of the restorative components of natural environments, as indicated by ART, but is not necessarily predictive of or necessary for attention restoration (Pearson & Craig, 2014), and nature connectedness as a psycho-evolutionary need to affiliate with the natural environment (Capaldi et al., 2014). More recent and emerging theories suggest that there are other potential mechanisms of change between exposure to nature and psychological outcomes, some of which are of particular interest as they are also implicated in common mental health difficulties. These include: sleep (Shin et al., 2020), mindfulness, with support for it mediating the association between nature connectedness and wellbeing (Choe et al., 2020; Djernis et al., 2019; Nisbet et al., 2019; Van Gordon et al., 2018), and physical activity (Bélanger et al., 2019; Rogerson et al., 2020). Other key factors relating to psychological change and wellbeing have also been implicated, such as self-esteem, with

mixed outcomes, but possible effects via physical activity (Barton et al., 2016; Wood et al., 2014) and social cohesion (Jennings & Bamkole, 2019; Tilov et al., 2017).

Some mechanisms, in particular those that may also be implicated in the development and maintenance of mental health, such as mood and affect, stress, rumination, sleep etc. (Alvaro et al., 2013; Grierson et al., 2016; Salleh, 2008; Stanton & Watson, 2014) could be important, clinically relevant, modifiable mechanisms. Exploring these in the adolescent literature is imperative to the ongoing development of nature-based interventions aimed at supporting mental health and wellbeing specifically in this population.

Finally, whilst there is evidence for the beneficial effects of nature in adolescents, it is important to acknowledge that certain types of nature may not be adaptive for everyone. In recognising the relationship between human beings and the environment as favourable for survival, it is important to acknowledge the negative evolutionary feature, biophobia (Olivos-Jara et al., 2020). Biophobia can be considered as a fear of natural elements, allowing for a safe reaction to potential threats in the environment (Ulrich, 1993). Some natural environments or features, therefore, may be aversive to some. Furthermore, childhood nature experiences and direct experiences which evoked negative perceptions of nature have been found to predict disgust sensitivity to and fear expectancy of nature in young adulthood, meaning that some adolescents may have reduced preferences for nature (Sugiyama et al., 2021).

**Aim**

The aim of the current review is to identify any mechanisms of psychological change following exposure to nature within an adolescent population.

## Methods and Analysis

This systematic review is in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

### Search Strategy

Comprehensive electronic searches were conducted up to 14th September 2021 in three major databases: Scopus, PsychINFO and Web of Science (WOS). The search strategy used Boolean operators to combine key words indicative of nature, mental health and adolescents (Table 1). Individual terms were searched in the titles, abstract, and/or keywords of research articles. Search strategies for each database can be found in Appendix A. Research papers were manually reviewed for the inclusion of mediation analyses. Reference lists of articles screened at the full text stage were manually checked to find any additional publications relevant to the search question.

**Table 1**

*Search Terms with Boolean Operators*

| Key Word | | Search Terms |
|---|---|---|
| Nature | | "contact with nature" OR "nature exposure" OR "exposure to nature" OR "natur* experience*" OR "access to nature" OR "green space*" OR greenspace OR greenery OR greenness OR forests OR "forest school" OR "shinrin yoku" OR "shinrin-yoku" OR "forest bathing" OR "forest environment" OR wilderness OR "blue space" OR park OR parks OR woodlands OR countryside OR "urban forest" OR "outdoor adventure interventions" OR "adventure therapy" OR gardening OR "natur* environment*" OR "outdoor adventure education" OR "adventure education" OR "adventure program" OR outdoors OR "green exercise" OR "nature therap*" OR "green play" OR "nature therap*" OR ecotherapy* OR "school landscape" |
| Mental Health | AND | "mental health" OR anxiety OR depress* OR mood OR well-being OR wellbeing OR well-being OR "strengths and difficulties" |
| Adolescence | AND | adolescen* OR teen* OR "young people" OR "young adult*" OR youth* |

**Eligibility and Study Selection**

Following the removal of duplicate studies, all records were reviewed based on the title and abstract, in line with the inclusion and exclusion criteria outlined in Table 2 using the PICO tool (population, intervention, comparison, outcomes and study design*;* McKenzie et al., 2019). The population age parameter was set according to Sawyer and colleagues (2018) definition of adolescence ranging from age 10-24 years. Studies with participants over 24 years were included as long as the average age of the sample was 24 or younger. Research that included a therapeutic intervention, such as wilderness-based therapies, outdoor psychotherapy and outdoor behavioural healthcare, were not included in order to distinguish

the impact of nature from the impact of therapeutic intervention on mental health. Beyond the PICOs question, research studies were limited to those published since 1990, in peer-reviewed journals and in the English language. All studies identified as potentially relevant were then reviewed in full text. A second independent reviewer reviewed six studies (20%) at the full text stage based on inclusion and exclusion criteria which resulted in full agreement.

**Table 2**

*Inclusion and Exclusion Criteria Based on the PICOs Question*

| PICOS | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| *Population* | Samples with an average age of 24 and under | |
| *Intervention* | Exposure to all types of nature | A therapeutic intervention or intervention delivered by trained mental health professionals |
| *Comparison* | All comparison groups | A lack of control group |
| *Outcomes* | Changes in mental health and psychological status | |
| *Study Design* | Experimental or quasi-experimental | |

**Data Extraction**

The following data were extracted using a pre-designed data extraction form: author(s), year of publication, country of study, population, sample size, mean age of sample, gender of participants, study design, type of nature exposure (experimental condition), comparison condition, outcome measures, data collection time points, main effects and inclusion of mediation analysis. Study authors were contacted where necessary information was missing.

**Study Quality and Risk of Bias**

Research articles were assessed using the Effective Public Health Practice Project (EPHPP) quality assessment tool (Appendix B; Thomas et al., 2004). The EPHPP tool assesses methodological quality on the basis of six components: selection bias, study design, confounders, blinding, data collection methods and withdrawals and drop-outs. The component sections are rated according to three outcomes: strong, moderate and weak. The overall global rating for each article is then classified according to the number of "weak" ratings it received, whereby strong is considered to have no weak ratings, moderate has one weak rating and weak has two or more weak ratings. A second independent reviewer reviewed the methodological quality of three papers. A weighted comparison of the reviewer ratings suggested substantial inter-rater agreement ($\kappa = .71$, $p = <.001$). Any discrepancies were resolved through a discussion and this subsequently led to the overall quality rating of one paper to be amended. The quality assessment tool was used in line with the authors recommendations whereby outcomes of only strong and moderately rated studies were included in the review (Thomas et al., 2004).

**Data Synthesis**

Main results from strong and moderately rated studies were extracted and organised into categories of outcomes on the basis of outcome measures used and the measurement of similar concepts. This iterative process involved discussion of suitable categories within the research team. Outcomes were then grouped into significant and non-significant findings within each category of methodological quality. A meta-analysis was not conducted due to large heterogeneity in outcomes and study characteristics including types of natural environments, types of nature contact and gender of participants.

## Results

### Search Results

A flowchart indicating the search outcome at each stage of the process can be seen in Figure 1. 76 papers were included for full-text review and 37 met eligibility criteria; however, a further 10 studies were excluded on the basis of using a semantic differential method (Osgood et al., 1957) as the sole psychological outcome measure, as these articles showed insufficient evidence of the development and validity of their primary outcomes, leading to uncertainty of the measurement rigour. This resulted in the inclusion of 27 papers for review.

### Study Characteristics

The characteristics of the 27 included papers in line with the PICOs criteria are shown in Table 3. All studies were published between 1996 and 2021 and were carried out across three continents: Asia, Australasia and Europe. When considering study designs, 20 studies adopted an experimental design and seven used a quasi-experimental design, whereby the method of allocating participants to conditions was not under the control of the investigators and therefore was not randomised. For comparison groups, 20 of the designs had an active control condition, six were education as usual and one wait-list for intervention. One study did not include a non-nature control. When considering study population characteristics, the mean age of samples were all under 24 years of age. Participants in eight studies were school aged students (13-18) and the remaining studies recruited young adults age 18+. Overall sample sizes ranged from 13 to 396, 59% of them with under 70 participants. One study used a female only sample, 11 a male only sample and 15 recruited mixed genders. The type of nature participants were exposed to varied greatly, as did the type of contact with nature. Nineteen studies used a one-off exposure to nature, six used engagement in activities in

nature and one used repeated access to nature. All studies collected data pre and post nature exposure, with three studies collecting data at a follow up point between 5-12 months post nature exposure.

The examined studies identified 60 significant outcomes of psychological change following exposure to nature (Table 4). All outcomes were assigned to one of 10 categories: Mood and Affect, Mental Health, Wellbeing, Perceived Restoration, Stress, Energy, Cognitive Functioning, Resilience, Self-concept and Pro-social Behaviour. Appendix C provides a summary of the measurement tools used in each study. Appendix D summarises the papers by outcomes.

**Figure 1**

*Study Selection Process Based on PRISMA Guidelines*

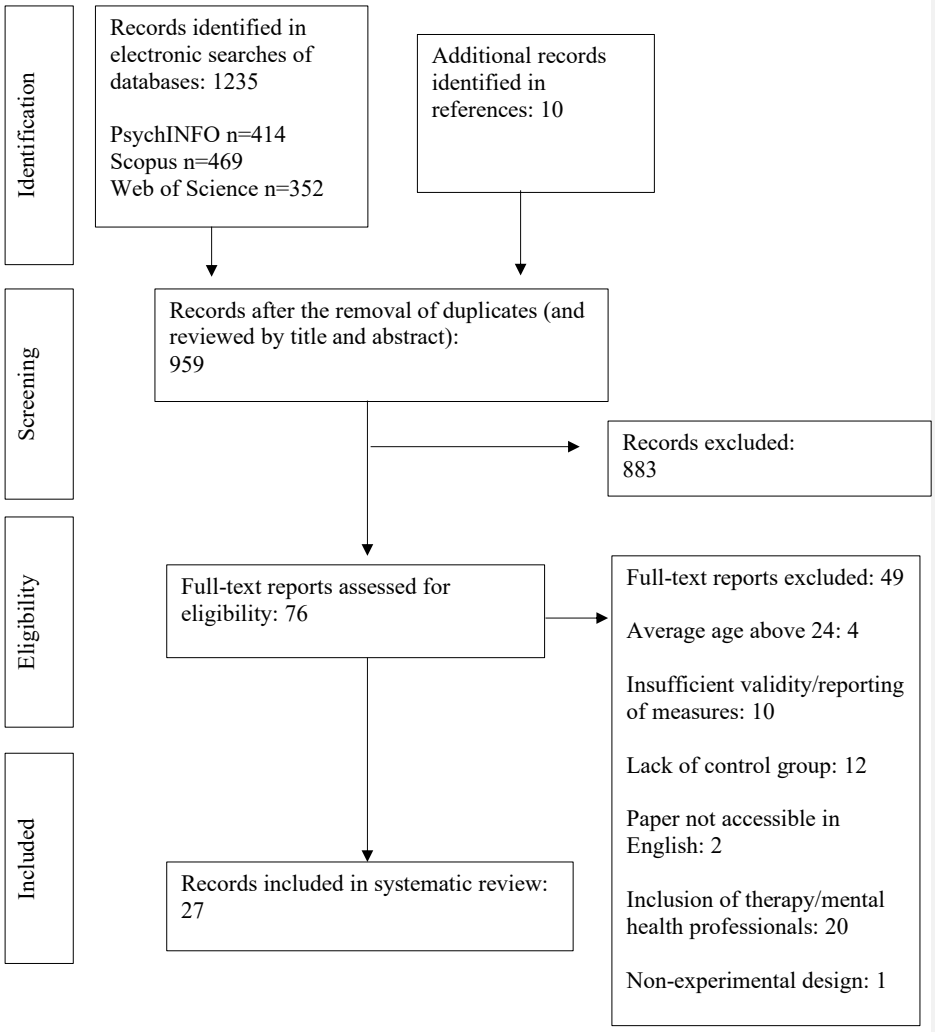


**Table 3**

*Study Characteristics*

| # | Authors (Year) | Country | N | Age in years Range (Mean ± SD) | Gender of Sample | Study Design | Nature Exposure (experimental) | Comparison | Q R |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Bielinis et al. (2019) | Poland | 32 | - (20.97 ± 0.65) | Female | Experimental | 20-minute walk, 15-minute exposure to snow covered forest | 20-minute walk to urban environment | M |
| 2 | Greenwood & Gatersleben (2016) | UK | 120 | 16-18 ( - ) | Mixed | Experimental | 20 minutes in grassed quandrangle: alone, with friend, with phone | Indoor for 20 minutes | W |
| 3 | Hassan et al. (2018) | China | 60 | 19-24 (19.60 ± 1.42) | Mixed | Cross-over experimental | 5-minute rest, 15-minute guided walk in bamboo forest | 5-minute rest, 15-minute guided walk in city area | W |
| 4 | Bielinis et al. (2021) | Poland | 22 | - (22.50 ± 4.67) | Mixed | Cross-over experimental | 15-minute viewing in snow covered forest | 15-minute viewing building landscape | W |

| # | Authors (Year) | Country | N | Age in years Range (Mean ± SD) | Gender of Sample | Study Design | Nature Exposure (experimental) | Comparison | Quality Rating |
|---|---|---|---|---|---|---|---|---|---|
| 5 | Bielinis, Omelan et al. (2018) | Poland | 54 | - (21.35 ± 1.39) | Mixed | Experimental | 15-minute viewing in forest in winter vs spring | Urban setting in winter vs in spring | Mod |
| 6 | Bielinis, Takayama et al. (2018) | Poland | 62 | - (21.45 ± 0.18) | Mixed | Experimental | 15-minute walk, 15-minute viewing in forest | 15 minutes in Urban environment | Mod |
| 7 | Hartig et al. (2003) | USA | 112 | - (20.8 ± 3.7) | Mixed | Experimental | Task vs no task in vegetation and wildlife preserve | Task vs no task in urban environment | Mod |
| 8 | Lee et al. (2011) | Japan | 12 | - (21.20 ± 0.9) | Male | Cross-over experimental | 15-minute forest viewing | 15-minute urban viewing | Weak |
| 9 | Lee et al. (2014) | Japan | 48 | - (21.10± 1.2) | Male | Cross-over experimental | Forest walking and self-paced walking in forest | Urban walking and self-paced walking in urban environment | Weak |
| 10 | Mao et al. (2012) | China | 20 | - (20.79 ±0.54) | Male | Experimental | 2 x 1.5 hour walks in forest area | 2 x 1.5 hour walks in city area | Weak |

| # | Authors (Year) | Country | N | Age in years Range (Mean ± SD) | Gender of Sample | Study Design | Nature Exposure (experimental) | Comparison | Quality Rating |
|---|---|---|---|---|---|---|---|---|---|
| 11 | Park et al. (2011) | Japan | 168 | - (20.40 ±4.1) | Male | Cross-over experimental | 15-minute viewing, 15-minute walk in forest (14 forests) | 15-minute viewing, 15-minute walk in urban area (14 areas) | Weak |
| 12 | Park et al. (2010) | Japan | 280 | - (21.70 ± 1.5) | Male | Cross-over experimental | 15-minute viewing, 15-minute walk in forest (24 forests) | 15-minute viewing, 15-minute walk in urban area (24 areas) | Weak |
| 13 | Song et al. (2014) | Japan | 17 | - (21.20 ± 1.7) | Male | Cross-over experimental | 15-minute walk in urban park | 15-minute walk in city area | Weak |
| 14 | Song et al. (2015) | Japan | 23 | - (22.3 ± 1.2) | Male | Cross-over experimental | 15-minute walk in urban park | 15-minute walk in city area | Weak |
| 15 | Song et al. (2013) | Japan | 13 | - (22.50 ± 3.1) | Male | Cross-over experimental | 15-minute walk in urban park | 15-minute walk in city area | Weak |
| 16 | Takayama et al. (2011) | Japan | 45 | - (21.21± 1.25) | Male | Cross-over experimental | 15-minute walk (morning), 15-minute viewing (afternoon) in forest | 15-minute walk (morning), 15-minute viewing (afternoon) in urban area | Mod |

| # | Authors (Year) | Country | N | Age in years Range (Mean ± SD) | Gender of Sample | Study Design | Nature Exposure (experimental) | Comparison | Quality Rating |
|---|---|---|---|---|---|---|---|---|---|
| 17 | Tsunetsugu et al. (2013) | Japan | 48 | - (21.10 ± 1.1) | Male | Cross-over experimental | 15-minute viewing in forest | 15-minute viewing urban site | Mod |
| 18 | McAnally et al. (2018) | New Zealand | 106 | - (14.43) | Male | Quasi-experimental | 2 terms of outdoor education | Education as usual | Weak |
| 19 | Fuegen & Breitenbecher (2018) | USA | 108 | 17-75 (21.59 ±7.69) | Mixed | Experimental | Outdoor exercise and outdoor rest (university grounds) | Indoor exercise vs indoor rest (simulated) | Mod |
| 20 | Shin & Oh (1996) | Korea | 32 | 18-32 (23.13) | Mixed | Quasi-experimental | 5-day forest program | Wait list control | Weak |
| 21 | Wang et al. (2016) | China | 140 | 18-24 (22.38 ± 2.56) | Mixed | Experimental | Exposure to video tapes of urban parks during stress recovery | Video tapes of urban roadways | Mod |
| 22 | Wood et al. (2013) | UK | 25 | - (13.10 + 0.3) | Mixed | Cross-over experimental | Exercise whilst viewing outdoor natural scenes | Exercise viewing built up environment | Mod |

| # | Authors (Year) | Country | N | Age in years Range (Mean ± SD) | Gender of Sample | Study Design | Nature Exposure (experimental) | Comparison | Quality Rating |
|---|---|---|---|---|---|---|---|---|---|
| 23 | Kelz et al, (2015) | Austria | 195 | 10-18 (14.40) | Mixed | Quasi-experimental | Access to green schoolyard | Control schools | Mod |
| 24 | Scarf et al. (2017) | New Zealand | 180 | - (16.54) | Mixed | Quasi-experimental | 10-day developmental voyage on a ship | Education as usual | Weak |
| 25 | Scarf et al. (2016) | New Zealand | 180 | 15-19 (16.56) | Mixed | Quasi-experimental | 10-day developmental voyage on a ship | Education as usual (but two different groups at T1 and T4) | Mod |
| 26 | Hayhurst et al. (2015) | New Zealand | 1): 120 2): 146 | 1) – (17.98) 2) - (16.47) | Mixed | Quasi-experimental | 10-day developmental voyage on a ship | No voyage | Weak |
| 27 | Hunter et al. (2013) | New Zealand | 1): 62 2): 396 | 1) - (16.46) 2) – (16.62) | Mixed | Quasi-experimental | 10-day developmental voyage on a ship | Education as usual | Weak |

*Note.* Mod = Moderate

[a] quality ratings are according to EPHPP quality appraisal assessment

[b] - not reported

**Table 4**

*Significant outcomes of psychological change following exposure to nature identified in each of the studies*

| # | Authors | Outcomes | Significant Results |
|---|---|---|---|
| 1 | Bielinis et al. (2019). | Tension/Anxiety (POMS) | Decreased after exposure to snow-covered forest environment compared to urban forest environment ($F = 18.06$, $p = .000$, $\eta^2 = .37$). |
| | | Depression/Dejection (POMS) | Decreased after exposure to snow-covered forest environment compared to urban forest environment ($F = 7.315$, $p = . .011$, $\eta^2 = .20$) |
| | | Anger/Hostility (POMS) | Decreased after exposure to snow-covered forest environment compared to urban forest environment ($F = 16.198$, $p = .000$, $\eta^2 = .35$) |
| | | Confusion (POMS) | Decreased after exposure to snow-covered forest environment compared to urban forest environment ($F = 9.172$, $p = .005$, $\eta^2 = .23$) |
| | | Negative affect (PANAS) | Increased after exposure to the Urban environment compared to forest environment ($F = 4.999$, $p = .033$, $\eta^2 = .14$) |
| | | Restoration (Restorative Outcome Scale) | Increased after exposure to the forest environment compared to urban environment ($F = 8.885$, $p = .006$, $\eta^2 = .23$) |
| | | Vitality (Subjective Vitality Scale) | Increased after exposure to the forest environment compared to urban environment ($F = 4.527$, $p = .042$, $\eta^2 = .13$) |
| 5 | Bielinis et al. (2018a) | Tension/Anxiety (POMS) | Significant effect of experimental interventions ($F = 7.47$, $p < .001$). Lowest values observed in forest in the winter. |
| | | Depression/Dejection (POMS) | Significant effect of experimental interventions ($F = 5.49$, $p < .001$). Lowest values observed in forest in the winter. |

**Commented [RM1]: Examiner: There is no indication of the strength or magnitude of the intervention effects in either the text or tables please add a column to Table 3 regarding the individual study results with effects sizes and draw on any results regarding dose response or sustainability of the interventions.**

**Commented [RM2R1]:** As I could not fit a new column to table 3 due to space, I have created a new table outlining the 60 significant results from the 11 included studies. Effect sizes were not reported in all studies and the measures of effect that were reported vary (from cohens d, to eta squared and partial eta squared). Given the heterogeneity in measures of effect and missing effect sizes, it is not possible to draw any conclusions regarding dose responses.

**Commented [RM3R1]:** I feel like I need to say why - is this because conclusions wouldn't necessarily be accurate based on effect sizes from only a limited number of papers? How else might I justify it?

| | | | |
|---|---|---|---|
| | | Anger/Hostility (POMS) | Significant effect of experimental interventions ($F$ = 4.25, $p$ < .001) Lowest values observed in forest in the winter. |
| | | Fatigue (POMS) | Significant effect of experimental interventions ($F$ = 4.79, $p$ <.001). Lowest values observed in forest winter and forest spring interventions. |
| | | Confusion (POMS) | Significant effect of experimental interventions ($F$ = 5.18, $p$ < .001). Lowest values observed in forest in the winter. |
| | | Vigour (POMS) | Significant effect of experimental interventions ($F$ = 4.96, $p$ < .001). Values were significantly higher in the forest environment during the winter than in the room or city conditions. |
| | | Positive Affect (PANAS) | Significant effect of experimental interventions ($F$ = 4.34, $p$ < .001) Significantly higher in the forest environment during both seasons. |
| | | Restoration (Restorative Outcome Scale) | Significant effect of experimental interventions ($F$ = 6.31, $p$ <.001). Highest values were observed in the forest during the winter and during the spring, but during the winter they were significantly higher than during the spring |
| | | Vitality (Subjective Vitality Scale) | Significant effect of experimental interventions ($F$ = 5.37, $p$ < .001). Values in the forest during the winter were significantly higher than during the spring, or in the room, or the city conditions. |
| 6 | Bielinis et al. (2018b) | Tension/Anxiety (POMS) | Significantly lower scores observed in the forest vs urban environment ($F$ =45.49 $p$ = .000). |
| | | Depression/Dejection (POMS) | Significantly lower scores observed in the forest vs urban environment ($F$ = 22.09 $p$ = .000). |
| | | Anger/Hostility (POMS) | Significantly lower scores observed in the forest vs urban environment ($F$ = 25.35, $p$ = .000). |

| | | | |
|---|---|---|---|
| | | Fatigue (POMS) | Significantly lower scores observed in the forest vs urban environment ($F$ = 28.1, $p$ = .000). |
| | | Confusion (POMS) | Significantly lower scores observed in the forest vs urban environment ($F$ = 20.3, $p$ = .000). |
| | | Vigour (POMS) | Significantly higher scores observed in the forest vs urban environment ($F$ = 28.35, $p$ = .000). |
| | | Positive Affect (PANAS) | Significantly higher scores observed in the forest vs urban environment ($F$ = 17.01, $p$ = .000). |
| | | Negative Affect (PANAS) | Significantly higher scores observed in the urban vs forest environment ($F$ = 15.18, $p$ = .000). |
| | | Restoration (Restorative Outcome Scale) | Significantly higher scores observed in the forest vs urban environment ($F$ = 35.27, $p$ = .000). |
| | | Vitality (Subjective Vitality Scale) | Significantly higher scores observed in the forest vs urban environment ($F$ = 27.68, $p$ = .000). |
| 7 | Hartig et al. (2003) | Diastolic Blood Pressure | Subjects with tree views showed significantly steeper DBP declines than the subjects in a viewless room ($F$(2,180) = 4.74, $p$ = .01) |
| | | Systolic Blood Pressure | A significant environment X time interaction in the analysis of the readings at 20, 30, 40, and 50 min ($F$(3,249) = 2.94, $p$ = .04). |
| | | Emotion (Zucker's Inventory of Personal Reactions) emotion | Subjects walking in the nature reserve experienced more positive emotion than those walking in the urban environment ($F$(1, 49) = 7.40, $p$ = .01) |
| | | Positive Affect (PANAS) | Positive affect increased at the nature reserve and decreased in the urban environment ($F$(1,100) = 56.83, $p$ < .001). |

| | | | |
|---|---|---|---|
| | | Attention (Necker Cube Pattern Control Task) | Performance improved in the natural environment but suffered in the urban environment, regardless of antecedent condition. ($F(1, 98) = 13.15$, $p < .001$) |
| 16 | Takayama et al. (2011) | Tension/Anxiety (POMS) | Significantly lower in the forest environment than in the urban areas ($p < .000$). |
| | | Fatigue (POMS) | Significantly lower in the forest environment than in the urban areas ($p = .000$) |
| | | Confusion (POMS) | Significantly lower in the forest environment than in the urban areas ($p = .000$) |
| | | Vigour (POMS) | Significantly higher in the forest environment after the viewing session ($p = .000$) |
| | | Positive Affect (PANAS) | Significantly higher in the forest environment than in the urban areas ($p = .001$) |
| | | Negative Affect (PANAS) | Significantly lower in the forest environment than in the urban areas ($p < .000$) |
| | | Restoration (Restorative Outcome Scale) | Significantly higher in the forest environment than in the urban areas ($p < .000$) |
| | | Vitality (Subjective Vitality Scale) | Significantly higher in the forest environment after walking ($p < .000$) and after the combined effect of walking and viewing ($p < .000$). |
| 17 | Tsunetsugu et al. (2013) | Diastolic Blood Pressure | Significantly lower in the forested areas than in the urban areas ($p = .034$, $\eta^2_p = .10$) |
| | | Heart Rate Variability (High Frequency) | Continuously significantly higher in the forested areas ($p < .01$, $d = .31$ - $.70$). |
| | | Heart Rate | Significantly lower in the forested area during every minute of viewing than in the urban areas ($p < .01$, $d = .49$ - $.71$) |

| | | | |
|---|---|---|---|
| | | Tension/Anxiety (POMS) | Significantly increased when viewing the scenery in urban areas ($p$ = .00, $\eta^2_p$ = .22) |
| | | Fatigue (POMS) | Significantly increased when viewing the scenery in urban areas ($p$ = .00, $\eta^2_p$ = .35) |
| | | Confusion (POMS) | Significantly increased when viewing the scenery in urban areas ($p$ = .01, $\eta^2_p$ = .35) |
| | | Vigour (POMS) | Significantly decreased when viewing the scenery in urban areas ($p$ = .00, $\eta^2_p$ = .26) |
| 19 | Fuegen & Breitenbecher (2018) | Positive Affect (PANAS) | Participants whose sessions took place outdoors experienced a slight increase in positive affect ($F$(1, 171) = 22.54, $p$ < .001, $\eta^2_p$= .12) |
| | | Energy (AD-ACL) | Participants whose sessions took place outdoors experienced an increase in energy ($F$(1, 174) = 18.99, $p$ < .001, $\eta^2_p$ = .10) |
| | | Tiredness (AD-ACL) | Participants whose sessions took place outside experienced a decrease in tiredness ($F$(1, 175) = 12.10, $p$ = .001, $\eta^2_p$ = .07) |
| 21 | Wang et al. (2016) | Skin Conductance | Significant differences across different scenes ($\chi$2(6) = 22.379, $p$ = .001, $\eta^2$= .16). Compared with viewing the Urban Roadway, subjects' mean SCR values were significantly reduced by viewing Lawn w/people ($p$ = .005), Lawn w/o people ($p$ = .006), Small Lake ($p$ = .022) and Walkway ($p$ = .022). |
| | | Electrocardiogram (R-R intervals) | Significant effect of viewing different sites on length of R–R intervals ($F$ (6, 126) = 2.499, $p$ = .026, $\eta^2$= .10). R–R intervals increased significantly more Lake (.116 ± .06 s, $p$ = .047), compared to viewing the Urban after viewing the Walkway (.125 ± .06 s, $p$ = .010) and Small Roadway (.063 ± .06 s). |
| | | Attention (Digit Span Backwards) | Participants' attentional levels improved significantly after watching Lawn w/ people ($p$ < .001, d = 1.09), Lawn w/o |

| | | | |
|---|---|---|---|
| | | | people ($p$ = .001, $d$ = .97 ), Plaza w/o people: ($p$ < .001, $d$ = 1.17), Small Lake ($p$ = .007, $d$ = .58), Walkway ($p$ = .001, $d$ = .73) |
| | | State Anxiety (State-trait Anxiety Inventory) | All six urban park scenes had a significant positive effect on state-anxiety relief, compared with the Urban Roadway scene (F(6, $F$(6, 133) = 11.59, $p$ < .001, $\eta^2$ = .31) |
| | | Restoration (Perceived Restorativeness) | Significant differences among the seven scenes ($F$(6, 133) = 25.68, $p$ < .001, $\eta^2$= .54). All six urban park scenes were perceived as more restorative than the Urban Roadway scene ($p$ < .001) |
| 23 | Kelz et al. (2015) | Diastolic Blood Pressure | Significantly lower for the experimental school's pupils at the second time of measurement compared with the mean of both times of the control school's measurements and the experimental school's first time of measurement ($F$(1, 184.3) = 15.46, $p$ = .001, $d$ = .41). |
| | | Systolic Blood Pressure | Significantly lower for the experimental school's pupils at the second time of measurement compared with the mean of both times of the control school's measurements and the experimental school's first time of measurement ($F$(1, 175.4) = 5.14, $p$ = .025, $d$ = .23). |
| | | Wellbeing (Intro-psychic Balance) | Pupils from the school had significantly higher scores after the installation of the schoolyard compared with the mean of both times of measurement at the control school and the first time of measurement at the experimental school. ($F$(1, 175.4) = 5.14, $p$ = .025, $d$ = .23 |
| | | Wellbeing (Recovery-stress Questionnaire) | Pupils from the school had significantly higher scores after the installation of the schoolyard compared with the mean of both times of measurement at the control school and the first time of measurement |

| | | | |
|---|---|---|---|
| | | | at the experimental school. ($F(1, 172.3) = 3.78$, $p = .053$, $d = 0.18$) |
| | | Restoration (Perceived Restorativeness) | Perceived restoration increased pre- to post-renovation for measures of compatibility only ($t(62) = 3.86$, $p = .001$, $d = .48$) |
| 25 | Scarf et al. (2016) | Resilience (Resilience Scale) | Significantly improved overtime ($F(1, 59) = 102.54$, $p < .001$, $\eta^2 = .63$. |

**Quality Appraisal**

Quality ratings for the studies are indicated in Table **3**. 11 studies were rated of a moderate quality and 16 studies were rated as weak quality. Component ratings within each individual studies can be found in Appendix C. Fifteen out of 17 weakly rated studies were rated as week for the blinding component rating.

**Mood and Affect**

After the removal of studies rated of a weak quality, negative mood states were found to significantly reduce in four studies (#1, #5, #6, #16) and positive mood states were found to significantly increase in three studies (#5, #6, #16). Where effect sizes were reported, a large effect was indicated. In these studies, participants were all university students exposed to forest environments. The POMs was used as the main outcome measure for mood, which aims to assess a variety of mood states: Tension, Depression, Anger, Vigour, Fatigue and Confusion. Takayama et al. (2011) found significant changes on all subscales except anger and depression following forest walking and viewing, however used a shortened version of the POMs (POMs; McNair et al., 1971). Positive affect was found to be significantly higher following nature contact in five studies (#1, #5, #6, #7, #19), with a medium effect as reported in one study only. Hartig et al. (2003) found that, in a natural environment, participants who did not complete a task vs participants completing a task requiring attention focus showed greater increases in positive affect, suggesting that the task worked against positive emotions. Negative affect

was significantly lower in one study of an all-male sample which found a large effect (#16); however, three studies (#1, #5, #9), including Bielinis et al. (2019) who recruited female participants only, did not find any significant differences.

**Stress**

Four studies found significant decreases in stress using a variety of outcome measures after the removal of weak studies (#17, #21, #23, #7). Tsunetsugu et al. (2013) and Wang et al. (2016) found heart rate to be slower after exposure to nature compared to urban environments, with medium effect sizes reported. Kelz et al. (2015) and Tsunetsugu et al. (2013) found measures of blood pressure to decrease following nature exposure, with small to medium effects; however, in the latter study, only significant differences in diastolic blood pressure were seen. Wang et al. (2016) also measured skin conductance which was found to reduce after viewing nature-based scenes, with a large effect reported. Hartig et al (20030 found viewing nature after completing a drive or task led to a more rapid decrease in diastolic blood pressure. Furthermore, walking in nature vs an urban setting initially led to a change in blood pressure suggestive of stress reduction, but this effect dissipated over time.

**Energy**

After removing methodologically weak studies, four papers found significant increases in measures of vitality (#1, #5, #6, #16) with a medium effect as reported in one study only. One paper reported significantly more self-reported feelings of being refreshed following exposure to forest environments, with a large effect (#17). An additional study by Fuegen and Breitenbecher (2018) found that exercise or rest sessions outside led to increased energy and decreases in tiredness compared to exercise or rest indoors sessions, with a small-medium effect. Indoor sessions, however, also included exposure to the outdoor scene via a visual stimulus; therefore, changes in energy and tiredness were not compared to a non-nature control, limiting the conclusions that can be made.

**Perceived Restoration**

After removing one study of weak quality, six papers found significant increases in perceived restoration (#1, #5, #6, #16, #21, #23). Where effect sizes were reported, a medium to large effect was indicated. Four of these studies used the Restorative Outcome Scale (ROS) (#1, #5, #6, #16), whereas two used the Perceived Restorativeness Scale (PRS) (#21, #23). Bielinis, Omelan et al. (2018) found that even in winter, when no leaves were present on the trees, 15 minutes of forest-bathing compared to viewing an urban environment led to increases in self-reported restoration.

**Mental Health**

After the removal of methodologically weak studies, only one study reported a change in mental health using a measure of anxiety. Specifically, following a stress induction procedure in a Chinese sample involving a mock spoken-English exam, Wang et al. (2016) found a significant decline in state anxiety after viewing nature-based urban park scenes, with a large effect reported.

**Self-Concept**

Self-concept was defined by measures of self-esteem and self-efficacy. After the removal of weak rated studies, no studies reported significant increases in self-concept. Wood et al. (2016) specifically looked at self-esteem following exercise whilst viewing natural or built scenes. Whilst they found self-esteem to be improved through physical activity alone, there was no effect of viewing natural scenes.

**Cognitive Functioning**

Following the removal of weak studies, two studies focusing on changes in attention indicated significant findings (#7, #21). Where effect sizes were reported, a medium to large effect was indicated.

However, in one of these studies (Hartig et al., 2003), increases in attention appeared to be due to performance decrements in the urban environment as opposed to performance increases in the nature environment. Two studies reported non-significant findings (#19, #23).

**Wellbeing**

Only one study exploring wellbeing was rated greater than weak quality. Specifically, in their quasi-experimental study, Kelz et al. (2015) found psychological wellbeing to increase on two different outcome measures after exposure to a nature-based schoolyard designed to include more greenery, seating and sporting equipment. Pre and post measures were taken over a seven-week period and compared to pupils at two schools without schoolyard changes. Small effect sizes were indicated.

**Resilience**

After removing studies of weak quality, one quasi-experimental study, as further described in the mediation section below, reported increases in resilience in high school participants following a 10-day voyage on a ship which was maintained at a 9 month follow up (#25). A large effect was reported.

**Pro-Social Behaviour**

Only one study explored the impact of nature exposure on pro-social behaviour between those who completed an outdoor education programme and controls. However, this was rated weak quality and no significant findings were found (#18).

**Mediation Analyses**

To consider any key indicated mechanisms of change, papers were manually searched for the inclusion of mediation analyses. Only one study used a formal analysis. Specifically, Scarf et al. (2016) carried out multiple and serial mediation analyses and found that sense of belonging directly

contributed to increases in resilience following a 10-day sailing voyage and centrality of identity indirectly predicted resilience immediately post voyage and at a 9 month follow up via belonging.

Hartig et al. (2007) used correlation analyses and found changes in attentional performance to correlate with changes in positive affect after partialling out the effects on environment. However, in absence of a formal mediation analysis, it is not possible to make any conclusions about casual mediators (Fiedler et al., 2011).

**Risk of Bias**

Only 11 studies out of the identified 27 were deemed to be of a moderate methodological quality and, even in these studies, important risks of bias were noted. Nine studies recruited participants who were only somewhat likely to be representative of an adolescent population. Eight of these studies used university students or young adult populations (#1, #5, #6, #7, #16, #17, #19, #21) and Scarf et al. (2016) did not make it clear what percentage of selected individuals agreed to participate in the study. Two studies were quasi-experimental in their design and therefore did not randomise participants (#24, #26). Five studies controlled for less than 80% of confounders or did not report whether relevant confounders were controlled for (#1, #7, #17, #21, #25). In eight of the studies the blinding procedure was not described or participants and assessors were not blind to the intervention (#7, #16, #17, #19, #21, #22, #23, #25).

## Discussion

The aim of the current review was to identify mechanisms of psychological change in adolescents following exposure to nature. Through a systematic review of the literature, 27 papers were selected. All studies had a mean sample age of equal or less than 24 years and included control conditions. Methodological quality reviewing identified 11 papers of a moderate quality from which outcomes associated with psychological change were identified and assigned to 11 categories.

Mood and affect was the most widely studied outcome of psychological change, with more significant than non-significant findings, except for measures of negative affect which demonstrated more non-significant findings. Both Zhang et al. (2020) and Roberts et al. (2020) identified improved wellbeing through increases in mood and positive affect following exposure to greenspace and nature-based activities in children and adolescents; however, unlike the current review, they did not identify any papers that specifically measured negative affect. In a meta-analysis of affect following nature contact, in which the majority of the participants were in late adolescence, McMahan and Estes (2015) also found nature to improve mental wellbeing through increased positive affect. Similarly, they reported that to a lesser degree nature decreases negative affect, but that the effect was moderated by location of study, type of affect measure and type of nature exposure. It is possible that these study and design related characteristics contributed to the identified heterogeneity of outcomes on measures of negative affect following nature exposure in the current review.

Just under half of the papers reported outcomes relating to stress and demonstrated more significant findings than non-significant. Studies reporting outcomes on stress showed great variation in the physiological indices used and had a high proportion of weakly rated studies. Whilst improvements in stress have been reported in previous children and adolescents reviews, measures of stress have varied from self-report to objective physiological measurements. Outcomes of stress discussed in the current review captured physiological outcomes only. In a review of adults that distinguished the physiological impact of nature on stress recovery, Corazon et al. (2019) also found considerable heterogeneity in outcomes, largely attributed to inappropriate use of physiological measures that were insufficiently sensitive to detect differences. Included in the current review, Wang et al. (2016) specifically used a stress-inducing task prior to nature exposure, enabling them to detect differences in stress recovery across different virtual scenes. Stress induction, in a reliable and valid manner, is paramount to exploring psychophysiological mechanisms in the clinical assessment of stress reduction (Bali & Jaggi, 2015). However, the task used by Wang et al. (2016) was not validated and no

manipulation check was carried out. Future work exploring stress reduction as a key mechanism of nature exposure should utilise validated stress induction tasks, such as the Trier Social Stress Test (Kirschbaum et al., 1993).

All outcomes relating to energy and perceived restoration were significant. Whilst perceived restorativeness has been identified as a mediating variable on psychological outcomes in the adult literature (Marselle et al., 2016), studies included in the current review used two differing measures of restoration. The ROS focuses on self-perceived changes in states and the PRS on the restorative qualities perceived in the environment. Both measurement outcomes, therefore, should not be interpreted together when drawing conclusions on attention restoration and potential mediation effects (Han, 2018). Furthermore, a review by Browning et al. (2020) found that experimental studies using perceived restoration reported more positive findings than expected, indicating publication bias in reporting the beneficial impacts of nature. Caution should be taken when interpreting perceived restorativeness as a possible mechanism on the basis of differing constructs and possible overreporting.

Generally, exposure to nature appeared to have a positive impact on outcomes of psychological change in adolescents, with significant findings identified within all categories except for self-concept and prosocial behaviour. Other systematic reviews on the benefits of access to nature on mental health and wellbeing in children and adolescents report similar positive outcomes (McCormick, 2017; Roberts et al., 2020; Tillmann et al., 2018; Zhang et al., 2020). However, only Tillmann et al. (2018) similarly looked at range of interactions with nature, compared to the other reviews that focused specifically on access to greenspace or nature-based activities only. A lack of significant outcomes for pro-social behaviour following nature exposure in the current review could be considered in light of a previous review by Putra et al. (2021), who only found limited evidence for the relationship between pro-social behaviour and greenspace due to it being moderated by socio-demographic factors and gender. Specifically, the association was stronger in children who only spoke English at home, those living in more affluent and remote areas and boys. Similarly, in considering self-concept in the current review,

Roberts et al. (2020) and Tillmann et al. (2018) found inconsistent results for outcomes of self-esteem. This further highlights an inconclusive link between nature exposure and self-esteem in an adolescent population.

Papers were manually reviewed for the inclusion of mediation analyses to consider any key mechanisms of change. Research using mediation analyses is an important first step for establishing the mechanisms through which an experimental manipulation or intervention leads to change, better ensuring that findings can be generalised into practice through knowing what is needed to optimise outcomes (Kazdin, 2007). Methodologically, mediation goes above and beyond demonstrating the overall relationship between two variables by exploring how an additional "third" variable can be incorporated into statistical analyses to undercover why or how the two variables are related (Mackinnon & Luecken, 2008). The identification of mediators and mechanisms, particularly in controlled experimental studies of nature exposure, are imperative in clarifying the connection between exposure and the diverse outcomes seen (Kazdin, 2007; Norwood et al., 2019).

In the current review, only one study included a formal mediation analysis. Scarf et al. (2016) specifically found a significant direct contribution of belonging on outcomes of resilience and an indirect contribution of centrality of identity, via belonging. This finding speaks to the role of social processes in outcomes of psychological change following nature contact and the study was one of six papers included in the review that used an experimental manipulation of nature exposure carried out with others. Previous research has supported, at least, the partially mediating role of various social processes between nature and psychological outcomes in adults and adolescents, including social interaction and social cohesion, highlighting the salience of social factors (De Vries et al., 2013; Dzhambov et al., 2018; Vanaken & Danckaerts, 2018). Given that exposure to nature involving social contact creates a complex social environment, there are likely to be a range of potential mechanisms of change and future research should aim to continue to understand how social factors may influence nature contact. Further experimental manipulations of exposure to nature, with and without social

contact, will be important to help distinguish the impact of nature experience from social predictors of psychological outcomes.

In considering other identified mechanisms of change, Hartig et al. (2007) alluded to their finding of weak correlations between attention and physiological measures supporting separate processes in line with ART and SRT. Furthermore, a positive correlation between attention and positive affect was found but methodological limitations meant that the authors were unable to carry out a mediation analysis to conclude whether one variable mediates the other. Whilst the conclusions that can be drawn on the basis of correlational evidence and a lack of mediation evidence are limited, these findings broadly capture the theories of stress reduction and attention restoration. The identified outcomes of nature exposure reported in the current review were in line with relevant theories. Decreases in stress and improvements in positive and negative mood states are in line with SRT. Improvements in positive and negative moods states, positive affect and anxiety are also in fitting with an emotional regulation theory of nature's benefits on psychological outcomes. Outcomes of improved vitality and perceived restoration are in line with ART. However as the theories of SRT, ART and emotional regulation highlight multiple possible pathways of effect, research studies operationalise the effects of nature exposure through varying indictors and findings indicate that the theories are not mutually exclusive (Egner et al., 2020). More theoretical development is therefore needed, more specifically through the appropriate use of theory-guided statistical pathway modelling, to explore interdependencies of pathways often treated as individually within the literature (Dzhambov et al., 2018) and to learn more about the key pathways of effect. Furthermore, findings from Scarf et al. (2016) suggest that social constructs might interact or be independent of the mechanisms supposed in the above theories. Firm conclusions on key mechanisms, however, cannot be made, given that the studies in the current review are methodologically limited and there is a paucity of mediation analyses.

**Strengths**

The current review, to our knowledge, is the first systematic review that aimed to review any potential mechanisms of nature in promoting psychological change in the adolescent literature, specifically in experimental and quasi-experimental studies with a control condition only. This builds on previous reviews where the evidence base has been dominated by cross-sectional studies (Zhang et al., 2020). Such designs, that include a nature-based manipulation, enable a better estimation of nature's effect on psychological change, accounting for more confounding variables than in cross-sectional research. Furthermore, the inclusion of studies with control conditions strengthens the findings drawn and conclusions made. By excluding studies with integrated mental health or wellbeing components, the review aimed to distinguish any mechanisms of nature exposure on psychological change independent of therapeutic input.

**Limitations**

The current review focused only on peer-reviewed articles, meaning grey literature and unpublished studies were not included, which may limit the generalisability of the findings. The quality of the literature was low overall. Only 11 out of 27 papers were rated as being of moderate methodological quality and used within the synthesis of results. The remaining included papers were classified as low quality, so conclusions from these papers were not drawn. In considering the categories of the quality assessment tool that supported weak quality ratings blinding should be carefully considered as this category was rated as weak in the majority of the 16 weakly rated studies. Full blinding in nature-based research is not possible due to being unable to blind participants to environmental conditions. Future systematic reviews in this area may wish to consider an alternative quality assessment tool or assign weights to the categories included so that ratings of blinding do not lead to the exclusion of important findings.

Some important methodological limitations and risk of bias also existed in the moderately rated studies, meaning that the findings should be interpreted with caution. Eight of the moderately rated

papers used undergraduate samples only, which captures a smaller range of adolescents (age 18-24) and therefore limits the extent to which findings can be applied to adolescents of a younger age range. Two of these studies (Takayama et al., 2011; Tsunetsugu et al., 2013) used a male undergraduate sample only and the majority of the other undergraduate samples were imbalanced with regards to gender. This is of particular importance as previous reviews have noted the relationship between nature and outcomes to vary by demographic factors such as gender (Putra et al., 2020; Zhang et al., 2020). Given that there may be gender differences in outcomes, conclusions drawn across genders may be limited.

The selection of study criteria may have influenced the limited findings of mechanisms of change. Whilst the selection of controlled, experimental studies was applied as a stringent identification of mediators given problems with non-experimental data in undermining assumptions of the statistical mediation model (Fairchild & McDaniel, 2017), as previously stated, the nature evidence base in an adolescent population is dominated by cross-sectional data. The selection criteria was therefore potentially too demanding, meaning that papers reporting mediation analyses were not included.

**Implications and Future Research**

Understanding mediating variables is imperative in investigating why or how experimental manipulations and interventions lead to change, highlighting potential mechanisms of change (Kazdin, 2007). The identification of mediators is an important first step of intervention development, leading to subsequent randomised control trials enhanced in components associated with the mediator to establish key targetable mechanisms (Kraemer et al., 2002). Given the paucity of controlled experimental studies with the inclusion of mediation analyses in the current review, future research should focus on highlighting the potential mediators of nature exposure on wellbeing in adolescents.

Whilst the identified outcomes of psychological change in the current review may be plausible mechanisms, the evidence is of low methodological quality. There is a need to test and clarify these outcomes as potential mediators in robustly controlled, experimental studies with longitudinal designs.

Furthermore, given that nature has benefits via a seemingly complex web of mechanisms (Hartig et al., 2014), there may be other mechanisms outside what was indicated in the current study.

Whilst outside the scope of this review, the methodological limitations of the included studies highlight the need to explore whether mechanisms of change differ within subpopulations of adolescence. Identification of these moderating variables is crucial in understanding how nature exposure might impact on sub-groups differently (Bratman et al., 2019). Given the diverse outcomes highlighted in the current review, the complexity of human-nature relations and potential differential effects according to moderating variables, it is entirely possible that multiple pathways exist. Ongoing research should aim to include advance multi-variate modelling to consider such complexity, specifically 'what works for whom'.

Given the heightened potential for nature exposure as a modifiable lifestyle behavioural (Jacka et al., 2012) nature may be a targetable factor in clinical practice for the prevention of mental health problems and requires further exploration (Piotrowski et al., 2021). Outcomes of mood, affect and stress in the current review are of particular interest as they are also implicated in the development and maintenance of mental health difficulties such as depression in adolescence. Paying attention to these as potential mechanisms in future research would allow for the development of clinically relevant nature-based interventions, including ‘active ingredients’ in an adolescent population. This would enable the design of interventions with greater clinical effectiveness.

**Conclusion**

This review systematically searched for evidence from controlled experimental research of key mechanisms of psychological change following nature exposure in an adolescent population. With a particular lack of statistical mediation models within the evidence, it is not possible to make any firm conclusions about the key mechanisms in this population. Given the current quality of the evidence, whilst outcomes of psychological change following nature exposure have been outlined, there is a need

for further research to design robust and longitudinal, experimental studies to test and evaluate for plausible mechanisms. Consideration of mediation and moderation pathways will be important for specifying what works best and for whom in an adolescent population, in order to inform the development of future nature-based interventions to support mental health and wellbeing.

**References**

Alfonsson, S., Johansson, K., Uddling, J., & Hursti, T. (2017). Differences in motivation and adherence to a prescribed assignment after face-to-face and online psychoeducation: an experimental study. *BMC Psychology*, *5*(1). https://doi.org/10.1186/S40359-017-0172-5

Alvaro, P, K, Roberts, R, M., & Harris,J,K. (2013). A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. *Sleep*, *36*(7), 1059–1068. https://doi.org/10.5665/SLEEP.2810

Antonelli, M., Donelli, D., Carlone, L., Maggini, V., Firenzuoli, F., & Bedeschi, E. (2021). Effects of forest bathing (shinrin-yoku) on individual well-being: an umbrella review. *Https://Doi.Org/10.1080/09603123.2021.1919293*. https://doi.org/10.1080/09603123.2021.1919293

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, *52*(1), 388–407. https://doi.org/10.3758/S13428-019-01237-X/TABLES/8

Asendorpf, J. B., Van De Schoot, R., Denissen, J. J. A., & Hutteman, R. (2014). Special issue: Planned missingness Reducing bias due to systematic attrition in longitudinal studies: The benefits of multiple imputation. *International Journal of Behavioral Development*, *38*(5), 453–460. https://doi.org/10.1177/0165025414542713

Auerbach, R. P., Admon, R., & Pizzagalli, D. A. (2014). Adolescent Depression: Stress and Reward Dysfunction. *Harvard Review of Psychiatry*, *22*(3), 139. https://doi.org/10.1097/HRP.0000000000000034

Bali, A., & Jaggi, A. S. (2015). Clinical experimental stress studies: Methods and assessment. *Reviews in the Neurosciences*, *26*(5), 555–579. https://doi.org/10.1515/REVNEURO-2015-0004/ASSET/GRAPHIC/J_REVNEURO-2015-0004_FIG_007.JPG

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

Bélanger, M., Gallant, F., Doré, I., O'Loughlin, J. L., Sylvestre, M. P., Abi Nader, P., Larouche, R., Gunnell, K., & Sabiston, C. M. (2019). Physical activity mediates the relationship between outdoor time and mental health. *Preventive Medicine Reports*, *16*, 101006.

https://doi.org/10.1016/j.pmedr.2019.101006

Bevan Jones, R., Thapar, A., Stone, Z., Thapar, A., Jones, I., Smith, D., & Simpson, S. (2018). Psychoeducational interventions in adolescent depression: A systematic review. In *Patient Education and Counseling* (Vol. 101, Issue 5, pp. 804–816). Elsevier Ireland Ltd. https://doi.org/10.1016/j.pec.2017.10.015

Bielinis, E., Janeczko, E., Takayama, N., Zawadzka, A., Słupska, A., Piętka, S., Lipponen, M., & Bielinis, L. (2021). The effects of viewing a winter forest landscape with the ground and trees covered in snow on the psychological relaxation of young Finnish adults: A pilot study. *PLoS ONE*, *16*(1 January). https://doi.org/10.1371/journal.pone.0244799

Bielinis, E., Lukowski, A., Omelan, A., Boiko, S., Takayama, N., & Grebner, D. L. (2019). The effect of recreation in a snow-covered forest environment on the psychological wellbeing of young adults: Randomized controlled study. *Forests*, *10*(10). https://doi.org/10.3390/f10100827

Bielinis, E., Omelan, A., Boiko, S., & Bielinis, L. (2018). The Restorative Effect of Staying in a Broad-Leaved Forest on Healthy Young Adults in Winter and Spring. In *BALTIC FORESTRY* (Vol. 24, Issue 2). https://www.balticforestry.mi.lt/ojs/index.php/BF/article/view/204

Bielinis, E., Takayama, N., Boiko, S., Omelan, A., & Bielinis, L. (2018). The effect of winter forest bathing on psychological relaxation of young Polish adults. *Urban Forestry and Urban Greening*, *29*, 276–283. https://doi.org/10.1016/j.ufug.2017.12.006

Blakemore, S. J. (2019). Adolescence and mental health. *The Lancet*, *393*(10185), 2030–2031. https://discovery.ucl.ac.uk/id/eprint/10075384/1/Blakemore_Lancet essay final 18 April 2019.pdf

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Kuo, M., Lawler, J. J., Levin, P. S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., … Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. In *Science Advances* (Vol. 5, Issue 7, p. eaax0903). American Association for the Advancement of Science. https://doi.org/10.1126/sciadv.aax0903

Bratman, G. N., Daily, G. C., Levy, B. J., & Gross, J. J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning*, *138*, 41–50. https://doi.org/10.1016/j.landurbplan.2015.02.005

Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. *Annals of the New York Academy of Sciences*, *1249*(1), 118–136. https://doi.org/10.1111/j.1749-6632.2011.06400.x

Bratman, G. N., Hamilton, J. P., Hahn, K. S., Daily, G. C., & Gross, J. J. (2015). Nature experience

reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(28), 8567–8572. https://doi.org/10.1073/pnas.1510459112

Bratman, G. N., Olvera-Alvarez, H. A., & Gross, J. J. (2021). The affective benefits of nature exposure. *Social and Personality Psychology Compass*, *15*(8), e12630. https://doi.org/10.1111/SPC3.12630

Bratman, G. N., Young, G., Mehta, A., Lee Babineaux, I., Daily, G. C., & Gross, J. J. (2021). Affective Benefits of Nature Contact: The Role of Rumination. *Frontiers in Psychology*, *0*, 584. https://doi.org/10.3389/FPSYG.2021.643866

Brent, D. A., & Birmaher, B. (2009). Adolescent Depression. *Http://Dx.Doi.Org/10.1056/NEJMcp012249*, *347*(9), 667–671. https://doi.org/10.1056/NEJMCP012249

Browning, M. H. E. M., Saeidi-Rizi, F., McAnirlin, O., Yoon, H., & Pei, Y. (2020). The Role of Methodological Choices in the Effects of Experimental Exposure to Simulated Natural Landscapes on Human Health and Cognitive Performance: A Systematic Review: *Https://Doi.Org/10.1177/0013916520906481*, *53*(7), 687–731. https://doi.org/10.1177/0013916520906481

Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: a meta-analysis. *Frontiers in Psychology*, *5*, 976. https://doi.org/10.3389/fpsyg.2014.00976

Capaldi, C., Passmore, H.-A., Nisbet, E., Zelenski, J., & Dopko, R. (2015). Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. *International Journal of Wellbeing*, *5*(4), 1–16. https://doi.org/10.5502/ijw.v5i4.449

Carpenter, J. R., & Kenward, M. G. (2008). *MAR methods for quantitative data. Missing data in randomised controlled trials—a practical guide.* National Institute for Health Research.

Chastin, S. F. M., De Craemer, M., Lien, N., Bernaards, C., Buck, C., Oppert, J. M., Nazare, J. A., Lakerveld, J., O'Donoghue, G., Holdsworth, M., Owen, N., Brug, J., Cardon, G., Conroy, D., Healy, G., Langøien, L. J., Reilly, J., Rutter, H., Salmon, J., … Wong, S. (2016). The SOS-framework (Systems of Sedentary behaviours): An international transdisciplinary consensus framework for the study of determinants, research priorities and policy on sedentary behaviour across the life course: A DEDIPAC-study. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1). https://doi.org/10.1186/s12966-016-0409-3

Choe, E. Y., Jorgensen, A., & Sheffield, D. (2020). Does a natural environment enhance the effectiveness of Mindfulness-Based Stress Reduction (MBSR)? Examining the mental health and

wellbeing, and nature connectedness benefits. *Landscape and Urban Planning*, *202*, 103886. https://doi.org/10.1016/J.LANDURBPLAN.2020.103886

Christensen, H., Griffiths, K. M., & Jorm, A. F. (2004). Delivering interventions for depression by using the internet: randomised controlled trial. *BMJ*, *328*(7434), 265. https://doi.org/10.1136/BMJ.37945.566632.EE

Clarke, A., Friede, T., Putz, R., Ashdown, J., Martin, S., Blake, A., Adi, Y., Parkinson, J., Flynn, P., Platt, S., & Stewart-Brown, S. (2011). Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Validated for teenage school students in England and Scotland. A mixed methods assessment. *BMC Public Health*, *11*(1), 1–9. https://doi.org/10.1186/1471-2458-11-487

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396. https://doi.org/10.2307/2136404

Compernolle, S., Desmet, A., Poppe, L., Crombez, G., De Bourdeaudhuij, I., Cardon, G., Van Der Ploeg, H. P., & Van Dyck, D. (2019). Effectiveness of interventions using self-monitoring to reduce sedentary behavior in adults: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), 1–16. https://doi.org/10.1186/S12966-019-0824-3/FIGURES/4

Corazon, S. S., Sidenius, U., Poulsen, D. V., Gramkow, M. C., & Stigsdotter, U. K. (2019). Psycho-physiological stress recovery in outdoor nature-based interventions: A systematic review of the past eight years of research. *International Journal of Environmental Research and Public Health*, *16*(10). https://doi.org/10.3390/ijerph16101711

Cox, D. T. C., Shanahan, D. F., Hudson, H. L., Fuller, R. A., Anderson, K., Hancock, S., & Gaston, K. J. (2017). Doses of Nearby Nature Simultaneously Associated with Multiple Health Benefits. *International Journal of Environmental Research and Public Health 2017, Vol. 14, Page 172*, *14*(2), 172. https://doi.org/10.3390/IJERPH14020172

Crutzen, R., Kohl, L., & De Vries, N. K. (2012). *Kennissynthese online preventie*.

Cuijpers, P., Beekman, A. T. F., & Reynolds, C. F. (2012). Preventing depression: A global priority. In *JAMA - Journal of the American Medical Association* (Vol. 307, Issue 10, pp. 1033–1034). NIH Public Access. https://doi.org/10.1001/jama.2012.271

Cuijpers, P., Karyotaki, E., de Wit, L., & Ebert, D. D. (2019). The effects of fifteen evidence-supported therapies for adult depression: A meta-analytic review. *Psychotherapy Research*, *0*(0), 1–15. https://doi.org/10.1080/10503307.2019.1649732

De Vries, S., van Dillen, S. M. E., Groenewegen, P. P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Social Science and*

*Medicine*, *94*, 26–33. https://doi.org/10.1016/j.socscimed.2013.06.030

Djernis, D., Lerstrup, I., Poulsen, D., Stigsdotter, U., Dahlgaard, J., & O'toole, M. (2019). A systematic review and meta-analysis of nature-based mindfulness: Effects of moving mindfulness training into an outdoor natural setting. *International Journal of Environmental Research and Public Health*, *16*(17). https://doi.org/10.3390/ijerph16173202

Donker, T., Griffiths, K. M., Cuijpers, P., & Christensen, H. (2009). Psychoeducation for depression, anxiety and psychological distress: A meta-analysis. *BMC Medicine*, *7*(1), 1–9. https://doi.org/10.1186/1741-7015-7-79/FIGURES/2

Dunning, D. L., Griffiths, K., Kuyken, W., Crane, C., Foulkes, L., Parker, J., & Dalgleish, T. (2019). Research Review: The effects of mindfulness-based interventions on cognition and mental health in children and adolescents – a meta-analysis of randomized controlled trials. *Journal of Child Psychology and Psychiatry*, *60*(3), 244–258. https://doi.org/10.1111/JCPP.12980

Dute, D. J., Bemelmans, W. J. E., & Breda, J. (2016). Using Mobile Apps to Promote a Healthy Lifestyle Among Adolescents and Students: A Review of the Theoretical Basis and Lessons Learned. *JMIR Mhealth Uhealth 2016;4(2):E39 Https://Mhealth.Jmir.Org/2016/2/E39*, *4*(2), e3559. https://doi.org/10.2196/MHEALTH.3559

Dzhambov, A., Hartig, T., Markevych, I., Tilov, B., & Dimitrova, D. (2018). Urban residential greenspace and mental health in youth: Different approaches to testing multiple pathways yield different conclusions. *Environmental Research*, *160*, 47–59. https://doi.org/10.1016/j.envres.2017.09.015

Dzhambov, A. M., Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., Gatseva, P., & Dimitrova, D. D. (2018). Multiple pathways link urban green- and bluespace to mental health in young adults. *Environmental Research*, *166*, 223–233. https://doi.org/10.1016/j.envres.2018.06.004

Ebert, D. D., & Cuijpers, P. (2018). It Is Time to Invest in the Prevention of Depression. *JAMA Network Open*, *1*(2), e180335-e180335. https://doi.org/10.1001/jamanetworkopen.2018.0335

Ebesutani, C., Regan, J., Smith, A., Reise, S., Higa-Mcmillan, C., & Chorpita, B. F. (2012). The 10-Item Positive and Negative Affect Schedule for Children, Child and Parent Shortened Versions: Application of Item Response Theory for More Efficient Assessment. *Journal of Psychopathology and Behavioral Assessment*, *34*(2), 191–203. https://doi.org/10.1007/s10862-011-9273-2

Egger, G. J., Binns, A. F., & Rossner, S. R. (2009). The emergence of "lifestyle medicine" as a structured approach for management of chronic disease. *Medical Journal of Australia*, *190*(3), 143–145. https://doi.org/10.5694/J.1326-5377.2009.TB02317.X

Egner, L. E., Sütterlin, S., & Calogiuri, G. (2020). Proposing a Framework for the Restorative Effects of Nature through Conditioning: Conditioned Restoration Theory. *Journal of Environmental Research and Public Health*, *17*(18), 6792.

Erdur-Bakera, Ö., & Bugaya, A. (2010). The short version of ruminative response scale: Reliability, validity and its relation to psychological symptoms. *Procedia - Social and Behavioral Sciences*, *5*, 2178–2181. https://doi.org/10.1016/j.sbspro.2010.07.433

Fairchild, A. J., & McDaniel, H. L. (2017). Best (but oft-forgotten) practices: mediation analysis. *The American Journal of Clinical Nutrition*, *105*(6), 1259–1271. https://doi.org/10.3945/AJCN.117.152546

Fiedler, K., Schott, M., & Meiser, T. (2011). What mediation analysis can (not) do ☆. *Journal of Experimental Social Psychology*, *47*, 1231–1236. https://doi.org/10.1016/j.jesp.2011.05.007

Firth, J., Solmi, M., Wootton, R. E., Vancampfort, D., Schuch, F. B., Hoare, E., Gilbody, S., Torous, J., Teasdale, S. B., Jackson, S. E., Smith, L., Eaton, M., Jacka, F. N., Veronese, N., Marx, W., Ashdown-Franks, G., Siskind, D., Sarris, J., Rosenbaum, S., … Stubbs, B. (2020). A meta-review of "lifestyle psychiatry": the role of exercise, smoking, diet and sleep in the prevention and treatment of mental disorders. *World Psychiatry*, *19*(3), 360–380. https://doi.org/10.1002/WPS.20773

Frumkin, H., Bratman, G. N., Breslow, S. J., Cochran, B., Kahn, P. H., Lawler, J. J., Levin, P. S., Tandon, P. S., Varanasi, U., Wolf, K. L., & Wood, S. A. (2017). Nature Contact and Human Health: A Research Agenda. *Environmental Health Perspectives*, *125*(7), 075001. https://doi.org/10.1289/EHP1663

Fusar-Poli, P., Correll, C. U., Arango, C., Berk, M., Patel, V., & Ioannidis, J. P. A. (2021). Preventive psychiatry: a blueprint for improving the mental health of young people. *World Psychiatry*, *20*(2), 200–221. https://doi.org/10.1002/WPS.20869

Gardner, B., Smith, L., Lorencatto, F., Hamer, M., & Biddle, S. J. H. (2016). How to reduce sitting time? A review of behaviour change strategies used in sedentary behaviour reduction interventions among adults. *Health Psychology Review*, *10*(1), 89–112. https://doi.org/10.1080/17437199.2015.1082146

Geisner, I. M., Neighbors, C., & Larimer, M. E. (2006). A randomized clinical trial of a brief, mailed intervention for symptoms of depression. *Journal of Consulting and Clinical Psychology*, *74*(2), 393–399. https://doi.org/10.1037/0022-006X.74.2.393

Goldberg, S. B., Tucker, R. P., Greene, P. A., Davidson, R. J., Wampold, B. E., Kearney, D. J., &

Simpson, T. L. (2017). *Mindfulness-based interventions for psychiatric disorders: A systematic review and meta-analysis A R T I C L E I N F O*. https://doi.org/10.1016/j.cpr.2017.10.011

Gore, F. M., Bloem, P. J., Patton, G. C., Ferguson, J., Joseph, V., Coffey, C., & Mathers, C. D. (2011). Global burden of disease in young people aged 10-24 years: a systematic analysis. *The Lancet*, *377*(9783), 2093–2102. https://doi.org/10.1016/S0140-6736(11)60512-6

Grant, K. E., Compas, B. E., Thurm, A. E., McMahon, S. D., & Gipson, P. Y. (2004). Stressors and child and adolescent psychopathology: measurement issues and prospective effects. *Journal of Clinical Child and Adolescent Psychology : The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, *33*(2), 412–425. https://doi.org/10.1207/S15374424JCCP3302_23

Greco, L. A., Baer, R. A., & Smith, G. T. (2011). Assessing Mindfulness in Children and Adolescents: Development and Validation of the Child and Adolescent Mindfulness Measure (CAMM). *Psychological Assessment*, *23*(3), 606–614. https://doi.org/10.1037/a0022819

Greenwood, A., & Gatersleben, B. (2016). Let's go outside! Environmental restoration amongst adolescents and the impact of friends and phones. *Journal of Environmental Psychology*, *48*, 131–139. https://doi.org/10.1016/j.jenvp.2016.09.007

Grierson, A. B., Hickie, I. B., Naismith, S. L., & Scott, J. (2016). The role of rumination in illness trajectories in youth: linking trans-diagnostic processes with clinical staging models. *Psychological Medicine*, *46*(12), 2467. https://doi.org/10.1017/S0033291716001392

Han, K.-T. (2018a). A review of self-report scales on restoration and/or restorativeness in the natural environment. *Journal of Leisure Research*, *49*(3–5), 151–176. https://doi.org/10.1080/00222216.2018.1505159

Han, K.-T. (2018b). A review of self-report scales on restoration and/or restorativeness in the natural environment. *Journal of Leisure Research*, *49*(3–5), 151–176. https://doi.org/10.1080/00222216.2018.1505159

Han, K. T. (2003). A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning*, *64*(4), 209–232. https://doi.org/10.1016/S0169-2046(02)00241-4

Harper, N. J., Fernee, C. R., & Gabrielsen, L. E. (2021). Nature's Role in Outdoor Therapies: An Umbrella Review. *International Journal of Environmental Research and Public Health 2021, Vol. 18, Page 5117*, *18*(10), 5117. https://doi.org/10.3390/IJERPH18105117

Hartig, T., Jamner, L., Evans, G. W., Jamner, L. D., Davis, D. S., & Arling, T. G. (2003). Tracking restoration in natural and urban field settings SEE PROFILE Tracking restoration in natural and

urban field settings. *Article in Journal of Environmental Psychology*, *23*, 109–123. https://doi.org/10.1016/S0272-4944(02)00109-3

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing and Planning Research*, *14*(4), 175–194. https://doi.org/10.1080/02815739708730435

Hartig, T., Mang, M., & Evans, G. W. (1991). Restorative Effects of Natural Environment Experiences: *Http://Dx.Doi.Org/10.1177/0013916591231001*, *23*(1), 3–26. https://doi.org/10.1177/0013916591231001

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014a). Nature and Health. *Annual Review of Public Health*, *35*(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014b). Nature and Health. *Annual Review of Public Health*, *35*(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Hassan, A., Tao, J., Li, G., Jiang, M., Aii, L., Zhihui, J., Zongfang, L., & Qibing, C. (2018). Effects of Walking in Bamboo Forest and City Environments on Brainwave Activity in Young Adults. *Evidence-Based Complementary and Alternative Medicine*, *2018*, 1–9. https://doi.org/10.1155/2018/9653857

Hayhurst, J., Hunter, J. A., Kafka, S., & Boyes, M. (2015). Enhancing resilience in youth through a 10-day developmental voyage. *Http://Dx.Doi.Org/10.1080/14729679.2013.843143*, *15*(1), 40–52. https://doi.org/10.1080/14729679.2013.843143

Hertzog, M. (2008). Considerations in Determining Sample Size for Pilot Studies. *Research in Nursing & Health*, *31*(2), 180–191. https://doi.org/10.1002/nur.20247

Heymans, M. W., & Eekhout, I. (2019). *Applied missing data analysis with SPSS and (R) Studio.*

Hoare, E., Callaly, E., & Berk, M. (2020). Can Depression Be Prevented? If So, How? *JAMA Psychiatry*, *77*(11), 1095–1096. https://doi.org/10.1001/JAMAPSYCHIATRY.2020.1273

Hossain, M. M., Sultana, A., Ma, P., Fan, Q., Sharma, R., Purohit, N., & Sharmin, D. F. (2020). *Effects of natural environment on mental health: an umbrella review of systematic reviews and meta-analyses*. https://doi.org/10.31234/OSF.IO/4R3MH

Hunter, J. A., Hayhurst, J., Kafka, S., Boyes, M., Ruffman, T., O'Brien, K., & Stringer, M. (2013). Elevated self-esteem 12 months following a 10-day developmental voyage. *Journal of Applied Social Psychology*, *43*(9), 1956–1961. https://doi.org/10.1111/JASP.12132

Jacka, F. N., Mykletun, A., & Berk, M. (2012). Moving towards a population health approach to the primary prevention of common mental disorders. *BMC Medicine*, *10*(1), 149. https://doi.org/10.1186/1741-7015-10-149

Jackson, S. B., Stevenson, K. T., Larson, L. R., Nils Peterson, M., & Seekamp, E. Outdoor Activity Participation Improves Adolescents' Mental Health and Well-Being during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health 2021, Vol. 18, Page 2506*, *18*(5), 2506. https://doi.org/10.3390/IJERPH18052506

Jackson, S. B., Stevenson, K. T., Larson, L. R., Peterson, M. N., & Seekamp, E. Connection to Nature Boosts Adolescents' Mental Well-Being during the COVID-19 Pandemic. *Sustainability 2021, Vol. 13, Page 12297*, *13*(21), 12297. https://doi.org/10.3390/SU132112297

Jacob, K. S., Bhugra, D., & Mann, A. H. (2002). A randomised controlled trial of an educational intervention for depression among asian women in primary care in the United Kingdom. *International Journal of Social Psychiatry*, *48*(2), 139–148. https://doi.org/10.1177/002076402128783190

Jakobsen, J. C., Gluud, C., Wetterslev, J., & Winkel, P. (2017). When and how should multiple imputation be used for handling missing data in randomised clinical trials - A practical guide with flowcharts. *BMC Medical Research Methodology*, *17*(1), 1–10. https://doi.org/10.1186/S12874-017-0442-1/TABLES/2

James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Accrombessi, M. M. K., … Murray, C. J. L. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 Diseases and Injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, *392*(10159), 1789–1858. https://doi.org/10.1016/S0140-6736(18)32279-7

Jennings, V., & Bamkole, O. (2019). The Relationship between Social Cohesion and Urban Green Space: An Avenue for Health Promotion. *International Journal of Environmental Research and Public Health 2019, Vol. 16, Page 452*, *16*(3), 452. https://doi.org/10.3390/IJERPH16030452

Johnsen, S. Å. K., & Rydstedt, L. W. (2013). Active use of the natural environment for emotion regulation. *Europe's Journal of Psychology*, *9*(4), 798–819. https://doi.org/10.5964/EJOP.V9I4.633

Johnson, J. G., Harris, E. S., Spitzer, R. L., & Williams, J. B. W. (2002). The Patient Health Questionnaire for Adolescents: Validation of an instrument for the assessment of mental disorders among adolescent primary care patients. *Journal of Adolescent Health*, *30*(3), 196–204. https://doi.org/10.1016/S1054-139X(01)00333-0

Jones, P. B. (2013). Adult mental health disorders and their age at onset. *British Journal of Psychiatry*,

*202*(s54), 5–10. https://doi.org/10.1192/bjp.bp.112.119164

Kabat-Zinn, J. (1994). Wherever you go ,There you are:Mindfulness meditation in Every-day Life.Hyperion. In *Hyperion*. Hachette Books. https://books.google.com/books/about/Wherever_You_Go_There_You_Are.html?id=-g-OSXrZeYYC

Kaplan, R., & Kaplan, S. (1989). *The Experience of Nature A Psychological Perspective*. Cambridge University Press.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. https://doi.org/https://doi.org/10.1016/0272-4944(95)90001-2

Kazdin, A. E. (2007). *Mediators and Mechanisms of Change in Psychotherapy Research*. https://doi.org/10.1146/annurev.clinpsy.3.022806.091432

Kechter, A., Black, D. S., Riggs, N. R., Warren, C. M., Ritt-Olson, A., Chou, C. P., & Pentz, M. A. (2019). Factors in the Perceived Stress Scale Differentially Associate with Mindfulness Disposition and Executive Function among Early Adolescents. *Journal of Child and Family Studies*, *28*(3), 814–821. https://doi.org/10.1007/S10826-018-01313-4/FIGURES/1

Keenan-Miller, D., Hammen, C. L., & Brennan, P. A. (2007). Health Outcomes Related to Early Adolescent Depression. *Journal of Adolescent Health*, *41*(3), 256–262. https://doi.org/10.1016/j.jadohealth.2007.03.015

Kellert, S. R., & Wilson, E. O. (1995). *The Biophilia Hypothesis*. Island Press. https://doi.org/https://doi.org/10.1177/027046769501500125

Kelz, C., Evans, G. W., & Röderer, K. (2015). The Restorative Effects of Redesigning the Schoolyard. *Environment and Behavior*, *47*(2), 119–139. https://doi.org/10.1177/0013916513510528

Kessler, R. C., Amminger, G. P., Aguilar-Gaxiola, S., Alonso, J., Lee, S., & Üstün, T. B. (2007). Age of onset of mental disorders: A review of recent literature. *Current Opinion in Psychiatry*, *20*(4), 359–364. https://doi.org/10.1097/YCO.0b013e32816ebc8c

Kirschbaum, C., Pirke, K.-M., & Hellhammer, D. H. (1993). The 'Trier Social Stress Test'-A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Ncuropsychobiology*, *28*, 76–81.

Korpela, K. M., Pasanen, T., Repo, V., Hartig, T., Staats, H., Mason, M., Alves, S., Fornara, F., Marks, T., Saini, S., Scopelliti, M., Soares, A. L., Stigsdotter, U. K., & Thompson, C. W. (2018). Environmental strategies of affect regulation and their associations with subjective well-being. *Frontiers in Psychology*, *9*(APR), 562. https://doi.org/10.3389/FPSYG.2018.00562/BIBTEX

Kostova, Z., Levin, L., Lorberg, B., & Ziedonis, D. (2019). Mindfulness-Based Interventions for Adolescents with Mental Health Conditions: A Systematic Review of the Research Literature. *Journal of Child and Family Studies 2019 28:10*, *28*(10), 2633–2649. https://doi.org/10.1007/S10826-019-01477-7

Kotera, Y., Richardson, M., & Sheffield, D. (2020). Effects of Shinrin-Yoku (Forest Bathing) and Nature Therapy on Mental Health: a Systematic Review and Meta-analysis. *Journal of Mental Health and Addiction*, 1–24. https://doi.org/10.1007/s11469-020-00363-4

Kowalski, K. C., Crocker, P. R. E., Donen, R. M., & Honours, B. (2004). *The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual* (Vol. 87, Issue 1).

Kraemer, H. C. ., Wilson, G. ., Fairburn, C. G. ., & Agras, W. S. (2002). Mediators and Moderators of Treatment Effects in Randomized Clinical Trials Cite this paper Evidence Base Updat e: 50 Years of Research on Treat ment for Child and Adolescent Anxiet y Leslie Rit h-Najarian Evidence-Based Psychosocial Treat ment s for Phobic and Anxiet y Disorders in Children and Adolesce…. *Archives of General Psychiatry*, *59*(10), 877–883. www.archgenpsychiatry.com

Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, *16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kuby, A. K., McLean, N., & Allen, K. (2015). Validation of the Child and Adolescent Mindfulness Measure (CAMM) with Non-Clinical Adolescents. *Mindfulness*, *6*(6), 1448–1455. https://doi.org/10.1007/s12671-015-0418-3

Lahart, I., Darcy, P., Gidlow, C., & Calogiuri, G. (2019). The Effects of Green Exercise on Physical and Mental Wellbeing: A Systematic Review. *International Journal of Environmental Research and Public Health*, *16*(8), 1352. https://doi.org/10.3390/ijerph16081352

Largo-Wight, E., William Chen, W., Dodd, V., & Weiler, R. (2011). Healthy workplaces: The effects of nature contact at work on employee stress and health. *Public Health Reports*, *126*(SUPPL. 1), 124–126. https://doi.org/10.1177/00333549111260s116

Lee, I., Choi, H., Bang, K. S., Kim, S., Song, M. K., & Lee, B. (2017). Effects of Forest Therapy on Depressive Symptoms among Adults: A Systematic Review. *International Journal of Environmental Research and Public Health 2017, Vol. 14, Page 321*, *14*(3), 321. https://doi.org/10.3390/IJERPH14030321

Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health*, *125*(2), 93–100. https://doi.org/10.1016/j.puhe.2010.09.005

Lee, Juyoung, Tsunetsugu, Y., Takayama, N., Park, B. J., Li, Q., Song, C., Komatsu, M., Ikei, H., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2014). Influence of forest therapy on cardiovascular relaxation in young adults. *Evidence-Based Complementary and Alternative Medicine*, *2014*. https://doi.org/10.1155/2014/834360

Mackinnon, D., & Luecken, L. (2008). How and for Whom? Mediation and Moderation in Health Psychology. *Health Psychology*, *27(2S)*(S99). https://doi.org/10.1037/0278-6133.27.2(Suppl.).S99

Mao, G. X., Lan, X. G., Cao, Y. B., Chen, Z. M., He, Z. H., Lv, Y. D., Wang, Y. Z., Hu, X. L., Wang, G. F., & Yan, J. (2012). Effects of short-term forest bathing on human health in a broad-leaved evergreen forest in Zhejiang Province, China. *Biomedical and Environmental Sciences*, *25*(3), 317–324. https://doi.org/10.3967/0895-3988.2012.03.010

Marselle, M. R. ., Irvine, K. N. ., Lorenzo-Arribas, A. ., & Warber, S. L. (2016). Does perceived restorativeness mediate the effects of perceived biodiversity and perceived naturalness on emotional well- being following group walks in nature? . *Journal of Environmental Psychology*, *46*, 217–232. https://doi.org/10.1016/j.jenvp.2016.04.008

Masterton, W., Carver, H., Parkes, T., & Park, K. (2020). Greenspace interventions for mental health in clinical and non-clinical populations: What works, for whom, and in what circumstances? *Health and Place*, *64*. https://doi.org/10.1016/j.healthplace.2020.102338

Mayer, F. S., Mcpherson Frantz, C., Bruehlman-Senecal, E., Dolliver, K., Bielagus, E., Doohan, C., Friedman, M., Kaplan, S., Keeler-Wolf, E., Luce, Z., Nazryan, D., Quay, L., Rock, M., Sytsma, S., Shauger, A., & Yager, M. (2009). Why Is Nature Beneficial? The Role of Connectedness to Nature. *Environment and Behavior*, *41*(5), 607–643. https://doi.org/10.1177/0013916508319745

McCormick, R. (2017). Does Access to Green Space Impact the Mental Well-being of Children: A Systematic Review. *Journal of Pediatric Nursing*, *37*, 3–7. https://doi.org/10.1016/J.PEDN.2017.08.027

Mcewan, K., Giles, D., Kotera, Y., Basran, J., Giles, D., Clarke, F. J., Kotera, Y., Evans, G., Terebenina, O., Minou, L., Teeling, C., Wood, W., & Weil, D. (2021). *A Pragmatic Controlled Trial of Forest Bathing Compared with Compassionate Mind Training in the UK: Impacts on Self-Reported Wellbeing and Heart Rate Variability*. https://doi.org/10.3390/su13031380

McGorry, P. D., Purcell, R., Goldstone, S., & Amminger, G. P. (2011). Age of onset and timing of treatment for mental and substance use disorders: implications for preventive intervention strategies and models of care. *Current Opinion in Psychiatry*, *24*(4), 301–306. https://doi.org/10.1097/YCO.0B013E3283477A09

McKenzie, J. E. ., Brennan, S. E. ., Ryan, R. E., Thomson, H. J. ., Johnston, R. V. ., & Thomas, J.

(2019). Defining the criteria for including studies and how they will be grouped for the synthesis. In J. P. T. . Higgins, J. . Thomas, J. . Chandler, M. . Cumpston, T. . Li, M. J. . Page, & V. A. Welch (Eds.), *Cochrane handbook for systematic reviews of interventions* (6.2, pp. 33–65). Cochrone. www.training.cochrane.org/handbook

McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *Journal of Positive Psychology*, *10*(6), 507–519. https://doi.org/10.1080/17439760.2014.994224

Merry, S. N., Hetrick, S. E., Cox, G. R., Brudevold-Iversen, T., Bir, J. J., & McDowell, H. (2011). Psychological and educational interventions for preventing depression in children and adolescents. In *Cochrane Database of Systematic Reviews* (pp. 1409–1685). John Wiley & Sons, Ltd. https://doi.org/10.1002/14651858.cd003380.pub3

Mikkelsen, K., Stojanovska, L., Polenakovic, M., Bosevski, M., & Apostolopoulos, V. (2017). Exercise and mental health. *Maturitas*, *106*, 48–56. https://doi.org/10.1016/J.MATURITAS.2017.09.003

Miyazaki, Y. (2018a). *Shinrin-yoku: The Japanese Way of Forest Bathing for Health and Relaxation*. Timber Press.

Miyazaki, Y. (2018b). *Shinrin-yoku: The Japanese Way of Forest Bathing for Health and Relaxation* . Timber Press. https://books.google.co.uk/books?hl=en&lr=&id=XX4-DwAAQBAJ&oi=fnd&pg=PT3&ots=Oh0A28bfGa&sig=Zh1GT0f1q02-L8RZRYfjqa-3VN8&redir_esc=y#v=onepage&q&f=false

Mohr, D. C., Spring, B., Freedland, E. K., Beckner, V., Arean, P., Hollon, S. D., Ockene, J., & Kaplan, R. (2009). *The Selection and Design of Control Conditions for Randomized Controlled Trials of Psychological Interventions*. https://doi.org/10.1159/000228248

Moss, S. (2012). *Natural Childhood*. http://www.friendsofhaileypark.org.uk/uploads/1/9/5/1/1951271/naturalchildhood_stephenmoss_nationaltrust.pdf

Mullen, S. (2018). Major depressive disorder in children and adolescents. *Ment Health Clin [Internet]*, *8*(6), 275–283. https://doi.org/10.9740/mhc.2018.11.275

Muñoz, R. F., Cuijpers, P., Smit, F., Barrera, A. Z., & Leykin, Y. (2010). Prevention of Major Depression. *Annual Review of Clinical Psychology*, *6*(1), 181–212. https://doi.org/10.1146/annurev-clinpsy-033109-132040

Muñoz, R. F., San, F. /, Hospital, F. G., Beardslee, W. R., & Leykin, Y. (2012). Major Depression Can Be Prevented. *American Psychologist*, *67*(4), 285. https://doi.org/10.1037/a0027666

Mygind, Laerke, Hartmeyer, R. D., & Mygind, E. (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*, 102–136. https://doi.org/10.31219/osf.io/wj2pg

Mygind, Lærke, Kjeldsted, E., Hartmeyer, R. D., Mygind, E., Bølling, M., & Bentsen, P. (2019). Immersive nature-experiences as health promotion interventions for healthy, vulnerable, and sick populations? A systematic review and appraisal of controlled studies. In *Frontiers in Psychology* (Vol. 10, Issue APR, p. 943). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2019.00943

Nandakumar, A. L., Vande Voort, J. L., Nakonezny, P. A., Orth, S. S., Romanowicz, M., Sonmez, A. I., Ward, J. A., Rackley, S. J., Huxsahl, J. E., & Croarkin, P. E. (2019). Psychometric Properties of the Patient Health Questionnaire-9 Modified for Major Depressive Disorder in Adolescents. *Journal of Child and Adolescent Psychopharmacology*, *29*(1), 34–40. https://doi.org/10.1089/cap.2018.0112

National Institute for Health and Care Excellence. (2019). *Depression in children and young people: identification and management [NG134]*. https://www.nice.org.uk/guidance/ng134

Nisbet, E. K., Zelenski, J. M., & Grandpierre, Z. (2019). Mindfulness in Nature Enhances Connectedness and Mood. *Ecopsychology*, *11*(2), 81–91. https://doi.org/10.1089/eco.2018.0061

Noordsy, D. L. (2019). *Lifestyle Psychiatry* . American Psychiatric Association Publishing. https://books.google.co.uk/books?hl=en&lr=&id=fJqRDwAAQBAJ&oi=fnd&pg=PP1&dq=lifestyle+psychiatry&ots=acgBapZ6CC&sig=Gum2zYQupNNvi9AsHX2JmpXdsjU&redir_esc=y#v=onepage&q=lifestyle psychiatry&f=false

Norwood, M. F., Lakhani, A., Fullagar, S., Maujean, 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. In *Landscape and Urban Planning* (Vol. 189, pp. 71–79). Elsevier B.V. https://doi.org/10.1016/j.landurbplan.2019.04.007

Olivos-Jara, P., Segura-Fernández, R., Rubio-Pérez, C., & Felipe-García, B. (2020). Biophilia and Biophobia as Emotional Attribution to Nature in Children of 5 Years Old. *Frontiers in Psychology*, *11*, 511. https://doi.org/10.3389/FPSYG.2020.00511/BIBTEX

Osgood, C. E. ., Suci, G. J. ., & Tannenbaum. P. H. (1957). *The measurement of meaning* . University of Illinois press. https://www.press.uillinois.edu/books/catalog/32mtm7sx9780252745393.html

Overbey, T. A., Diekmann, F., & Lekies, K. S. (2021). Nature-based interventions for vulnerable youth: a scoping review. *International Journal of Environmental Health Research*. https://doi.org/10.1080/09603123.2021.1998390/FORMAT/EPUB

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer,

L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*. https://doi.org/10.1136/BMJ.N71

Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine*, *15*(1), 18–26. https://doi.org/10.1007/s12199-009-0086-9

Park, Bum Jin, Furuya, K., Kasetani, T., Takayama, N., Kagawa, T., & Miyazaki, Y. (2011). Relationship between psychological responses and physical environments in forest settings. *Landscape and Urban Planning*, *102*(1), 24–32. https://doi.org/10.1016/j.landurbplan.2011.03.005

Passmore, H. A., & Howell, A. J. (2014). Nature involvement increases hedonic and eudaimonic well-being: A two-week experimental study. *Ecopsychology*, *6*(3), 148–154. https://doi.org/10.1089/eco.2014.0023

Patalay, P., & Gage, S. H. (2019). Changes in millennial adolescent mental health and health-related behaviours over 10 years: a population cohort comparison study. *International Journal of Epidemiology*, *48*(5), 1650–1664. https://doi.org/10.1093/IJE/DYZ006

Pearson, D. G., & Craig, T. (2014). The great outdoors? Exploring the mental health benefits of natural environments. *Frontiers in Psychology*, *0*, 1178. https://doi.org/10.3389/FPSYG.2014.01178

Petito, A., Pop, T. L., Namazova-Baranova, L., Mestrovic, J., Nigri, L., Vural, M., Sacco, M., Giardino, I., Ferrara, P., & Pettoello-Mantovani, M. (2020). The Burden of Depression in Adolescents and the Importance of Early Recognition. *The Journal of Pediatrics*, *218*, 265-267.e1. https://doi.org/10.1016/J.JPEDS.2019.12.003

Piotrowski, M. C., Lunsford, J., & Gaynes, B. N. (2021). Lifestyle psychiatry for depression and anxiety: Beyond diet and exercise. *Lifestyle Medicine*, *2*(1), e21. https://doi.org/10.1002/LIM2.21

Putra, I. G. N. E., Astell-Burt, T., Cliff, D. P., Vella, S. A., & Feng, X. (2021). Association between caregiver perceived green space quality and the development of prosocial behaviour from childhood to adolescence: Latent class trajectory and multilevel longitudinal analyses of Australian children over 10 years. *Journal of Environmental Psychology*, *74*, 101579. https://doi.org/10.1016/J.JENVP.2021.101579

Putra, I. G. N. E., Astell-Burt, T., Cliff, D. P., Vella, S. A., John, E. E., & Feng, X. (2020). The Relationship Between Green Space and Prosocial Behaviour Among Children and Adolescents: A Systematic Review. *Frontiers in Psychology*, *0*, 859. https://doi.org/10.3389/FPSYG.2020.00859

Racine, N., McArthur, B. A., Cooke, J. E., Eirich, R., Zhu, J., & Madigan, S. (2021). Global Prevalence of Depressive and Anxiety Symptoms in Children and Adolescents During COVID-19: A Meta-analysis. *JAMA Pediatrics*, *175*(11), 1142–1150. https://doi.org/10.1001/JAMAPEDIATRICS.2021.2482

Read, A., Mazzucchelli, T. G., & Kane, R. T. (2016). A preliminary evaluation of a single session behavioural activation intervention to improve well-being and prevent depression in carers. *Clinical Psychologist*, *20*(1), 36–45. https://doi.org/10.1111/CP.12084

Richardson, M. (2019). Beyond Restoration: Considering Emotion Regulation in Natural Well-Being. *Ecopsychology*, *11*(2), 123–129. https://doi.org/10.1089/ECO.2019.0012/ASSET/IMAGES/LARGE/FIGURE1.JPEG

Richardson, M., Hunt, A., Hinds, J., Bragg, R., Fido, D., Petronzi, D., Barbett, L., Clitherow, T., & White, M. (2019). A measure of nature connectedness for children and adults: Validation, performance, and insights. *Sustainability (Switzerland)*, *11*(12), 3250. https://doi.org/10.3390/SU11123250

Richardson, M., Mcewan, K., & Sheffield, D. (2016). Joy and Calm: How an Evolutionary Functional Model of Affect Regulation Informs Positive Emotions in Nature Coping with Pain View project Pain in People with Dementia: a Systematic Review of the Effectiveness of Observational/Behavioural Pain Assessment Tools in the UK View project. *Evolutionary Psychological Science*, *2*(4), 308–320. https://doi.org/10.1007/s40806-016-0065-5

Roberts, A., Hinds, J., & Camic, P. M. (2020a). Nature activities and wellbeing in children and young people: a systematic literature review. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 298–318. https://doi.org/10.1080/14729679.2019.1660195

Roberts, A., Hinds, J., & Camic, P. M. (2020b). Nature activities and wellbeing in children and young people: a systematic literature review. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 298–318. https://doi.org/10.1080/14729679.2019.1660195

Roberts, A., Hinds, J., & Camic, P. M. (2020c). Nature activities and wellbeing in children and young people: a systematic literature review. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 298–318. https://doi.org/10.1080/14729679.2019.1660195

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Fernando Estévez-López, ·, Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., Molina-García, P., Henriksson, H., Mena-Molina, A., Martínez-Vizcaíno, V., Catena, A., Löf, M., Kirk, ·, Erickson, I., David, ·, Lubans, R., Francisco, ·, Ortega, B., & Esteban-Cornejo, I. (2019). SYSTEMATIC REVIEW Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic

Review and Meta-Analysis. *Sports Medicine*, *49*(9), 1383–1410. https://doi.org/10.1007/s40279-019-01099-5

Rogers, A. E., Caruso, C. C., & Aldrich, M. S. (1993). Reliability of sleep diaries for assessment of sleep/wake patterns. *Nursing Research*, *42*(6), 368–371. https://doi.org/10.1097/00006199-199311000-00010

Rogerson, M., Wood, C., Pretty, J., Schoenmakers, P., Bloomfield, D., & Barton, J. (2020). Regular Doses of Nature: The Efficacy of Green Exercise Interventions for Mental Wellbeing. *International Journal of Environmental Research and Public Health*, *17*(5), 1526. https://doi.org/10.3390/ijerph17051526

Rosenberg, M. (1965). *Society and the adolescent self-image.* University Press. https://doi.org/10.1007/s12671-015-0407-6

Salleh, M. R. (2008). Life Event, Stress and Illness. *The Malaysian Journal of Medical Sciences : MJMS*, *15*(4), 9. /pmc/articles/PMC3341916/

Sawyer, S. M., Azzopardi, P. S., Wickremarathne, D., & Patton, G. C. (2018). The age of adolescence. *The Lancet Child & Adolescent Health*, *2*(3), 223–228. https://doi.org/10.1016/S2352-4642(18)30022-1

Scarf, D., Hayhurst, J. G., Riordan, B. C., Boyes, M., Ruffman, T., & Hunter, J. A. (2017). Increasing resilience in adolescents: The importance of social connectedness in adventure education programmes. *Australasian Psychiatry*, *25*(2), 154–156. https://doi.org/10.1177/1039856216671668

Scarf, D., Moradi, S., McGaw, K., Hewitt, J., Hayhurst, J. G., Boyes, M., Ruffman, T., & Hunter, J. A. (2016). Somewhere I belong: Long-term increases in adolescents' resilience are predicted by perceived belonging to the in-group. *British Journal of Social Psychology*, *55*(3), 588–599. https://doi.org/10.1111/bjso.12151

Schuch, F., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P., Reichert, T., Bagatini, N. C., Bgeginski, R., & Stubbs, B. (2017). Physical activity and sedentary behavior in people with major depressive disorder: A systematic review and meta-analysis. *Journal of Affective Disorders*, *210*, 139–150. https://doi.org/10.1016/J.JAD.2016.10.050

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health Benefits from Nature Experiences Depend on Dose. *Scientific Reports*, *6*(1), 1–10. https://doi.org/10.1038/srep28551

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*, 1–32. https://doi.org/10.1146/ANNUREV.CLINPSY.3.022806.091415

Shin, J. C., Parab, K. V., An, R., & Grigsby-Toussaint, D. S. (2020). Greenspace exposure and sleep: A systematic review. *Environmental Research*, *182*. https://reader.elsevier.com/reader/sd/pii/S0013935119308771?token=1ECAD41092FA6E1B51D31BBEFC0D571BE5271AC6552C0A1FC6655247950B1795FC705A4AC234DBEE07FAF64070B0D41B&originRegion=eu-west-1&originCreation=20211014143815

Shin, W. S., & Oh, H. K. (1996). The influence of the forest program on depression level. *Journal of Korean Society of Forest Science*, *85*(4), 586–595. https://www.koreascience.or.kr/article/JAKO199616247607311.pdf

Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. *Frontiers in Ecology and the Environment*, *14*(2), 94–101. https://doi.org/10.1002/fee.1225

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., Salazar de Pablo, G., Il Shin, J., Kirkbride, J. B., Jones, P., Kim, J. H., Kim, J. Y., Carvalho, A. F., Seeman, M. V., Correll, C. U., & Fusar-Poli, P. (2021). Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Molecular Psychiatry 2021*, *17*, 1–15. https://doi.org/10.1038/s41380-021-01161-7

Song, C., Ikei, H., Igarashi, M., Miwa, M., Takagaki, M., & Miyazaki, Y. (2014). Physiological and psychological responses of young males during spring-time walks in urban parks. *Journal of Physiological Anthropology*, *33*(1). https://doi.org/10.1186/1880-6805-33-8

Song, C., Ikei, H., Igarashi, M., Takagaki, M., & Miyazaki, Y. (2015). Physiological and psychological effects of a walk in Urban parks in fall. *International Journal of Environmental Research and Public Health*, *12*(11), 14216–14228. https://doi.org/10.3390/ijerph121114216

Song, C., Joung, D., Ikei, H., Igarashi, M., Aga, M., Park, B. J., Miwa, M., Takagaki, M., & Miyazaki, Y. (2013). Physiological and psychological effects of walking on young males in urban parks in winter. *Journal of Physiological Anthropology*, *32*(1). https://doi.org/10.1186/1880-6805-32-18

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine*, *166*(10), 1092–1097. https://doi.org/10.1001/archinte.166.10.1092

Stanton, K., & Watson, D. (2014). Positive and Negative Affective Dysfunction in Psychopathology. *Social and Personality Psychology Compass*, *8*(9), 555–567. https://doi.org/10.1111/SPC3.12132

Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Wood, A. M., & Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ*, *338*(7713), 157–160. https://doi.org/10.1136/BMJ.B2393

Stevenson, M. P., Schilhab, T., & Bentsen, P. (2018). Attention Restoration Theory II: a systematic

review to clarify attention processes affected by exposure to natural environments. In *Journal of Toxicology and Environmental Health - Part B: Critical Reviews* (Vol. 21, Issue 4, pp. 227–268). Taylor and Francis Inc. https://doi.org/10.1080/10937404.2018.1505571

Stockings, E. A., Degenhardt, L., Dobbins, T., Lee, Y. Y., Erskine, H. E., Whiteford, H. A., & Patton, G. (2016). Preventing depression and anxiety in young people: a review of the joint efficacy of universal, selective and indicated prevention. *Psychological Medicine*, *46*(1), 11–26. https://doi.org/10.1017/S0033291715001725

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*, 103971. https://doi.org/10.1016/J.LANDURBPLAN.2020.103971

Takayama, N., Korpela, K., Lee, J., Morikawa, T., Tsunetsugu, Y., Park, B.-J., Li, Q., Tyrväinen, L., Miyazaki, Y., & Kagawa, T. (2011). Emotional, Restorative and Vitalizing Effects of Forest and Urban Environments at Four Sites in Japan. *Int. J. Environ. Res. Public Health*, *11*, 11. https://doi.org/10.3390/ijerph110707207

Tambs, K., & Røysamb, E. (2014). Selection of questions to short-form versions of original psychometric instruments in MoBa. *Norsk Epidemiologi*, *24*(1–2), 195–201. https://doi.org/10.5324/nje.v24i1-2.1822

Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., Parkinson, J., Secker, J., & Stewart-Brown, S. (2007). The Warwick-Dinburgh mental well-being scale (WEMWBS): Development and UK validation. *Health and Quality of Life Outcomes*, *5*, 63. https://doi.org/10.1186/1477-7525-5-63

Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A Process for Systematically Reviewing the Literature: Providing the Research Evidence for Public Health Nursing Interventions. *Worldviews on Evidence-Based Nursing*, *1*(3), 176–184. https://doi.org/10.1111/J.1524-475X.2004.04006.X

Tiirikainen, K., Haravuori, H., Ranta, K., Kaltiala-Heino, R., & Marttunen, M. (2019). Psychometric properties of the 7-item Generalized Anxiety Disorder Scale (GAD-7) in a large representative sample of Finnish adolescents. *Psychiatry Research*, *272*, 30–35. https://doi.org/10.1016/j.psychres.2018.12.004

Tillmann, S., Clark, A. F., & Gilliland, J. A. (2018). Children and nature: Linking accessibility of natural environments and children's health-related quality of life. *International Journal of Environmental Research and Public Health*, *15*(6). https://doi.org/10.3390/ijerph15061072

Tillmann, S., Tobin, D., Avison, W., & Gilliland, J. (2018a). Mental health benefits of interactions with nature in children and teenagers: A systematic review. *Journal of Epidemiology and Community Health*, 958–966. https://doi.org/10.1136/jech-2018-210436

Tillmann, S., Tobin, D., Avison, W., & Gilliland, J. (2018b). Mental health benefits of interactions with nature in children and teenagers: A systematic review. *Journal of Epidemiology and Community Health*, *72*(10), 958. https://doi.org/10.1136/jech-2018-210436

Tilov, B., Dzhambov, A., & Dimitrova, D. (2017). *Social cohesion mediates the association between urban greenspace and mental health in youth*. https://apps.webofknowledge.com/full_record.do?product=WOS&search_mode=CombineSearches&qid=6&SID=D3wstEbazaQiv6gaF7C&page=5&doc=219

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination Reconsidered: A Psychometric Analysis. In *Cognitive Therapy and Research* (Vol. 27, Issue 3).

Tsunetsugu, Y., Lee, J., Park, B.-J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013a). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape and Urban Planning*, *113*, 90–93. https://doi.org/10.1016/j.landurbplan.2013.01.014

Tsunetsugu, Y., Lee, J., Park, B. J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013b). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape and Urban Planning*, *113*, 90–93. https://doi.org/10.1016/j.landurbplan.2013.01.014

Tursi, M. F. D. S., Baes, C. V. W., Camacho, F. R. D. B., Tofoli, S. M. D. C., & Juruena, M. F. (2013). Effectiveness of psychoeducation for depression: a systematic review. *Australian & New Zealand Journal of Psychiatry*, *47*(11), 1019–1031. https://doi.org/10.1177/0004867413491154

Ulrich, R. (1981). Natural Versus Urban Scenes: Some Psychophysiological Effects. *Environment and Behavior*, *13*(5), 523–556. https://journals.sagepub.com/doi/pdf/10.1177/0013916581135001

Ulrich, R. S. (1983). Aesthetic and Affective Response to Natural Environment. *Behavior and the Natural Environment*, 85–125. https://doi.org/10.1007/978-1-4613-3539-9_4

Ulrich, R. S. (1993). Biophilia, biophobia, and natural landscapes Design Guidelines View project Healthcare Architecture View project. *The Biophilia Hypothesis, 7*, 73–137. https://www.researchgate.net/publication/284655696

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991a). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991b). Stress recovery during exposure to natural and urban environments. *Journal of Environmental*

*Psychology*, *11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Van Bronswijk, S., & Beijers, L. (2018). *Effectiveness of psychotherapy for treatment-resistant depression: A meta-analysis and meta-regression Personalized and precision mental healthcare: special interest group View project Interpersoonlijke psychotherapie View project*. https://doi.org/10.1017/S003329171800199X

Van Gordon, W., Shonin, E., & Richardson, M. (2018). Mindfulness and Nature. *Mindfulness*, *9*(5), 1655–1658. https://doi.org/10.1007/s12671-018-0883-6

Vanaken, G. J., & Danckaerts, M. (2018). Impact of green space exposure on children's and adolescents' mental health: A systematic review. In *International Journal of Environmental Research and Public Health* (Vol. 15, Issue 12). MDPI AG. https://doi.org/10.3390/ijerph15122668

Wang, X., Rodiek, S., Wu, C., Chen, Y., & Li, Y. (2016). Stress recovery and restorative effects of viewing different urban park scenes in Shanghai, China. *Urban Forestry & Urban Greening*, *15*, 112–122. https://doi.org/10.1016/j.ufug.2015.12.003

Watkins, E. ., & Roberts, H. (2020). Reflecting on rumination: Consequences, causes, mechanisms and treatment of rumination. *Behaviour Research and Therapy*, *127*, 103573. https://doi.org/10.1016/J.BRAT.2020.103573

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. . *Psychological Bulletin*, *134*(2), 163. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1032.5493&rep=rep1&type=pdf

White, M. P., Alcock, I., Grellier, J., Wheeler, B. W., Hartig, T., Warber, S. L., Bone, A., Depledge, M. H., & Fleming, L. E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports*, *9*(1), 1–11. https://doi.org/10.1038/s41598-019-44097-3

Wilson, E. O. (1984). *Biophilia*. Harvard University Press. https://www.degruyter.com/document/doi/10.4159/9780674045231/html

Wong, V. W. H., Ho, F. Y. Y., Shi, N. K., Sarris, J., Chung, K. F., & Yeung, W. F. (2021). Lifestyle medicine for depression: A meta-analysis of randomized controlled trials. *Journal of Affective Disorders*, *284*, 203–216. https://doi.org/10.1016/J.JAD.2021.02.012

Wood, C., Angus, C., Pretty, J., Sandercock, G., & Barton, J. (2013). A randomised control trial of physical activity in a perceived environment on self-esteem and mood in UK adolescents. *International Journal of Environmental Health Research*, *23*(4), 311–320. https://doi.org/10.1080/09603123.2012.733935

Wood, C., Gladwell, V., & Barton, J. (2014). A Repeated Measures Experiment of School Playing Environment to Increase Physical Activity and Enhance Self-Esteem in UK School Children. *PLoS ONE*, *9*(9), e108701. https://doi.org/10.1371/journal.pone.0108701

World Health Organization. (2021a). *Adolescent mental health*. https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health

World Health Organization. (2021b). *Depression*. https://www.who.int/news-room/fact-sheets/detail/depression

Ystgaard, M. (1993). *Vulnerable Youth and Social Support*. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Ystgaard+M.+Sårbar+ungdom+og+sosial+støtte.+En+tilnærming+til+forebygging+av+psykisk+stress+og+selvmord.+Oslo%3A+Senter+for+sosialt+nettverk+og+helse%2C+1993.&btnG=#d=gs_cit&u=%252Fscholar%253Fq%253Dinfo%253

Zaman, R., Hankir, A., & Jemni, M. (2019). LIFESTYLE FACTORS AND MENTAL HEALTH. *Psychiatria Danubina*, *31*, 217–220.

Zhang, Y., Mavoa, S., Zhao, J., Raphael, D., & Smith, M. (2020a). The association between green space and adolescents mental well-being: A systematic review. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 18, pp. 1–26). MDPI AG. https://doi.org/10.3390/ijerph17186640

Zhang, Y., Mavoa, S., Zhao, J., Raphael, D., & Smith, M. (2020b). The Association between Green Space and Adolescents' Mental Well-Being: A Systematic Review. *International Journal of Environmental Research and Public Health*, *17*(18), 6640. https://doi.org/10.3390/ijerph17186640

# Appendices

## Appendix A

## Electronic Search Strategies for Each Database: SCOPUS, Web of Science and PsychINFO

### *SCOPUS*

( TITLE-ABS-KEY ( "contact with nature" OR "nature exposure" OR "exposure to nature" OR "natur* experience*" OR "access to nature" OR "green space*" OR greenspace OR greenery OR greenness OR forests OR "forest school" OR "shinrin yoku" OR "shinrin-yoku" OR "forest bathing" OR "forest environment" OR wilderness OR "blue space" OR park OR parks OR woodlands OR countryside OR "urban forest" OR "outdoor adventure interventions" OR "adventure therapy" OR gardening OR "natur* environment*" OR "outdoor adventure education" OR "adventure education" OR "adventure program" OR outdoors OR "green exercise" OR "nature therap*" OR "green play" OR "nature therap*" OR ecotherapy* OR "school landscape" ) ) AND ( TITLE-ABS-KEY ( "mental health" OR anxiety OR depress* OR mood OR well-being OR wellbeing OR well-being OR "strengths and difficulties" ) ) AND ( TITLE-ABS-KEY ( adolescen* OR teen*or "young people" OR "young adult*" OR youth* ) )

### *Web of Science*

#4: #3 AND #2 AND #1
#3: TS =( adolescen* OR teen*OR "young people" OR "young adult*" OR youth*)
#2: TS=("mental health" OR anxiety OR depress* OR mood OR well-being OR wellbeing OR well-being OR "strengths and difficulties")
#1: TS =("contact with nature" OR "nature exposure" OR "exposure to nature" OR "natur* experience*" OR "access to nature" OR "green space*" OR greenspace OR greenery OR greenness OR forests OR "forest school" OR "shinrin yoku" OR "shinrin-yoku" OR "forest bathing" OR "forest environment" OR wilderness OR "blue space" OR park OR parks OR woodlands OR countryside OR "urban forest" OR "outdoor adventure interventions" OR "adventure therapy" OR gardening OR "natur* environment*" OR "outdoor adventure education" OR "adventure

education" OR "adventure program" OR outdoors OR "green exercise" OR "nature therap*" OR "green play" OR "nature therap*" OR ecotherapy* OR "school landscape")

***PsychINFO***

1:("contact with nature" OR "nature exposure" OR "exposure to nature" OR "natur* experience*" OR "access to nature" OR "green space*" OR greenspace OR greenery OR greenness OR forests OR "forest school" OR "shinrin yoku" OR "shinrin-
yoku" OR "forest bathing" OR "forest environment" OR wilderness OR "blue space" OR park OR parks OR woodlands OR countryside OR "urban forest" OR "outdoor adventure interventions" OR "adventure therapy" OR gardening OR "natur* environment*" OR "outdoor adventure education" OR "adventure education" OR "adventure program" OR outdoors OR "green exercise" OR "nature therap*" OR "green play" OR "nature therap*" OR ecotherapy* OR "school landscape")
2: ("mental health" or anxiety or depress* or mood or well-being or wellbeing or well-being or "strengths and difficulties").tw.
3. (adolescen* or teen* or "young people" or "young adult*" or youth*).tw.
4. 1 and 2 and 3

## Appendix B

### Effective Public Health Practice Project Quality Assessment tool (Thomas et al., 2004)

**QUALITY ASSESSMENT TOOL FOR QUANTITATIVE STUDIES**


COMPONENT RATINGS

SELECTION BIAS

**(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?**

1 Very likely
2 Somewhat likely
3 Not likely
4 Can't tell

**(Q2) What percentage of selected individuals agreed to participate?**

1 80 - 100% agreement
2 60 – 79% agreement
3 less than 60% agreement
4 Not applicable
5 Can't tell

| RATE THIS SECTION | STRONG | MODERATE | WEAK |
|---|---|---|---|
| See dictionary | 1 | 2 | 3 |

STUDY DESIGN

**Indicate the study design**

1 Randomized controlled trial
2 Controlled clinical trial
3 Cohort analytic (two group pre + post)
4 Case-control
5 Cohort (one group pre + post (before and after))
6 Interrupted time series
7 Other specify _____
8 Can't tell

**Was the study described as randomized? If NO, go to Component C.**

No Yes

**If Yes, was the method of randomization described? (See dictionary)**

No Yes

**If Yes, was the method appropriate? (See dictionary)**

No Yes

| RATE THIS SECTION | STRONG | MODERATE | WEAK |
|---|---|---|---|
| See dictionary | 1 | 2 | 3 |

## CONFOUNDERS

**(Q1) Were there important differences between groups prior to the intervention?**

1 Yes
2 No
3 Can't tell

**The following are examples of confounders:**

1 Race
2 Sex
3 Marital status/family
4 Age
5 SES (income or class)
6 Education
7 Health status
8 Pre-intervention score on outcome measure

**(Q2) If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?**

1 80 - 100% (most)
2 60 - 79% (some)
3 Less than 60% (few or none)
4 Can't Tell

| RATE THIS SECTION | STRONG | MODERATE | WEAK |
|---|---|---|---|
| See dictionary | 1 | 2 | 3 |

## BLINDING

**(Q1) Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?**

1 Yes
2 No
3 Can't tell

**(Q2) Were the study participants aware of the research question?**

1 Yes
2 No
3 Can't tell

| RATE THIS SECTION | STRONG | MODERATE | WEAK |
|---|---|---|---|
| See dictionary | 1 | 2 | 3 |

## DATA COLLECTION METHODS

**(Q1) Were data collection tools shown to be valid?**

1 Yes
2 No
3 Can't tell

**(Q2) Were data collection tools shown to be reliable?**

1 Yes
2 No
3 Can't tell

| RATE THIS SECTION | STRONG | MODERATE | WEAK |
|---|---|---|---|
| **See dictionary** | 1 | 2 | 3 |

## WITHDRAWALS AND DROP-OUTS

**(Q1) Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?**

1 Yes
2 No
3 Can't tell
4 Not Applicable (i.e. one time surveys or interviews)

**(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest).**

1 80 -100%
2 60 - 79%
3 less than 60%
4 Can't tell
5 Not Applicable (i.e. Retrospective case-control)

| RATE THIS SECTION | STRONG | MODERATE | WEAK | |
|---|---|---|---|---|
| **See dictionary** | 1 | 2 | 3 | Not Applicable |

## INTERVENTION INTEGRITY

**(Q1) What percentage of participants received the allocated intervention or exposure of interest?**

1 80 -100%
2 60 - 79%
3 less than 60%
4 Can't tell

**(Q2) Was the consistency of the intervention measured?**

1 Yes
2 No
3 Can't tell

**(Q3) Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?**

4 Yes
5 No
6 Can't tell

## ANALYSES

**(Q1) Indicate the unit of allocation (circle one)**

community organization/institution practice/office individual

**(Q2) Indicate the unit of analysis (circle one)**

community organization/institution practice/office individual

**(Q3) Are the statistical methods appropriate for the study design?**

1 Yes
2 No
3 Can't tell

**(Q4) Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?**

1 Yes
2 No
3 Can't tell

## GLOBAL RATING

**COMPONENT RATINGS**
Please transcribe the information from the gray boxes on pages 1-4 onto this page. See dictionary on how to rate this section.

| | | | | | |
|---|---|---|---|---|---|
| **A** | **SELECTION BIAS** | **STRONG** | **MODERATE** | **WEAK** | |
| | | 1 | 2 | 3 | |
| **B** | **STUDY DESIGN** | **STRONG** | **MODERATE** | **WEAK** | |
| | | 1 | 2 | 3 | |
| **C** | **CONFOUNDERS** | **STRONG** | **MODERATE** | **WEAK** | |
| | | 1 | 2 | 3 | |
| **D** | **BLINDING** | **STRONG** | **MODERATE** | **WEAK** | |
| | | 1 | 2 | 3 | |
| **E** | **DATA COLLECTION METHOD** | **STRONG** | **MODERATE** | **WEAK** | |
| | | 1 | 2 | 3 | |
| **F** | **WITHDRAWALS AND DROPOUTS** | **STRONG** | **MODERATE** | **WEAK** | |
| | | 1 | 2 | 3 | Not Applicable |

## GLOBAL RATING FOR THIS PAPER (circle one):

| | | |
|---|---|---|
| 1 | STRONG | (no WEAK ratings) |
| 2 | MODERATE | (one WEAK rating) |
| 3 | WEAK | (two or more WEAK ratings) |

With both reviewers discussing the ratings:

Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings?

No Yes

If yes, indicate the reason for the discrepancy

1 Oversight
2 Differences in interpretation of criteria
3 Differences in interpretation of study

**Final decision of both reviewers (circle one):**

**1 STRONG**
**2 MODERATE**
**3 WEAK**

**Appendix C**

**Component Ratings for EPHPP Quality Appraisal Assessment**

| Authors (Year) | EPHPP Criteria for quantitative Studies | | | | | | |
|---|---|---|---|---|---|---|---|
| | Selection Bias | Study Design | Confounders | Blinding | Data Collection Method | Withdrawals and Dropouts | Overall Rating |
| Bielinis et al. (2019) | Moderate | Strong | Weak | Moderate | Strong | Strong | Moderate |
| Greenwood and Gatersleben (2016) | Moderate | Strong | Weak | Weak | Moderate | Not Applicable | Weak |
| Hassan et al.(2018) | Moderate | Strong | Weak | Weak | Weak | Not Applicable | Weak |
| Bielinis et al. (2021) | Moderate | Strong | Weak | Weak | Strong | Not Applicable | Weak |
| Bielinis et al. (2018a) | Moderate | Strong | Strong | Moderate | Strong | Weak | Moderate |
| Bielinis et al. (2018b) | Moderate | Strong | Weak | Moderate | Strong | Not Applicable | Moderate |
| Hartig et al. (2003) | Moderate | Strong | Strong | Weak | Moderate | Not Applicable | Moderate |
| Lee et al. (2011) | Moderate | Strong | Moderate | Weak | Weak | Not Applicable | Weak |
| Lee et al. (2014) | Strong | Strong | Moderate | Weak | Weak | Not Applicable | Weak |
| Mao et al. (2012) | Moderate | Strong | Moderate | Weak | Weak | Not Applicable | Weak |
| Park et al. (2011) | Moderate | Strong | Weak | Weak | Strong | Not Applicable | Weak |
| Park et al. (2010) | Moderate | Strong | Weak | Weak | Weak | Not Applicable | Weak |
| Song et al. (2014) | Moderate | Weak | Strong | Weak | Weak | Not Applicable | Weak |
| Song et al. (2015) | Moderate | Weak | Strong | Weak | Weak | Not Applicable | Weak |
| Song et al . (2013) | Moderate | Weak | Strong | Weak | Strong | Not Applicable | Weak |
| Takayama et al. (2011) | Moderate | Strong | Strong | Weak | Strong | Not Applicable | Moderate |
| Tsunetsugu et al. (2013) | Moderate | Strong | Moderate | Weak | Strong | Not Applicable | Moderate |
| McAnally et al. (2018) | Moderate | Moderate | Strong | Weak | Strong | Weak | Weak |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fuegen and Breitenbecher (2018) | Moderate | Strong | Strong | Weak | Strong | Not Applicable | Moderate |
| Shin and Oh (1996) | Moderate | Moderate | Strong | Weak | Strong | Weak | Weak |
| Wang et al. (2016) | Moderate | Strong | Weak | Weak | Strong | Not Applicable | Moderate |
| Wood et al. (2013) | Strong | Strong | Strong | Weak | Strong | Strong | Moderate |
| Kelz et al. (2015) | Strong | Moderate | Strong | Weak | Strong | Moderate | Moderate |
| Scarf et al. (2017) | Moderate | Weak | Strong | Strong | Strong | Weak | Weak |
| Scarf et al. (2016) | Moderate | Moderate | Moderate | Moderate | Strong | Weak | Moderate |
| Hayhurst et al. (2015) | Moderate | Moderate | Strong | Weak | Strong | Weak | Weak |
| Hunter et al. (2013) | Moderate | Moderate | Strong | Weak | Moderate | Weak | Weak |

**Appendix D**

**Summary of the Measurement Tools Used in Each Study**

| Outcome | Tool or measurement | Studies |
|---|---|---|
| Mood and Affect | Profile of Mood States | Bielinis et al. (2019); Bielinis et al. (2021); Bielinis, Omelan et al. (2018); Bielinis, Takayama et al. (2018); Mao et al. (2012); Park et al. (2011); Park et al. (2010). |
| | Profile of Mood States – Short Form | Lee et al. (2011); Lee et al. (2014); Song et al. (2014); Song et al. (2015); Song et al . (2013); Takayama et al. (2011); Tsunetsugu et al. (2013). |
| | Profile of Mood States – Adolescents | Wood et al. (2013). |
| | Activation- Deactivation Adjective Checklist | Fuegen and Breitenbecher (2018). |
| | Positive and Negative Affect Schedule | Bielinis et al. (2019); Bielinis et al. (2021); |

| | | |
|---|---|---|
| | | Bielinis, Omelan et al. (2018); Bielinis, Takayama et al. (2018); |
| | Zuckerman's Inventory of Personal Reactions | Takayama et al. (2011); Fuegen and Breitenbecher (2018). |
| | Overall Happiness Scale | Greenwood and Gatersleben (2016); Hassan et al. (2018). |
| | | Hartig et al. (2003) |
| Mental Health | Beck Depression Inventory | Shin and Oh (1996) |
| | State Trait Anxiety Inventory | Hassan et al.(2018); Lee et al. (2014); Song et al. (2014); Song et al. (2013); Song et al. (2015) |
| | State Trait Anxiety Inventory- State version | Wang et al. (2016). |
| Wellbeing | Basler Well-Being Questionnaire | Kelz et al. (2015) |
| | Recovery-Stress Questionnaire | Kelz et al. (2015) |
| Perceived Restoration | Restorative Outcome Scale | Bielinis et al. (2019); Bielinis et al. (2021); Bielinis, Omelan et al. (2018); |

| | | |
|---|---|---|
| | | Bielinis, Takayama et al. (2018);<br>Takayama et al. (2011); |
| | Perceived Restorativeness Scale | Wang et al. (2016);<br>Kelz et al. (2015) |
| Stress | Heart Rate (Beats per minute) | Greenwood and Gatersleben (2016);<br>Lee et al. (2011); Lee et al. (2014);<br>Park et al. (2010); Song et al. (2014);<br>Song et al. (2015); Song et al . (2013); Tsunetsugu et al. (2013); |
| | Electrocardiogram (R-R intervals) | Wang et al. (2016) |
| | Heart Rate Variability (low-frequency and high-frequency band variance, R-R intervals) | Lee et al. (2011); Lee et al. (2014);<br>Park et al. (2010); Song et al. (2014);<br>Song et al. (2013). |
| | Blood Pressure (Systolic and Diastolic) | Greenwood and Gatersleben (2016);<br>Hartig et al. (2003); Lee et al. (2011);<br>Tsunetsugu et al. (2013);<br>Hassan et al.(2018); |

| | | |
|---|---|---|
| | Salivary Cortisol | Park et al. (2010); Lee et al. (2014); Kelz et al. (2015) |
| | Serum Cortisol and Testosterone | Lee et al. (2011); Park et al. (2010) |
| | Electroencephalogram (High Alpha, High Beta) | Mao et al. (2012) |
| | Skin Conductance Response | Hassan et al. (2018)<br>Wang et al. (2016) |
| Energy | Subjective Vitality Scale | Bielinis et al. (2019); Bielinis et al. (2021); Bielinis, Omelan et al. (2018); Bielinis, Takayama et al. (2018); |
| | Activation-Deactivation Adjective Checklist (energy and tiredness) | Takayama et al. (2011)<br>Fuegen and Breitenbecher (2018) |
| | Stress-refresh Feeling Test | Tsunetsugu et al. (2013); Lee et al. (2011); Lee et al. (2014) |
| Cognitive Functioning | Necker Cube Pattern Test | Greenwood and Gatersleben (2016);Hartig et al. (2003) |
| | Digit Span Backwards | Fuegen and Breitenbecher (2018); Wang et al. (2016) |
| | Attention Network Task | Kelz et al. (2015) |

| | | |
|---|---|---|
| | Search and Memory Task | Hartig et al. (2003) |
| | The Symbol Digit Modalities Test | Kelz et al. (2015) |
| Resilience | Resilience Scale - Shortened Version | Scarf et al. (2017); Scarf et al. (2016); Hayhurst et al. (2015) |
| Self-concept | Rosenberg Self-esteem Scale | McAnally et al. (2018); Wood et al. (2013). |
| | Single Item Self-esteem Scale | Hunter et al. (2013) |
| | Self-Description Questionnaire III | Hayhurst et al. (2015) |
| | General Self-efficacy Scale | Hayhurst et al. (2015) |
| Pro-social Behaviour | Strengths and Difficulties Questionnaire | McAnally et al. (2018) |
| | Empathic Concern Sub-scale | McAnally et al. (2018) |

**Appendix E**

**Summary of Papers by Outcomes**

| Outcome | | Weak | | Moderate | | Strong | |
|---|---|---|---|---|---|---|---|
| | | NS | PS | NS | PS | NS | PS |
| Mood and Affect | Negative Mood | | Bielinis et al. (2021); Lee et al. (2011); Lee et al. (2014); Mao et al. (2012); Park et al. (2011); Park et al. (2010); Song et al. (2014); Song et al. (2015);Song et al.(2013) | Tsunetsugu et al. (2013); Wood et al. (2013) | Bielinis et al. (2019); Bielinis, Takayama et al. (2018); Takayama et al. (2011) | | Bielinis, Omelan et al. (2018) |

| | | | | | |
|---|---|---|---|---|---|
| Positive Mood | | Bielinis et al. (2021); Lee et al. (2011); Lee et al. (2014); Mao et al. (2012); Park et al. (2011); Park et al. (2010); Song et al. (2014); Song et al. (2015); Song et al . (2013) | Tsunetsugu et al. (2013); Bielinis et al. (2019). | Bielinis, Takayama et al. (2018); Takayama et al. (2011) | Bielinis, Omelan et al. (2018) |
| Positive Affect | Bielinis et al. (2021) | Greenwood and Gatersleben (2016); Song et al. (2015) | | Bielinis et al. (2019); Bielinis, Takayama et al. (2018); Hartig et al. | Bielinis, Omelan et al. (2018) |

| | | | | | |
|---|---|---|---|---|---|
| | | | | (2003); Fuegen and Breitenbecher (2018) | |
| | Negative Affect | Bielinis et al. (2021) | Bielinis et al. (2019); Fuegen and Breitenbecher (2018) | Takayama et al. (2011) | Bielinis, Omelan et al. (2018) |
| Mental Health | Anxiety | | Hassan et al. (2018); Lee et al. (2014); Song et al. (2014); Song et al. (2015) | Wang et al. (2016) | |
| | Depression | | Shin and Oh (1996) | | |
| Wellbeing | | | McAnally et al. (2018) | Kelz et al. (2015) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Restoration | Perceived Restoration | | Bielinis et al. (2021) | | Bielinis et al. (2019); Bielinis, Takayama et al. (2018); Takayama et al. (2011); Wang et al. (2016); Kelz et al. (2015) | Bielinis, Omelan et al. (2018) |
| Cognitive Functioning | Attention | | Greenwood and Gatersleben (2016) | Fuegen and Breitenbecher (2018) | Hartig et al. (2003); Wang et al. (2016) | |
| | Executive Functioning | | | Kelz et al. (2015) | | |
| Stress | Heart Rate | Greenwood and Gatersleben (2016) | Lee et al. (2011); Lee et al. (2014); | | Tsunetsugu et al. (2013) | |

| | | |
|---|---|---|
| | Park et al. (2010); Song et al. (2014); Song et al. (2015); Song et al. (2013) | |
| Electrocardiogram | | Wang et al. (2016) |
| Heart Rate Variability | Lee et al. (2011); Lee et al. (2014); Park et al. (2010); Song et al. (2014); Song et al. (2015) | |

| | | | | |
|---|---|---|---|---|
| | | | Song et al . (2013) | |
| | Blood Pressure | Greenwood and Gatersleben (2016); Lee et al. (2011) | Hassan et al.(2018); Park et al. (2010); Lee et al. (2014) | Tsunetsugu et al. (2013); Kelz et al. (2015); Hartig et al (2003) |
| | Cortisol | | Lee et al. (2011); Mao et al. (2012); Park et al. (2010) | |
| | Electroencephalogram | | Hassan et al.(2018) | |
| | Skin Conductance | | | Wang et al. (2016) |

| | | | | |
|---|---|---|---|---|
| Energy | Vitality | Bielinis et al. (2021) | Bielinis et al. (2019); Bielinis, Takayama et al. (2018); Takayama et al. (2011) | Bielinis, Omelan et al. (2018) |
| | Tiredness | | Fuegen and Breitenbecher (2018) | |
| | Energy | | Fuegen and Breitenbecher (2018) | |
| | Refreshed | Lee et al. (2014); Lee et al. (2011) | Tsunetsugu et al. (2013) | |
| Resilience | | Hayhurst et al. (2015) | Scarf et al. (2017); Scarf et al. (2016) | |

| | | | | |
|---|---|---|---|---|
| Self-concept | Self-esteem | | McAnally et al. (2018); Hunter et al. (2013); Hayhurst et al. (2015) | Wood et al. (2013) |
| | Self-efficacy | | Hayhurst et al. (2015) | |
| Pro-social behaviour | Pro-social behaviour | McAnally et al. (2018) | | |
| | Strengths and difficulties | McAnally et al. (2018) | | |
| | Empathy | McAnally et al. (2018) | | |

## Appendix F

## Copy of Instructions for Authors for Journal of Adolescent Health

Review specific instructions:

Each review article must have a 200-word summary abstract. Review articles are limited to 4500 words, 5 tables/figures, and an unlimited number of references. Review articles should include a 50-word Implications and Contribution summary statement.

General Guidance:

The following list will be useful during the final checking of an article prior to sending it to the *Journal* for review. Please consult this Guide for Authors for further details of any item.

**Ensure that the following items are present:**

**Cover letter**
• Disclosure of any prior publications or submissions with any overlapping information
• A statement that the work is not under consideration elsewhere
• Disclosure of any potential conflict of interest, real and perceived, for all named authors
• Names and contact information for 5 potential reviewers

**Statements of Authorship**
•Please submit a separate statement for each named author

**Title page**
• Article title
• Full names, academic degrees (Masters level and above), and affiliations of all authors
• Name, address, e-mail address, telephone and fax number of the corresponding author
• Sources of funding and acknowledgements of support and assistance
• Disclosure of potential conflicts, real and perceived, for all named authors
• Clinical trials registry site and number
• List of abbreviations

**Manuscript**
• Please double-space
• BR>• Abstract in the appropriate format: Structured for Original Articles and Briefs or Summary for Review Articles and Clinical Observations
•BR>• List of keywords
•Implications and Contributions statement
• IRB statement in the Methods section
• References should be in the correct format for this journal; all references mentioned in the Reference list are cited in the text, and vice versa
• Figure titles should be on a new page
• Manuscript has been 'spell-checked' and 'grammar-checked'

**Tables**
• Each saved as a separate document, including title and footnotes

**Figures**
• Each saved as a separate file, with captions/legends (without titles)
• Color figures are clearly marked as being intended for color reproduction on the Web (free of charge) and in print, or to be reproduced in color on the Web (free of charge) and in black-and-white in print; if only color on the Web is required, black-and-white versions of the figures are also supplied for printing purposes

• Permission has been obtained for use of copyrighted material from other sources (including the Web)
• Copies of prior and/or in press publications related to the current submission can be uploaded as separate files or e-mailed to the Managing Editor
• For any further information please visit our customer support site at https://service.elsevier.com.

**Contact with Nature in Adolescents Experiencing Depressive Symptomology. A Pilot, Two-Week, Psychoeducation Intervention.**

Megan Alison Rowley

**Primary Research Supervisor:** Dr Matthew Owens-Solari

**Secondary Research Supervisor:** Dr Raluca Topciu

**Nominated Journal:** International Journal of Environmental Research and Public Health

This manuscript has been submitted in partial fulfilment of a Doctoral degree in Clinical Psychology.

**Abstract**

Adolescence is a significant period of vulnerability for the development of depression, highlighting it as a critical time for preventative interventions. Nature contact is a modifiable aspect of lifestyle that has shown promise for the prevention of mental ill health and requires further exploration in an adolescent population. 103 adolescents with depressive symptomology were randomised either to an interactive, online, nature-based psychoeducation session or to a wait-list control. Pre/post measures and a daily diary were completed over a two-week period, with intervention participants recommended to increase their nature contact during this time. Depression, anxiety, negative affect and perceived stress significantly decreased over the two-week period in both conditions. Nature connection, mindfulness, wellbeing and positive affect also significantly increased over this time in both conditions. No significant differences were found on outcomes between those who received the intervention and control participants. Potential reasons for a lack of group differences in outcomes are discussed. Across the two weeks, both conditions had contact with nature at a level that may have been sufficient to improve outcomes for all, supporting a potential beneficial effect of nature contact. Interventions supporting increased nature contact in an adolescent population warrant further research.

Adolescence is a particular time of vulnerability for the development of mental health disorders such as depression (Blakemore, 2019; Solmi et al., 2021). Given the significant contribution of depression to the global burden of disease and to the burden on adolescent functioning (James et al., 2018; Petito et al., 2020), there is a need to develop novel preventative interventions. Nature contact is one targetable aspect of a contemporary lifestyle that shows promise for the prevention of mental health (Frumkin et al., 2017; Piotrowski et al., 2021). The beneficial impact of nature contact and nature-based interventions (nature-based interventions) on mental health and wellbeing (Hossain et al., 2020; Harper et al., 2021), alongside the potential to target clinically relevant mechanisms (Owens & Bunce, 2022), highlights the need for further research into nature-based interventions for depression. Exploration of nature-based interventions in adolescent populations is of particular interest given that adolescence presents a key developmental window for the prevention of mental health (Muñoz et al., 2012) and young people, in particular, are at risk of an increased sedentary lifestyle (Moss, 2012).

Commented [RM4]: Examiner: 15. P69 – "development novel" should be develop novel

Globally, 5.0% of adults suffer from depression, making it a significant contributor to the burden of disease and a leading cause of severe disability (James et al., 2018; World Health Organization, 2021b). Adolescence presents a period of risk for the development of depression. A significant proportion of mental health disorders have their onset in adolescence, 62.5% of them occurring before the age of 25 with a peak age at onset of 14.5 years and a median age at onset of 18 years (Solmi et al., 2021). Depression is currently a leading cause of illness and disability among adolescents (Gore et al., 2011; World Health Organization, 2021a), with rates of depressive symptoms having risen over time (Patalay & Gage, 2019). Furthermore, the prevalence of depression in adolescents has doubled in response to the COVID-19 pandemic (Racine et al., 2021). Youth onset depression has the potential to place a severe burden on adolescents' health and social functioning (Petito et al.,

2020). Adolescent depression is associated with poorer health outcomes, higher healthcare utilisation and a chronic, recurrent episodic course (Keenan-Miller et al., 2007). Untreated depression in this population is likely to increase the risk of substance abuse, suicidality and impact on academic, work and social functioning (Mullen, 2018).

Despite the early onset of mental health and the increasing prevalence of adolescent depression, effective treatment often occurs years later, with the treatment delay increasing for cases with an earlier onset (McGorry et al., 2011). In addition, low uptake, disparities in access and attitudinal barriers means that a significant proportion of individuals remain untreated (Ebert & Cuijpers, 2018; Muñoz et al., 2012). Furthermore, whilst current treatments work for some, most psychotherapies have a moderate effect at best (Cuijpers et al., 2019; Van Bronswijk & Beijers, 2018). Reduced uptake and the modest efficacy of treatment approaches limits the extent to which the burden associated with depression can be reduced (McGorry et al., 2011) and has led to the drive for prevention interventions as a global public health priority (Cuijpers et al., 2012; Hoare et al., 2020). Many individuals who develop major depressive disorder will experience subthreshold symptoms of depression for several years prior and, given that depression typically emerges in young adulthood, adolescence presents a key developmental window for preventative interventions, aimed at averting the disorder's course (Muñoz et al., 2012).

The development of multi-level approaches to depression prevention is imperative in the advancement of the prevention field in order to account for differing levels at which depression risks exist, i.e. individual level and socio-environmental level (Hoare et al., 2020). Prevention has three levels of intervention: universal, which is aimed at entire populations; selective, a targeted intervention which targets population subgroups with high-risk factors associated with a disorders' development, and indicated, a second targeted intervention aimed at individuals who have early signs or symptoms of a disorder (Muñoz et al., 2012). In young

people, universal, selective and indicated preventative interventions have been found as feasible in improving outcomes of poor mental health (Pablo et al., 2021; Conley et al., 2017).

Research indicates including educational and psychological components within interventions reduces the relative risk of young people developing depression (Stockings et al., 2016). Psychoeducation is an approach that broadly delivers information relating to health and self-management, aiming to inform and empower individuals to make decisions about their health behaviours (Bevan Jones et al., 2018). Psychoeducation has been utilised as a brief prevention and treatment intervention to support the reduction of depressive symptoms as a first-level approach (Donker et al., 2009), with highest effect sizes in reducing affective symptoms (Pablo et al., 2021). One-off, passive psychoeducation interventions offered to depressed individuals via email, a website and a leaflet were found to significantly reduce depressive symptoms, relative to control (Christensen et al., 2004; Geisner et al., 2006; Jacob et al., 2002). Psychoeducation has shown promise in its role in preventing depression in at-risk adolescents, alongside managing depressive symptoms in those with depression (Bevan Jones et al., 2018). Merry et al. (2011) found that psychological and/or educational interventions aimed at adolescents reduced the risk of having a depressive disorder post intervention, at 3-9 months in targeted and universal interventions and at 12 months for targeted interventions.

A more recent approach within the increased focus on prevention interventions has placed emphasis on targeting lifestyle behaviours as modifiable factors associated with mental health (Jacka et al., 2012; Zaman et al., 2019). This growing area, coined lifestyle psychiatry, aims to support the holistic management of mental health and psychological wellbeing via a focus on lifestyle factors traditionally associated with supporting physical health (Firth et al., 2020; Noordsy, 2019). With developing evidence of lifestyle behaviours

such as physical activity, adequate sleep, smoking and diet playing a causal role in the onset of mental health (Firth et al., 2020), there is a need for research to establish effective preventative lifestyle interventions in young people (Fusar-Poli et al., 2021). More recently, with a growing evidence base for the impact of nature on health and wellbeing (Cox et al., 2017; Hossain et al., 2020), there have been calls to explore contact with nature in clinical practice as a novel targetable lifestyle factor for the prevention of depression (Piotrowski et al., 2021). This may be of increasing importance in adolescence, a period associated with decreased nature contact.

Of increasing concern, nature contact is one aspect of a contemporary lifestyle that is in decline in adolescence (Bratman et al., 2019; Greenwood & Gatersleben, 2016). There has been clear shift in time spent in nature by adolescents largely due to the impact of a technology focused generation and modern risks, such as 'stranger danger', lessening the freedom to be outdoors (Moss, 2012; Richardson et al., 2019). Reduced contact with nature has also been further exacerbated by the COVID-19 pandemic, with a decline in participation in outdoor activities and connection to nature in adolescents (Jackson, et al., 2021a; Jackson, et al., 2021b). This is important as, not only does reduced nature contact lead to disaffection and disconnection towards the environment, it risks psychological costs due to the diminishing positive impact of nature on health and wellbeing (Bratman et al., 2019; Richardson et al., 2019; Soga & Gaston, 2016). This has been particularly evident in an adolescent population during the COVID-19 pandemic (Jackson, et al., 2021a; Jackson, et al., 2021b). The development of nature-based interventions, therefore, has never been more imperative.

The development of nature-based interventions offers promise for the prevention and treatment of mental health (Frumkin et al., 2017). An umbrella review of the mental health impacts of exposure to natural environments, across all ages, highlighted the potential

beneficial effects of nature on mental health outcomes (Hossain et al., 2020). More specifically, in an adolescent population improvements have been reported in relation to mood, wellbeing and stress (McCormick, 2017; Tillmann et al., 2018; Zhang et al., 2020), positive affect (Roberts et al., 2020), depressive symptoms (Zhang et al., 2020b) and self-esteem and resilience (Mygind, Hartmeyer et al., 2019; Tillmann et al., 2018). Such benefits highlight the potential of nature-based interventions to improve functioning in non-clinical samples of adolescents but also the use of nature-based interventions for mental health.

Research into nature-based interventions for mental health difficulties in youth focuses largely on therapeutic programmes such as wilderness therapy. Whilst such programmes lead to positive changes on a broad range of psychosocial and wellbeing indicators, nature-based interventions are often part of an integrative treatment programme (Overbey et al., 2021). This makes it unclear as to whether the therapeutic aspects of nature-based interventions lead to benefits or whether simply being in nature is enough to enhance wellbeing (Roberts et al., 2020). In an umbrella review of nature-based interventions with therapeutic practices, which reported overall positive benefits to mental health (Harper et al., 2021), only two systematic reviews explicitly considered nature-based interventions for depression (Kotera et al., 2020; I. Lee et al., 2017). These reviews considered the effects of forest bathing, or 'shinrin-yoku' in Japanese, which involves bathing or immersion in the environment, using the five senses (Miyazaki, 2018). Whilst the authors concluded that forest bathing was an effective therapy for decreasing depressive symptoms in both clinical and non-clinical samples, studies focused on participants age 17+. This highlights a paucity of research into nature-based interventions with a specific focus on adolescent depression. Furthermore, the evidence base has been found to lack methodological rigour, with insufficient randomised control group designs and a lack of exploration around key constructs related to mental health (Kotera et al., 2020; I. Lee et al., 2017).

Given that nature presents a complex social and environmental setting, there is a need to further explore causal mechanisms of change for the beneficial effects of nature-based interventions, in order to develop more detailed theories of change for improved mental health (Harper et al., 2021). More specifically, when developing nature-based interventions for depressive symptoms, there is a need to explore constructs that may link both nature and depression. These mechanisms may be modifiable targets for future nature-based interventions, warranting further testing in rigorous, experimentally controlled studies (Owens & Bunce, 2022). There are several candidates which may be clinically relevant to depression in adolescent populations, as outlined below.

**Stress**

For adolescents in particular, life stress, both acute and chronic, is believed to play a central role in the onset, development and maintenance of depression (Auerbach et al., 2014; Grant et al., 2004). The Stress Reduction Theory (SRT; Ulrich et al., 1991) posits that nature leads to psychophysiological restoration through a reduction in stress and is a key theory of change following nature contact. SRT is supported through positive outcomes following nature contact on a range of physiological and emotional parameters (Corazon et al., 2019).

**Sleep**

Sleep disturbance, alongside being a symptom of mental health difficulties, is also believed to be a risk factor proceeding onset, particularly sleep disturbance experienced in childhood (Alvaro et al., 2013). A review of evidence supports improvement in sleep quality and quantity following nature exposure, specifically suggesting that higher green space exposure is associated with a reduced risk of poor quality and shortened sleep (J. C. Shin et al., 2020).

**Rumination**

Rumination, defined as repetitive and recurrent negative thinking about the self, feelings, concerns and upsetting experiences (Watkins, 2008), is a process that has been found to causally contribute to the onset of multiple mental health disorders (Watkins & Roberts, 2020). This, alongside evidence for a developmental trajectory over the life span, highlights rumination as a modifiable risk factor in youth (Grierson et al., 2016). Nature contact has been found to reduce rumination, possibly mediated by reductions in the subgenual prefrontal cortex (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015; Mcewan et al., 2021). Furthermore, Bratman et al. (2021) found that rumination mediates the association between nature and negative affect, suggesting that it may be a key mechanism of change.

**Mindfulness**

Mindfulness defined as "paying attention in a particular way: on purpose, in the present moment and non-judgmentally" (Kabat-Zinn, 1994, p. 4), has been found to alleviate a range of mental health disorders through the application of mindfulness-based interventions (Goldberg et al., 2017). Whilst the evidence is less robust in an adolescent population, mindfulness has been found to be efficacious for depression, anxiety and stress in adult populations (Dunning et al., 2019; Kostova et al., 2019). Nature-based mindfulness has been found to lead to psychological and wellbeing benefits, alongside increased nature connectedness, with some evidence to suggest that the effects of mindfulness are further enhanced in nature (Choe et al., 2020; Djernis et al., 2019; Nisbet et al., 2019). Furthermore, mindfulness has been found to mediate the relationship between nature connectedness and wellbeing (Van Gordon et al., 2018), highlighting it as a potential mechanism of change.

**Physical Activity**

Physical activity has been found to significantly impact mental health in both adults and adolescents through a range of psychological changes, including self-esteem, improved mood states and wellbeing (Mikkelsen et al., 2017; Rodriguez-Ayllon et al., 2019). Green exercise interventions have been found to have large effects on mental wellbeing in adults (Rogerson et al., 2020), and there is limited evidence that green exercise is superior to exercise without exposure to nature (Lahart et al., 2019). This is supported in adolescents, with moderate to vigorous physical activity mediating the effect of outdoor time on improved mental health (Bélanger et al., 2019), which suggests that physical activity could be a mechanism of change.

Despite progress in nature-based interventions for mental health in adults, the underlying mechanisms and processes are still unclear (Masterton et al., 2020). There is therefore a need for research on nature-based interventions to be theory generating, in order to develop in-depth theories of change (Harper et al., 2021) and enhance the future development of nature-based interventions for depression. More specifically, research on nature-based interventions with a specific focus on depression is particularly lacking in adolescent populations.

To this end, the present study investigated the effect of a pilot, two-week, nature-based psychoeducation intervention in adolescents experiencing depressive symptomology. This pilot randomised controlled trial used a pretest-posttest design to compare a contact with nature psychoeducation intervention with a wait-list control on mood and wellbeing outcomes, including: depression, anxiety, wellbeing, affect, perceived stress, mindfulness, rumination, self-esteem, physical activity, nature connection and sleep.

## Materials and Methods

### Participants

Participants were 109 adolescents ($M$ = 19.60, $SD$ = 3.83) with depressive symptomology. They were recruited from secondary schools, universities and social media via electronic and paper written correspondence and poster advertisements (Appendix A). Participants were randomly assigned to one of two conditions: intervention vs wait-list control. Nineteen individuals withdrew following randomisation, thirteen due to a lack of time commitment, the rest unknown. Participants received a renumeration of £5 in vouchers or four course credits towards university module assessments and, upon completion of final measures were entered into a prize draw for one of three £50 Amazon vouchers, with winners picked at random. They were informed that the study aimed to explore the effects of a 'benefits of nature' education session on the wellbeing of young people with symptoms of low mood.

### Sample Size Calculation

Based on findings by Passmore and Howell (2014) using the Positive and Negative Affect Schedule (Watson et al., 1988) as a primary outcome measure, the required sample size was 108 to achieve 90% power and a medium-sized effect ($f$ = .25). To guard against a possible 20% follow-up drop-out attrition the study aimed to recruit a target sample of 130. This sits above the recommended minimum sample size of 30-40 participants per group in pilot studies involving group comparisons (Hertzog, 2008).

### Method of Data Collection

***Materials and Measures***

**Positive and Negative Affect Schedule- Child- Short Form (PANAS-C-SF; Ebesutani et al., 2012).** A 10-itemed version of the Positive and Negative Affect Schedule to measure the extent of positive and negative emotions felt by participants. It was scored to create mean scores for positive affect (PA) and negative affect (NA), with higher scores indicating greater PA and NA (Appendix B). Both scales have been found to have good internal consistency in children and adolescents (PA $\alpha = .86$ and NA $\alpha = .82$) (Ebesutani et al., 2012).

**Patient Health Questionnaire modified for Teens (PHQ-9M; Johnson et al., 2002).** Adapted from the original 9-item Patient Health Questionnaire (Kroenke et al., 2001), making it more suited to adolescents, the PHQ-9M was used to assess changes in the presence and severity of depressive symptoms over time. It has been found to be a reliable and valid symptom assessment tool with an internal consistency $\alpha = .88$ (Nandakumar et al., 2019). The question on suicidality was removed for this study, resulting in an 8-item measure with a total score of 24. Higher scores represent greater depression severity (Appendix C).

**General Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006).** A 7-item scale which was used to screen for changes in the presence and severity of generalized anxiety symptoms over time. Total scores range from 0 to 21, with higher scores indicating greater anxiety severity. It has been reported to have similar psychometric properties in adolescents as in adult samples, with good internal consistency $\alpha = .91$ (Tiirikainen et al., 2019) (Appendix D).

**Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS; Tennant et al., 2007).** A 14-item measure of mental wellbeing developed to evaluate interventions aimed at improving mental wellbeing. It was used to assess any changes in wellbeing and covers both eudaimonic (positive functioning) and hedonic (subjective) aspects of wellbeing with an internal consistency, $\alpha = .87$ (Clarke et al., 2011). The scale has a minimum score of 14 and maximum of 70, with higher scores representing higher mental wellbeing (Appendix E).

**Perceived Stress Scale (PSS; Cohen et al., 1983).** A 10-item measure used to assess participants' experience of stress over the past month but was amended at time two to ask about participants' level of stress in the last two weeks only. It has been found to be a reliable and valid measure in adolescent populations, with moderate internal consistency, $\alpha = .70$ (Kechter et al., 2019). Total scores range from 0 to 40 with higher scores indicating greater perceived stress (Appendix F).

**Nature Connection Index (NCI; Richardson et al., 2019).** A 6-item scale to measure how connected to nature participants felt and whether this changed over time. Responses were converted into a weighted point index score from 0 to a maximum of 100, as recommended by the authors. Higher scores correspond to greater nature connection (Appendix G). It has been found to be a valid and reliable measure for both children ($\alpha = .85$) and adult ($\alpha = .92$) populations (Richardson et al., 2019).

**Child and Adolescent Mindfulness Measure (CAMM; Greco et al., 2011).** This 10-item scale was used as a measure of mindfulness over time and focuses on two aspects of mindfulness: accepting without judgement and acting with awareness. Scores range from 0 to

40 and higher scores reflect higher levels of mindfulness (Appendix H). It has support for good internal consistency in adolescents, α = .84 (Kuby et al., 2015).

**Ruminative Response Scale-Short Form (RRS-10; Treynor et al., 2003).** A 10-item questionnaire which was used to measure changes in the tendency to ruminate over time. Scores range from 10 to 40, with higher scores indicating higher levels of ruminative responses (Appendix I). It has a total alpha score of α = .72 in adolescents (Erdur-Bakera & Bugaya, 2010).

**Shortened Rosenburg Self-Esteem Scale (SRSS; Tambs & Røysamb, 2014).** A 4-item measure of global self-worth, developed from the 10-item Rosenburg Self-esteem Scale (Rosenberg, 1965), used to identify positive and negative feelings about the self. The measure was validated from an adolescent sample with an alpha reliability α = .80 (Tambs & Røysamb, 2014; Ystgaard, 1993). It has a minimum score of 0 and a maximum score of 12, with higher scores corresponding to greater self-esteem (Appendix J).

**Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski et al., 2004).** A 10-item measure scored on eight items to assess general levels of physical activity. It was amended with cultural specific modifications so that commonly played English sports were added to question one (e.g. rugby, hockey, tennis, lacrosse), irrelevant sports were removed (street hockey, cross-country skiing and ice hockey) and the terminology was modified (soccer to football). It was scored by calculating an overall activity summary score ranging from a score of 1, indicating low physical activity to a score of 5 indicating high physical activity. The scale had an satisfactory alpha score α = .58 in the current study (Appendix K).

**Contact with Nature Intervention.** The intervention was developed and delivered by the researcher. A theory driven and evidence-based approach was taken towards the intervention development, combining published research evidence and psychological theories of the benefits of nature. The intervention was delivered virtually in small groups and consisted of an interactive 25-minute psychoeducation session (Appendix L). Using a multimodal approach, including the live generation of a word cloud, use of text, images and a video (see supplementary material), the session provided education on the psychological and wellbeing benefits of nature contact. This was in line with three main theories: Biophilia Hypothesis (Wilson, 1984), Stress Reduction (Ulrich et al., 1991) and Attention Restoration (R. Kaplan & Kaplan, 1989). The session also included a five senses exercise to promote immersion in nature through the use of the senses, taken from the practice of forest bathing or 'shinrin-yoku', known to have physiological and psychological benefits (Miyazaki, 2018). The various intervention components can be seen in Table 1.

**Table 1**
*Intervention Components*

| Section | Content |
|---|---|
| 1. Defining Nature | Definition, types of natural environments |
| 2. Benefits of Nature | Video outlining benefits of nature physically, mentally, emotionally, socially, behaviourally |
| 3. How Nature is Helpful | Overview of Biophilia Hypothesis, Stress Reduction Theory. Introduction to the fight or flight response, how nature impacts on recovery from fight or flight, impact of nature on mood. Overview of Attention Restoration Theory, impact of nature on attention. |
| 4. Five Senses Exercise | Introduction to the use of five senses for immersion. Live exercise to practice attending to current environment using the five senses. Using five senses to focus on |

| | |
|---|---|
| | aspects of nature. Practice using a nature based video. |
| 5. Plan for the following two weeks of intervention | Outlining recommendations for spending time in nature over a two week period. How to access drop box and complete questionnaires. |

**Daily Diary.** Participants were asked to complete an online daily diary over a two-week period to capture time spent in nature and their sleep (Appendix M). Sleep was measured via a standardised sleep diary as a reliable assessment of sleep/wake patterns (Rogers et al., 1993) and was used to calculate sleep duration. To check compliance to the intervention and the validity of the reported nature contact, participants were asked to upload a photo of their time in nature after each contact.

***Procedure***

Gorilla Experiment Builder (Anwyl-Irvine et al., 2020) was used to host the screening, randomisation and completion of all measures. All interested participants completed an initial depressive symptomology screen using the PHQ-9M and a demographic questionnaire (Appendix N). Those with a score ≥ 5 were eligible to participate. Participants were randomly assigned without replacement to one of the two conditions via balanced randomisation. Control participants completed time one measures and immediately started their two-week diary period. Intervention participants were diverted to a central booking system in order to book onto a psychoeducation session. The session itself lasted for one hour to allow for participants to complete time one measures prior to the psychoeducation. Upon completion of the session, intervention participants were advised to have as much contact with nature over a two-week period, with the recommended dose of 120 minutes per week and no less than 30-minutes a week, in line with previous findings (Shanahan et al., 2016;

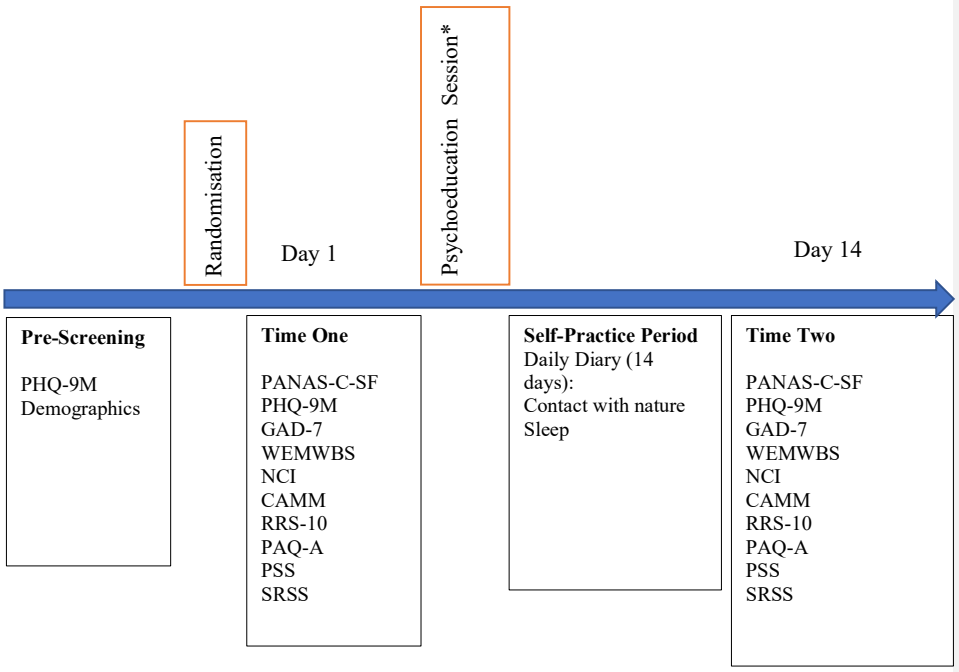
White et al., 2019). Measures were completed again at the end of the two-week period (Figure 1). Participants who did not complete these measures after being contacted up to three times were coded as missing (drop-out). Wait-list control participants were given the opportunity to attend the psychoeducation session upon completion of the study.

***Ethical Considerations***

The study protocol was approved by the University of Exeter Psychology Ethics Committee (eCLESPsy002003; Appendix O). Participants gave electronic informed consent to participate in the study and, where participants were under 16 years of age, written parental consent was also gained (Appendix P). Participants were able to withdraw at any time and request for their data to be destroyed up until the analysis had begun. Where participants indicated scores of depression above the clinical cut off (PHQ-9 >10) they were contacted and a risk screen was completed. In the event of participants indicating risk, they would have been advised to make an appointment with their GP and consent would have been gained to contact their GP to inform them of the disclosed risk. For immediate risk the participant would have been immediately supported via contact with the GP, crisis team or emergency services. Participants who indicated that additional support for their depression would be beneficial were signposted using the list of support services and resources (Appendix Q) and to their local Improving Access to Psychological Therapies service if age 16+. Participants were alerted to some of the included questionnaires being of a sensitive nature or potentially difficult to answer and advised that they did not have to answer a question if they did not wish. The researchers contact details were available to them in case of feeling distressed and all participants had access to the list of additional support resources which was emailed to them when they were either assigned to either the control or intervention conditions. A written debrief was provided to participants at the end of the study (Appendix R).

**Figure 1**

*Study Timeline*




*Note.* *Completed by intervention participants only.

Data were analysed using IBM SPSS Statistics version 26.0 and checked for normality, univariate and multivariate outliers and homogeneity of variance. Where variables were non-normal and had significant outliers, they were transformed in order to reduce the influence of outliers on the analyses. Due to 26.7% of missing data at time two, and a significant baseline difference between those that completed the study and those that dropped out leading to potential bias, the multiple imputation procedure in SPSS was used to impute the missing data (Asendorpf et al., 2014). The predictive mean matching method was adopted, as recommended by Heymans and Eekhout (2019) and the missing at random

(MAR) assumption was made. All outcome variables were included in the imputation model and five imputated datasets were created as a sufficient number of imputations on theoretical grounds (Carpenter & Kenward, 2008). Where the complete-case and multiple imputation analyses led to diametrically opposed conclusions on significance, conclusions were drawn from the multiple imputation output. This is because, when missing data are considered MAR, the complete-case estimates may be biased (Jakobsen et al., 2017). Where it was not possible to report a pooled value, the range of imputated values are reported.

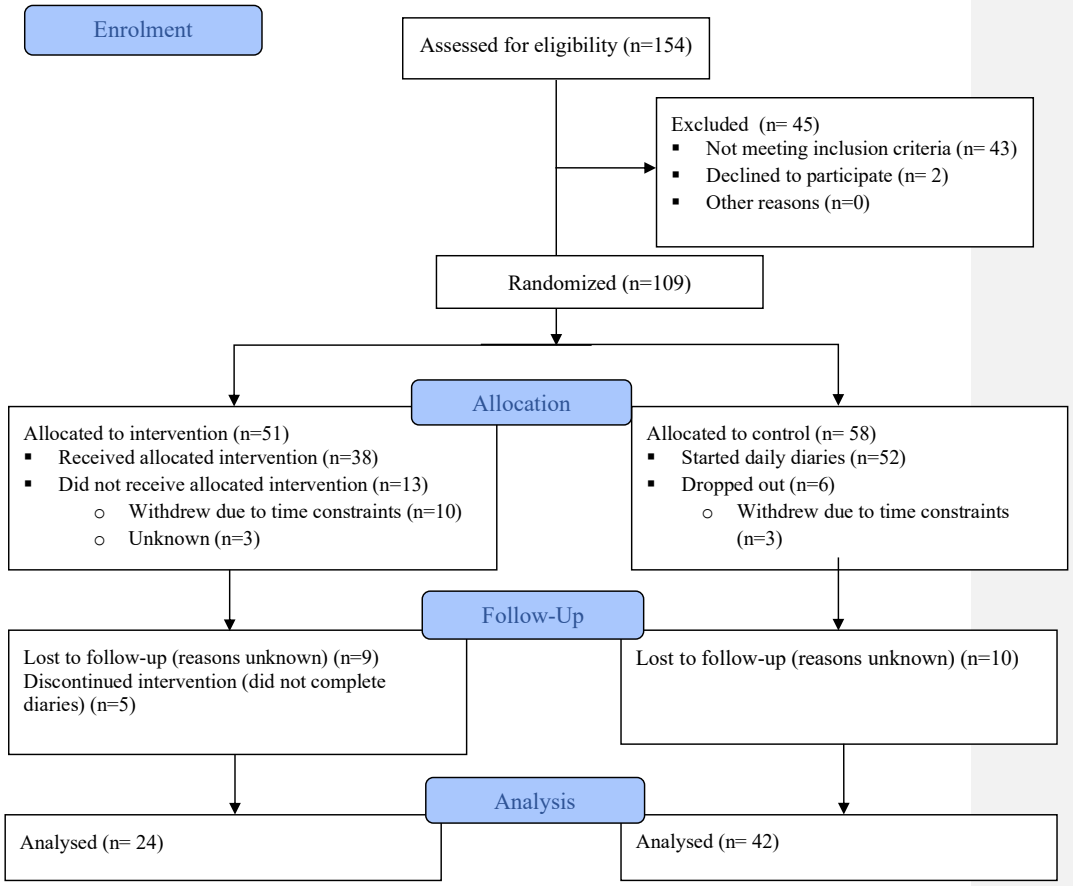
## Results

### *Participant Flow*

A Consolidated Standards of Reporting Trials (CONSORT; 2010) diagram can be seen in Figure 2 indicating the number of participants who were randomly assigned to each group leading to the number of participants analysed per group.

**Figure 2**

*CONSORT Participant Flow Diagram*




***Baseline Differences***

Table 2 shows demographic data according to condition. Demographic data were analysed using independent samples t-tests and chi-squared tests of independence. Where

expected counts were greater than 5, Fisher exact values for 2X2 contingency tables and Fisher-Freeman-Halton values for contingency tables greater than 2X2 are reported. Experimental and intervention conditions were matched on gender (two-tailed $p = .341$), age ($t$ (87) = .55, $p = .583$, $d = .12$), ethnicity (two-tailed $p = .752$), diagnosed mental health disorders (two-tailed $p = .70$), engagement in psychological treatment ($\chi^2$ (1) = 0.34, $p = .755$), medical problems ($\chi^2$ (1) = 0.33, $p = .619$) and dog ownership ($\chi^2$ (1) = 1.48, $p = .276$).

One-way analyses of variance (ANOVAs) indicated that were no significant differences between conditions on time one baseline measures (Table 3).

**Table 2**

*Demographic Data According to Condition*

| | Experimental ($n$ = 38) | Control ($n$ = 52) |
|---|---|---|
| Age | $M$ =19.69 $SD$ = 2.59 | $M$ =19.44 $SD$ = 3.79 |
| Gender | | |
| Female | 29 | 46 |
| Male | 6 | 4 |
| Non-Binary | 2 | 2 |
| Other | 1 | 0 |
| Ethnicity | | |
| White | 31 | 38 |
| Asian or Asian British | 6 | 6 |
| Black/African/Caribbean or Black | 0 | 1 |
| British | | |
| Mixed or Multiple Ethnicities | 1 | 2 |
| Other Ethnic group | 0 | 2 |
| Not stated | 0 | 3 |
| Diagnosed Mental Health Disorder | | |
| None | 21 | 35 |
| Depression | 1 | 1 |

| | | |
|---|---|---|
| Bipolar | 0 | 0 |
| Schizophrenia or psychosis | 0 | 0 |
| Generalised Anxiety Disorder | 1 | 2 |
| Panic | 0 | 1 |
| Eating Disorder | 1 | 0 |
| Obsessive Compulsive Disorder | 1 | 0 |
| Post-Traumatic Stress Disorder | 0 | 0 |
| Phobia | 0 | 0 |
| Personality disorder | 0 | 0 |
| Other | 0 | 1 |
| Co-Morbid | 7 | 9 |
| In Psychological Treatment | 6 | 6 |
| Diagnosed Medical Condition | 10 | 11 |
| Have a Dog | 12 | 23 |

**Table 3**

*One-way ANOVA Outcomes Comparing Baseline Measures Between Conditions*

| Outcome | df | df error | *F* | *p* | $\eta^2$ | Condition | Mean | SD |
|---|---|---|---|---|---|---|---|---|
| Depression | 1 | 88 | 0.73 | .395 | .01 | 1 | 10.1 | 4.7 |
| | | | | | | 2 | 11.0 | 5.3 |
| Positive Affect | 1 | 88 | 0.06 | .806 | .01 | 1 | 14.0 | 4.7 |
| | | | | | | 2 | 13.8 | 4.0 |
| Negative Affect | 1 | 88 | 0.41 | .523 | .01 | 1 | 12.2 | 4.3 |
| | | | | | | 2 | 12.8 | 4.6 |
| Generalised Anxiety | 1 | 88 | 0.10 | .920 | < .001 | 1 | 8.9 | 5.6 |
| | | | | | | 2 | 9.0 | 5.8 |
| Wellbeing | 1 | 88 | 0.38 | .541 | < .001 | 1 | 41.4 | 8.0 |
| | | | | | | 2 | 40.3 | 8.9 |
| Perceived Stress | 1 | 88 | 0.01 | .928 | .01 | 1 | 23.2 | 6.3 |
| | | | | | | 2 | 23.05 | 6.2 |
| Mindfulness | 1 | 88 | 1.46 | .230 | .02 | 1 | 20.7 | 8.1 |
| | | | | | | 2 | 18.8 | 7.6 |
| Nature Connection | 1 | 88 | 0.01 | .831 | < .001 | 1 | 48.4 | 21.3 |
| | | | | | | 2 | 47.9 | 22.7 |
| Physical Activity | 1 | 88 | 0.05 | .831 | < .001 | 1 | 1.8 | .7 |
| | | | | | | 2 | 1.8 | .5 |
| Self-esteem | 1 | 87 | 0.31 | .577 | < .001 | 1 | 7.9 | 2.6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2 | 8.1 | 2.2 |
| Rumination | 1 | 88 | 0.02 | .888 | < .001 | 1 | 24.2 | 4.8 |
| | | | | | | 2 | 24.4 | 6.2 |

*Note.* 1 = control and 2 = intervention conditions

***Retention and Drop-Outs***

24 cases (26.7%; intervention $n = 14$; control $n = 10$) had incomplete data due to not completing time two follow-up measures. This amounted to 63.16 % retention in the intervention condition and 80.77 % retention in the control condition. The resulting sample of complete data was $n = 24$ for the intervention condition and $n = 42$ in the control. There was a significant difference found on baseline levels of positive affect between completers and drop-outs, with positive affect being significantly lower in those that dropped out. No other significant differences were found on baseline measures between completers and drop-outs (Table 4).

**Table 4**

*One-way ANOVA Outcomes Comparing Baseline Measures Between Completers and Drop-Outs*

| Outcome | df | df error | *F* | *p* | $\eta^2$ | Group | Mean | SD |
|---|---|---|---|---|---|---|---|---|
| Depression | 1 | 88 | 0.23 | .635 | < .001 | 1 | 10.3 | 4.9 |
| | | | | | | 2 | 10.9 | 5.2 |
| Positive Affect | 1 | 88 | 7.43 | .008 | .08 | 1 | 14.7 | 4.3 |
| | | | | | | 2 | 11.9 | 3.8 |
| Negative Affect | 1 | 88 | 1.84 | .178 | .02 | 1 | 12.1 | 4.5 |
| | | | | | | 2 | 13.5 | 4.1 |
| Generalised Anxiety | 1 | 88 | 0.16 | .695 | < .001 | 1 | 8.8 | 5.5 |
| | | | | | | 2 | 9.3 | 5.9 |
| Wellbeing | 1 | 88 | 3.15 | .080 | .35 | 1 | 41.9 | 8.5 |
| | | | | | | 2 | 38.4 | 7.5 |
| Perceived Stress | 1 | 88 | 0.65 | .422 | .01 | 1 | 22.8 | 6.6 |
| | | | | | | 2 | 24.0 | 6.2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mindfulness | 1 | 88 | 1.04 | .311 | .01 | 1 | 20.4 | 7.3 |
| | | | | | | 2 | 18.5 | 7.6 |
| Nature Connection | 1 | 88 | 0.14 | .708 | .00 | 1 | 48.7 | 20.3 |
| | | | | | | 2 | 46.8 | 25.8 |
| Physical Activity | 1 | 88 | 0.21 | .885 | < .001 | 1 | 1.8 | .6 |
| | | | | | | 2 | 1.8 | .7 |
| Self-esteem | 1 | 87 | 1.09 | .299 | .01 | 1 | 8.2 | 2.5 |
| | | | | | | 2 | 7.5 | 2.3 |
| Rumination | 1 | 88 | 0.09 | .766 | < .001 | 1 | 24.2 | 5.2 |
| | | | | | | 2 | 24.6 | 5.8 |

*Note.* 1 = completers and 2 = drop-outs

***Compliance***

Compliance with the completion of the daily diaries was assessed by measuring the missing entries. In the intervention condition 63.1% of participants completed all 14 entries, 15% completed less than half, including 5.2% who completed 0 entries. In the control condition 59% of participants completed all 14 entries, 32.7% less than half which includes 11.5% of participants who completed 0 entries.

***Intervention Outcomes***

**Multivariate Analyses.** A repeated measure multivariate analysis of variance (MANOVA) was carried out to examine any changes in outcomes of depression, positive affect, negative affect, anxiety, wellbeing, perceived stress, mindfulness, nature connection, physical activity, self-esteem and rumination as dependent variables (DVs). The repeated measure was time (time one vs time two) and between-subject variable was condition (intervention vs control).

The multivariate result was significant for time, Pillai's Trace = .439-.500, $F$ (11, 33-78) = 3.00 -5.56, $p$ = <.001 -.007, $\eta^2$ = .41- .50, indicating a difference in outcomes between time one and time two at the multivariate level. Significant univariate effects were found such that depression, anxiety, negative affect, perceived stress were significantly lower at time

two, compared to time one. Mindfulness and nature connection were significantly higher at time two, along with wellbeing and positive affect when taken from multiply imputated outcomes (Table 4). For outcomes of physical activity, two out of six imputations were significant ($F$ (1,43-88) = 4.14, 8.05, $p$ =. 045, .006, $\eta^2$ = .05, .08) and four out of six imputations were non-significant ($F$ (1,43-88) = 0.85 -2.03, $p$ = .158 -.360, $\eta^2$ = .01 -.03). For outcomes of self-esteem, four out of six imputations were significant ($F$ (1,43-88) = 4.09 - 6.11, $p$ = .015 - .046, $\eta^2$ = .044 -.051) and two out of six imputations were non-significant: ($F$ (1,43-88) = 1.98, 3.41, $p$ =.167, .068, $\eta^2$ = .044, .037).

There were no significant multivariate differences between intervention and control conditions, Pillai's Trace = .07 -.40, $F$ (11, 33-78) = 0.49 -2.03, $p$ = .058 -.899, $\eta^2$ = .07 -.40. Furthermore, the change in outcomes over time in those who completed the intervention did not differ from the change in outcomes over time from those in the control condition at the multi-variate level, Pillai's Trace = .08 -.17, $F$ (11, 33-78) = .60-.88, $p$ = .564 -.821, $\eta^2$ = .08 - .17. Means for each condition on primary outcomes of depression, negative affect and wellbeing can be seen in Figure 3.

**Table 4**

*Univariate Effects Over Time Following MANOVA*

| Outcome | df | df error | $F$ | $p$ | $\eta^2$ | Time | Means (standard error) | 99.9% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lower Bound | Upper Bound |
| Depression | 1 | 43-88 | 10.39-19.88 | <.001-.002* | .13-.20 | 1 | 10.6 (.5) | 9.53 | 11.61 |
| | | | | | | | 8.6 (.5) | | |
| | | | | | | 2 | | 7.60 | 9.59 |
| Anxiety | 1 | 43-88 | 7.41-16.41 | <.001-.009* | .14-.18 | 1 | 8.6 (.6) | 7.77 | 10.14 |
| | | | | | | 2 | 7.0 (.6) | 5.85 | 8.10 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wellbeing | 1 | 43-88 | 2.30-11.38 | .001-.137** | .05-.09 | 1 | 40.9 (.9) | 39.14 | 42.65 |
| | | | | | | 2 | 43.4 (.8) | 41.92 | 44.92 |
| Positive Affect | 1 | 43-88 | 4.27-5.48 | =.003-.515** | .05-.48 | 1 | 13.9 (.5) | 12.99 | 14.82 |
| | | | | | | 2 | 15.0 (.4) | 14.14 | 15.65 |
| Negative Affect | 1 | 43-88 | 6.43-11.24 | .001-.013* | .07-.15 | 1 | 12.5 (.5) | 11.60 | 13.47 |
| | | | | | | 2 | 11.3 (.4) | 10.52 | 12.12 |
| Perceived Stress | 1 | 43-88 | 20.30-39.01 | <.001* | .23-32 | 1 | 23.1 (.7) | 21.81 | 24.42 |
| | | | | | | 2 | 20.4 (.6) | 19.17 | 21.58 |
| Mindfulness | 1 | 43-88 | 4.88-16.10 | <.001-.033* | .14-.16 | 1 | 19.8 (.8) | 18.16 | 21.32 |
| | | | | | | 2 | 22.5 (.7) | 21.81 | 23.85 |
| Nature Connection | 1 | 43-88 | 2.99-7.12 | .009-.033* | .01-.08 | 1 | 48.2 (2.3) | 43.58 | 52.74 |
| | | | | | | 2 | 53.3 (2.3) | 49.70 | 56.99 |
| Rumination | 1 | 43-88 | 0.12-0.62 | .487-.734 | <.001-.01 | 1 | 24.31 (.58) | 23.18 | 25.45 |
| | | | | | | 2 | 24.04 (.58) | 22.91 | 25.17 |

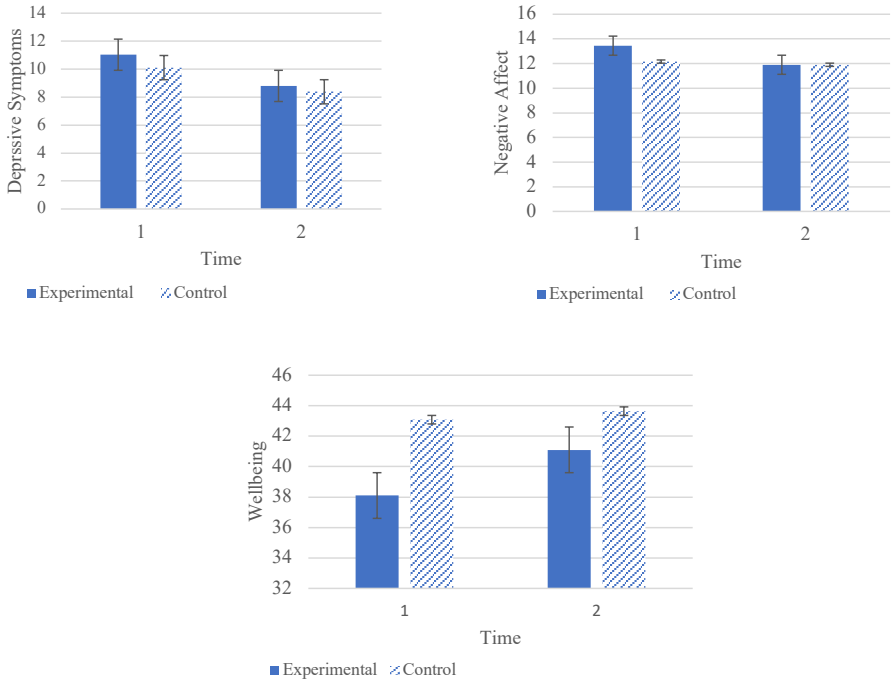
*Note.* Means and Standard errors for each time point are displayed

*significant

** significant on the basis of multiple imputation outcomes only

**Figure 3**

*Changes in Outcomes of Depressive Symptoms, Negative Affect and Wellbeing Over Time for Each Condition*




*Note. Pooled means across imputated data sets and standard errors are displayed.*

**Sleep.** An independent samples t-test did not find any significant differences in the average sleep duration of intervention ($M$ = 8.4, $SE$ = 0.2) and control ($M$ = 8.8, $SE$ = 0.2) participants ($t$ (1030) = 1.37, $p$ = .185, $d$ = .34).

**Contact with Nature.** No significant differences were found between intervention ($M$ = 474.5, $SE$ = 60.3) and control ($M$ = 553.4, $SE$ = 85.8) conditions in the amount of minutes spent in contact with nature over the two-week period ($t$ (640) = 0.76, $p$ =.438, $d$ = .10).

***Complete-Case Analysis***

When analyses were restricted to the complete cases only, without the imputation of missing data, similar multivariate results were obtained. Similar univariate effects were found except for changes in wellbeing, positive affect and nature connection over time which were non-significant when analysing complete cases only but became significant using multiple imputation. In these cases, weight was given to multiple imputated outcomes. For outcomes of physical activity and self-esteem, the complete case-analysis univariate effects were supported in three of the imputations, specifically a non-significant effect of physical activity and significant effect of self-esteem overtime.

## Discussion

The aim of this study was to explore the effect of a pilot psychoeducation nature-based intervention on wellbeing outcomes in adolescents experiencing depressive symptomology. Measures of depression, anxiety, negative affect and perceived stress significantly decreased over a two-week period in both conditions. Nature connection, mindfulness, wellbeing and positive affect also significantly increased over this time in both conditions. Similarly, there was some evidence to suggest that outcomes of physical activity and self-esteem increased over the two weeks, again for both conditions. Whilst multiple imputation was used to reduce bias, in particular due to significant baseline differences on measures of positive affect between those that completed the study and those who dropped out, these results should still be interpreted with caution. No significant differences, however, were found in outcomes over time between intervention and control participants.

In a study exploring daily doses of nature on mental health, Cox et al. (2017) found that people who had spent less time outdoors in the past seven days reported worse depression and anxiety, alongside support for a specific dose-response relationship of time spent

outdoors and better mental health. Both conditions in the current study reported a weekly average of nature contact greater than 200 minutes. White et al (2019) examined the association between time spent in nature per week and self-reported wellbeing outcomes in those aged 16+. After controlling for residential green space, neighbourhood and individual characteristics, higher wellbeing became significantly greater with nature contact ≥120 mins and positive benefits peaked between 200-300 minutes per week. Given that both conditions had an average dose of nature greater than this speculated threshold for improved wellbeing, increases in wellbeing and reductions in depression and anxiety symptoms for all could have been due to both intervention and control conditions increasing their time spent in nature over the two-week period. This is supported by significant increases in nature connectedness seen in both conditions over time, an outcome found to be strongly associated with exposure to nature (Mayer et al., 2009). With a lack of significant group differences, it may be that the intervention would be of greater benefit in those who are more sedentary and spend less time outdoors, such as individuals from urban settings (Chastin et al., 2016) or individuals diagnosed with major depressive disorder (Schuch et al., 2017).

Whilst the use of a wait-list control group can be useful for a first evaluation of novel interventions, it poses a threat to internal validity by altering health-promoting behaviours and/or influencing outcome expectancies (Mohr et al., 2009). With control participants being aware of the research aims they may have been vulnerable to these control condition effects. In addition, previous reviews have suggested that nature-based research relying on self-referred participants is more likely to attract those with an interest in nature (Corazon et al., 2019; Harper et al., 2021). Blinding participants to the research question and intervention allocation presents significant challenges for behavioural-environmental interventions (Mygind, Kjeldsted et al., 2019); however, an attempt to blind participants from the specific research aim may have buffered against any control condition and self-selection bias effects.

Both conditions were required to complete a diary over the two weeks, monitoring their nature contact. Objective self-monitoring about the type, frequency, duration and/or intensity of a behaviour, for example through the use of a diary, has been identified as a key behaviour change technique in reducing short-term sedentary behaviours (Compernolle et al., 2019; Gardner et al., 2016). From this it is plausible to speculate that monitoring contact with nature was enough to increase the amount of contact in the control condition, acting like an intervention in itself. Future studies should consider the use of an active control condition in which participants engage in an alternative task during the intervention period or a wait-list control with only pre and post measures. Read et al. (2016), for example, used a pre/post design for a one-session behavioural activation intervention aimed at improving wellbeing in individuals at risk of major depressive disorder. Control participants were asked to complete baseline measures two weeks prior to attending an appointment in which the intervention was offered immediately after the time two measures were taken.

Whilst psychoeducation interventions (PIs) targeting adolescents with or at risk of depression have shown promise as a first-level approach (Bevan Jones et al., 2018), levels of adherence may have impacted on the interventions' effectiveness. When comparing a psychoeducation session delivered online and face to face, Alfonsson et al. (2017) found that self-reported motivation was higher and adherence to an assignment set for the subsequent week was greater in the face-face session vs online. With the potential to further exacerbate difficulties with motivation and adherence relating to online interventions, adolescents with depressive symptoms may experience low energy, poor concentration and reduced motivation (Brent & Birmaher, 2009). Furthermore, it is possible that participants experiencing depressive symptoms had reduced motivation or encountered barriers to adhere to the intervention's recommendations after the online session (Wong et al., 2021). It could also be speculated that this contributed to the significant number of participant drop-out and a better

retention in the control condition who did not have to complete the additional assignment of spending time in nature. Control participants also completed the two-week monitoring period immediately after signing up to the study. It is possible that their motivation to take part in the study may have been at its highest upon the point of agreeing to take part, supporting greater retention.

As the current study recommended participants to actively make a lifestyle modification, supporting adherence is key for improvement (Egger et al., 2009). Daily reminders to complete the contact diary may not have been sufficient to support nature contact in adolescents with depressive symptomology. Future research could look to use technology to strengthen adherence, such as smart-phone reminders, use of a mobile application or wearable devices in order to support participants' awareness of engaging in lifestyle changes, to set targets and self-monitor engagement (Dute et al., 2016; Wong et al., 2021). In addition, it may be that involving the support of the system around adolescents could work to promote adherence. Crutzen et al. (2012) found that web-based interventions were more effective when embedded in existing healthcare or education structures compared to when implemented as stand alone. Further, previous psychoeducation studies for adolescent depression have involved presenting content to families (Bevan Jones et al., 2018) in line with The National Institute for Health and Care Excellence guidelines for the management of depression in children and young people, which indicates that family involvement is important in treatment to aid motivation (NICE, 2019). Whilst not a clinical sample, the current intervention may have been enhanced by including an adjunct parent/carer session or delivering the intervention within a school environment.

It is possible that a one-off online intervention may not have been sufficient enough to promote an increase in nature contact and improved outcomes in the intervention participants. Whilst there is little consensus as to the number and duration of sessions in psychoeducation

for depression, evidence for passive interventions comes from interventions with 1-6 sessions (Donker et al., 2009) and support for active interventions is drawn from interventions ranging from 2-12 sessions (Bevan Jones et al., 2018; Tursi et al., 2013). The current intervention was considered an active intervention, as it asked participants to undertake the recommendation of increasing contact with nature (Donker et al., 2009); therefore, it may be that a one-off session was not sufficient to lead to differences in outcomes between conditions. Furthermore, the two-week intervention period may not have been a sufficient follow-up period to see an effect. Merry et al. (2011) found that short-term effects on the risk for a depressive episode onset are greater for universal psychological and educational interventions than for targeted interventions, but that targeted interventions have longer-term outcomes. Interventions in this review had an average of 8-12 sessions. As the current study used an indicated targeted population, greater preventative benefits may have been seen with a longer intervention period and a longer-term follow-up.

When considering the content of the intervention, larger effect sizes have been found in active psychoeducation interventions with the inclusion of CBT techniques when targeting depression (Donker et al., 2009). Bevan-Jones et al (2018) found that, alongside information on lifestyle, learning about symptom identification and how to plan activities could be important content of psychoeducation interventions targeting adolescent depression. A single session of psychoeducation on the benefits of nature alone may not have been enough to influence wellbeing and depressive symptoms. Future research should explore an intervention with a greater number of sessions and the edition of CBT techniques.

Given the self-directed nature of the intervention, it was not possible to control the types of nature contact participants had over the two-week period. Maes et al (2021) found differing effects of various natural-environment-types on mental health and overall wellbeing in an adolescent population. More specifically, woodland exposure was most consistently

associated with beneficial outcomes, with weaker associations with green space exposure and inconsistent associations with blue space exposure. Education on the most beneficial environments for wellbeing may promote contact with certain types of nature. Furthermore, in relation to depressive symptoms, Lee et al (2017) found that simply "viewing nature" or "being present near nature" may not be sufficient enough to impact on levels of depression. Nisbet et al (2019) found that individuals who engaged in mindfulness in nature reported a greater connectedness and their negative mood states decreased below the levels of participants who did not engage in mindfulness. Supporting participants to use their five senses may not have been enough in the current intervention; future psychoeducation interventions could look to enhance the therapeutic benefit of nature contact through an adjunct mindfulness education component.

**Strengths**

To our knowledge, this is the first study to explore the use of a nature-based psychoeducation session for adolescents with depressive symptomology. The online session had strengths in its utilisation of multi-media and an interactive exercise in order to communicate the information, making it more engaging and accessible (Bevan Jones et al., 2018). The use of an online intervention allowed for widespread recruitment and for participants from a range of geographical locations to attend the session. The use of multiple-imputation to handle missing data at time two prevented the exclusion of data from the original sample, buffering against a loss of power and precision within the statistical analysis (Sterne et al., 2009).

**Limitations**

The use of an indicated sample in the current study was used in order to overcome issues with power, due to the need for large sample sizes in universal preventative interventions (Muñoz et al., 2010); however, the current study was only pilot and exploratory in nature. Whilst a sample size needed for adequate statistical power was determined pre-intervention, difficulties with recruitment and participant drop-out resulted in fewer participants than the minimum recommendation of 30-40 per group by Hertzog (2008). This may have resulted in the study being underpowered to detect significant condition differences and could explain the lack of effect to some extent. Recruitment of a larger sample size would have allowed for drop-out, whilst yielding adequate power. Furthermore, whilst balanced randomisation using Gorilla aimed to balance groups, the use of a random without replacement setting meant that allocations would have been dependent on all previous allocations and would not have taken into account participant drop out. This likely led to unequal participants in intervention and control conditions.

Despite reminders being sent for the completion of data, there was a large amount of missing data at follow-up and lower compliance with daily diaries, particularly in the control condition. Significant differences at baseline on measures of positive affect between completers and drop-outs indicate a loss of people that had lower baseline levels of positive affect. Whilst multiple imputation was used to reduce this differential attrition bias, it is possible that the study findings were impacted by this. It may be that these participants found it more difficult to engage with the study. Use of qualitative feedback could have been used to further understand issues of attrition, the acceptability of the methods and acceptability of the intervention. Gathering additional data on how participants engaged with the Gorilla experiment platform, using google analytics for example, may have given insights to any issues of online engagement that possibly contributed to participant drop out. Future trials should aim to understand issues of acceptability and engagement, in particular for those

reporting lower positive affect. Furthermore, greater emphasis on the importance of completing the follow-up data at baseline and during the online session, even if participants do not fully adhere to the daily monitoring, will be important. Ecological momentary assessment could enhance the sampling of participants' daily nature contact by collecting real-time data as opposed to completing a diary at the end of the day, potentially minimising recall bias (Shiffman et al., 2008).

Whilst the session was interactive in order to aid active engagement, we cannot be certain about the extent to which participants attended to the information presented. The use of an online intervention made it difficult to check whether participants were fully attending to the content, as there was no control over the environment in which they attended the session. An end of intervention attention check could be used to check engagement with the intervention content.

As this pilot study was a proof of principle study and exploratory in nature, it was beyond the scope to prospectively register the study and to exclude participants who were currently receiving psychological support. Both would be important in future definitive randomised controlled trials.

Collecting and adjusting for a baseline measure of time spent in nature in the current study may have taken into account any imbalances in baseline between groups (Clifton et al., 2019). Future work could gather a baseline measure of nature contact and adjust for this using an analysis of covariance to limit bias in any reporting of the interventions effect.

**Conclusion**

The aim of the current study was to explore the effect of a pilot, two-week, psychoeducation, nature-based intervention in adolescents experiencing depressive symptomology. Whilst no group differences were found, improvements in measures of depression, anxiety, affect, perceived stress, mindfulness and wellbeing were seen for all.

Given that both groups had contact with nature at a level that may have been enough to improve outcomes, and increases in nature connectedness were found for all, it suggests that there could be benefits of supporting nature contact as a modifiable lifestyle factor in adolescents with depressive symptoms. Helping adolescents to be more mindful of their contact with nature has the potential to be embedded into schools, supporting the universal promotion of healthier lifestyle behaviours. More targeted approaches, that could be embedded within statutory and third sectors, such as nature psychoeducation adjunct to existing psychological approaches or social prescribing, could encourage adolescents with depressive symptoms to get regular doses of nature. Enhancing the provision of online interventions has implications for the widespread dissemination of preventative approaches and may be beneficial for buffering against reduced help-seeking and the low uptake of traditional treatment approaches in an adolescent population. The results of the current study provide a platform for future research to continue to explore the benefits of brief nature-based interventions aimed at improving wellbeing and depressive symptoms in an adolescent population. On-going research should consider the development of nature psychoeducation adjunct to existing psychological approaches with a greater number of sessions and longer-term follow-ups and an exploration of adolescent sub-groups that may benefit more from nature-based interventions.

**References**

Alfonsson, S., Johansson, K., Uddling, J., & Hursti, T. (2017). Differences in motivation and adherence to a prescribed assignment after face-to-face and online psychoeducation: an experimental study. *BMC Psychology*, *5*(1). https://doi.org/10.1186/S40359-017-0172-5

Alvaro, P, K, Roberts, R, M., & Harris,J,K. (2013). A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. *Sleep*, *36*(7), 1059–1068. https://doi.org/10.5665/SLEEP.2810

Antonelli, M., Donelli, D., Carlone, L., Maggini, V., Firenzuoli, F., & Bedeschi, E. (2021). Effects of forest bathing (shinrin-yoku) on individual well-being: an umbrella review. *Https://Doi.Org/10.1080/09603123.2021.1919293*. https://doi.org/10.1080/09603123.2021.1919293

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, *52*(1), 388–407. https://doi.org/10.3758/S13428-019-01237-X/TABLES/8

Asendorpf, J. B., Van De Schoot, R., Denissen, J. J. A., & Hutteman, R. (2014). Special issue: Planned missingness Reducing bias due to systematic attrition in longitudinal studies: The benefits of multiple imputation. *International Journal of Behavioral Development*, *38*(5), 453–460. https://doi.org/10.1177/0165025414542713

Auerbach, R. P., Admon, R., & Pizzagalli, D. A. (2014). Adolescent Depression: Stress and Reward Dysfunction. *Harvard Review of Psychiatry*, *22*(3), 139. https://doi.org/10.1097/HRP.0000000000000034

Bali, A., & Jaggi, A. S. (2015). Clinical experimental stress studies: Methods and assessment. *Reviews in the Neurosciences*, *26*(5), 555–579. https://doi.org/10.1515/REVNEURO-2015-0004/ASSET/GRAPHIC/J_REVNEURO-2015-0004_FIG_007.JPG

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

Bélanger, M., Gallant, F., Doré, I., O'Loughlin, J. L., Sylvestre, M. P., Abi Nader, P., Larouche, R., Gunnell, K., & Sabiston, C. M. (2019). Physical activity mediates the relationship between outdoor time and mental health. *Preventive Medicine Reports*, *16*, 101006. https://doi.org/10.1016/j.pmedr.2019.101006

Bevan Jones, R., Thapar, A., Stone, Z., Thapar, A., Jones, I., Smith, D., & Simpson, S.

(2018). Psychoeducational interventions in adolescent depression: A systematic review. In *Patient Education and Counseling* (Vol. 101, Issue 5, pp. 804–816). Elsevier Ireland Ltd. https://doi.org/10.1016/j.pec.2017.10.015

Bielinis, E., Janeczko, E., Takayama, N., Zawadzka, A., Słupska, A., Piętka, S., Lipponen, M., & Bielinis, L. (2021). The effects of viewing a winter forest landscape with the ground and trees covered in snow on the psychological relaxation of young Finnish adults: A pilot study. *PLoS ONE*, *16*(1 January). https://doi.org/10.1371/journal.pone.0244799

Bielinis, E., Lukowski, A., Omelan, A., Boiko, S., Takayama, N., & Grebner, D. L. (2019). The effect of recreation in a snow-covered forest environment on the psychological wellbeing of young adults: Randomized controlled study. *Forests*, *10*(10). https://doi.org/10.3390/f10100827

Bielinis, E., Omelan, A., Boiko, S., & Bielinis, L. (2018). The Restorative Effect of Staying in a Broad-Leaved Forest on Healthy Young Adults in Winter and Spring. In *BALTIC FORESTRY* (Vol. 24, Issue 2). https://www.balticforestry.mi.lt/ojs/index.php/BF/article/view/204

Bielinis, E., Takayama, N., Boiko, S., Omelan, A., & Bielinis, L. (2018). The effect of winter forest bathing on psychological relaxation of young Polish adults. *Urban Forestry and Urban Greening*, *29*, 276–283. https://doi.org/10.1016/j.ufug.2017.12.006

Blakemore, S. J. (2019). Adolescence and mental health. *The Lancet*, *393*(10185), 2030–2031. https://discovery.ucl.ac.uk/id/eprint/10075384/1/Blakemore_Lancet essay final 18 April 2019.pdf

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Kuo, M., Lawler, J. J., Levin, P. S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., … Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. In *Science Advances* (Vol. 5, Issue 7, p. eaax0903). American Association for the Advancement of Science. https://doi.org/10.1126/sciadv.aax0903

Bratman, G. N., Daily, G. C., Levy, B. J., & Gross, J. J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning*, *138*, 41–50. https://doi.org/10.1016/j.landurbplan.2015.02.005

Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. *Annals of the New York Academy of*

*Sciences*, *1249*(1), 118–136. https://doi.org/10.1111/j.1749-6632.2011.06400.x

Bratman, G. N., Hamilton, J. P., Hahn, K. S., Daily, G. C., & Gross, J. J. (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(28), 8567–8572. https://doi.org/10.1073/pnas.1510459112

Bratman, G. N., Olvera-Alvarez, H. A., & Gross, J. J. (2021). The affective benefits of nature exposure. *Social and Personality Psychology Compass*, *15*(8), e12630. https://doi.org/10.1111/SPC3.12630

Bratman, G. N., Young, G., Mehta, A., Lee Babineaux, I., Daily, G. C., & Gross, J. J. (2021). Affective Benefits of Nature Contact: The Role of Rumination. *Frontiers in Psychology*, *0*, 584. https://doi.org/10.3389/FPSYG.2021.643866

Brent, D. A., & Birmaher, B. (2009). Adolescent Depression. *Http://Dx.Doi.Org/10.1056/NEJMcp012249*, *347*(9), 667–671. https://doi.org/10.1056/NEJMCP012249

Browning, M. H. E. M., Saeidi-Rizi, F., McAnirlin, O., Yoon, H., & Pei, Y. (2020). The Role of Methodological Choices in the Effects of Experimental Exposure to Simulated Natural Landscapes on Human Health and Cognitive Performance: A Systematic Review: *Https://Doi.Org/10.1177/0013916520906481*, *53*(7), 687–731. https://doi.org/10.1177/0013916520906481

Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: a meta-analysis. *Frontiers in Psychology*, *5*, 976. https://doi.org/10.3389/fpsyg.2014.00976

Capaldi, C., Passmore, H.-A., Nisbet, E., Zelenski, J., & Dopko, R. (2015). Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. *International Journal of Wellbeing*, *5*(4), 1–16. https://doi.org/10.5502/ijw.v5i4.449

Carpenter, J. R., & Kenward, M. G. (2008). *MAR methods for quantitative data. Missing data in randomised controlled trials—a practical guide.* National Institute for Health Research.

Chastin, S. F. M., De Craemer, M., Lien, N., Bernaards, C., Buck, C., Oppert, J. M., Nazare, J. A., Lakerveld, J., O'Donoghue, G., Holdsworth, M., Owen, N., Brug, J., Cardon, G., Conroy, D., Healy, G., Langøien, L. J., Reilly, J., Rutter, H., Salmon, J., … Wong, S. (2016). The SOS-framework (Systems of Sedentary behaviours): An international

transdisciplinary consensus framework for the study of determinants, research priorities and policy on sedentary behaviour across the life course: A DEDIPAC-study. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1). https://doi.org/10.1186/s12966-016-0409-3

Choe, E. Y., Jorgensen, A., & Sheffield, D. (2020). Does a natural environment enhance the effectiveness of Mindfulness-Based Stress Reduction (MBSR)? Examining the mental health and wellbeing, and nature connectedness benefits. *Landscape and Urban Planning*, *202*, 103886. https://doi.org/10.1016/J.LANDURBPLAN.2020.103886

Christensen, H., Griffiths, K. M., & Jorm, A. F. (2004). Delivering interventions for depression by using the internet: randomised controlled trial. *BMJ*, *328*(7434), 265. https://doi.org/10.1136/BMJ.37945.566632.EE

Clarke, A., Friede, T., Putz, R., Ashdown, J., Martin, S., Blake, A., Adi, Y., Parkinson, J., Flynn, P., Platt, S., & Stewart-Brown, S. (2011). Warwick-Edinburgh Mental Well-being Scale (WEMWBS): Validated for teenage school students in England and Scotland. A mixed methods assessment. *BMC Public Health*, *11*(1), 1–9. https://doi.org/10.1186/1471-2458-11-487

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396. https://doi.org/10.2307/2136404

Compernolle, S., Desmet, A., Poppe, L., Crombez, G., De Bourdeaudhuij, I., Cardon, G., Van Der Ploeg, H. P., & Van Dyck, D. (2019). Effectiveness of interventions using self-monitoring to reduce sedentary behavior in adults: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), 1–16. https://doi.org/10.1186/S12966-019-0824-3/FIGURES/4

Corazon, S. S., Sidenius, U., Poulsen, D. V., Gramkow, M. C., & Stigsdotter, U. K. (2019). Psycho-physiological stress recovery in outdoor nature-based interventions: A systematic review of the past eight years of research. *International Journal of Environmental Research and Public Health*, *16*(10). https://doi.org/10.3390/ijerph16101711

Cox, D. T. C., Shanahan, D. F., Hudson, H. L., Fuller, R. A., Anderson, K., Hancock, S., & Gaston, K. J. (2017). Doses of Nearby Nature Simultaneously Associated with Multiple Health Benefits. *International Journal of Environmental Research and Public Health 2017, Vol. 14, Page 172*, *14*(2), 172. https://doi.org/10.3390/IJERPH14020172

Crutzen, R., Kohl, L., & De Vries, N. K. (2012). *Kennissynthese online preventie*.

Cuijpers, P., Beekman, A. T. F., & Reynolds, C. F. (2012). Preventing depression: A global priority. In *JAMA - Journal of the American Medical Association* (Vol. 307, Issue 10, pp. 1033–1034). NIH Public Access. https://doi.org/10.1001/jama.2012.271

Cuijpers, P., Karyotaki, E., de Wit, L., & Ebert, D. D. (2019). The effects of fifteen evidence-supported therapies for adult depression: A meta-analytic review. *Psychotherapy Research*, *0*(0), 1–15. https://doi.org/10.1080/10503307.2019.1649732

De Vries, S., van Dillen, S. M. E., Groenewegen, P. P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Social Science and Medicine*, *94*, 26–33. https://doi.org/10.1016/j.socscimed.2013.06.030

Djernis, D., Lerstrup, I., Poulsen, D., Stigsdotter, U., Dahlgaard, J., & O'toole, M. (2019). A systematic review and meta-analysis of nature-based mindfulness: Effects of moving mindfulness training into an outdoor natural setting. *International Journal of Environmental Research and Public Health*, *16*(17). https://doi.org/10.3390/ijerph16173202

Donker, T., Griffiths, K. M., Cuijpers, P., & Christensen, H. (2009). Psychoeducation for depression, anxiety and psychological distress: A meta-analysis. *BMC Medicine*, *7*(1), 1–9. https://doi.org/10.1186/1741-7015-7-79/FIGURES/2

Dunning, D. L., Griffiths, K., Kuyken, W., Crane, C., Foulkes, L., Parker, J., & Dalgleish, T. (2019). Research Review: The effects of mindfulness-based interventions on cognition and mental health in children and adolescents – a meta-analysis of randomized controlled trials. *Journal of Child Psychology and Psychiatry*, *60*(3), 244–258. https://doi.org/10.1111/JCPP.12980

Dute, D. J., Bemelmans, W. J. E., & Breda, J. (2016). Using Mobile Apps to Promote a Healthy Lifestyle Among Adolescents and Students: A Review of the Theoretical Basis and Lessons Learned. *JMIR Mhealth Uhealth 2016;4(2):E39 Https://Mhealth.Jmir.Org/2016/2/E39*, *4*(2), e3559. https://doi.org/10.2196/MHEALTH.3559

Dzhambov, A., Hartig, T., Markevych, I., Tilov, B., & Dimitrova, D. (2018). Urban residential greenspace and mental health in youth: Different approaches to testing multiple pathways yield different conclusions. *Environmental Research*, *160*, 47–59. https://doi.org/10.1016/j.envres.2017.09.015

Dzhambov, A. M., Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., Gatseva, P., & Dimitrova, D. D. (2018). Multiple pathways link urban green- and bluespace to mental health in young adults. *Environmental Research*, *166*, 223–233. https://doi.org/10.1016/j.envres.2018.06.004

Ebert, D. D., & Cuijpers, P. (2018). It Is Time to Invest in the Prevention of Depression. *JAMA Network Open*, *1*(2), e180335-e180335. https://doi.org/10.1001/jamanetworkopen.2018.0335

Ebesutani, C., Regan, J., Smith, A., Reise, S., Higa-Mcmillan, C., & Chorpita, B. F. (2012). The 10-Item Positive and Negative Affect Schedule for Children, Child and Parent Shortened Versions: Application of Item Response Theory for More Efficient Assessment. *Journal of Psychopathology and Behavioral Assessment*, *34*(2), 191–203. https://doi.org/10.1007/s10862-011-9273-2

Egger, G. J., Binns, A. F., & Rossner, S. R. (2009). The emergence of "lifestyle medicine" as a structured approach for management of chronic disease. *Medical Journal of Australia*, *190*(3), 143–145. https://doi.org/10.5694/J.1326-5377.2009.TB02317.X

Egner, L. E., Sütterlin, S., & Calogiuri, G. (2020). Proposing a Framework for the Restorative Effects of Nature through Conditioning: Conditioned Restoration Theory. *Journal of Environmental Research and Public Health*, *17*(18), 6792.

Erdur-Bakera, Ö., & Bugaya, A. (2010). The short version of ruminative response scale: Reliability, validity and its relation to psychological symptoms. *Procedia - Social and Behavioral Sciences*, *5*, 2178–2181. https://doi.org/10.1016/j.sbspro.2010.07.433

Fairchild, A. J., & McDaniel, H. L. (2017). Best (but oft-forgotten) practices: mediation analysis. *The American Journal of Clinical Nutrition*, *105*(6), 1259–1271. https://doi.org/10.3945/AJCN.117.152546

Fiedler, K., Schott, M., & Meiser, T. (2011). What mediation analysis can (not) do ☆. *Journal of Experimental Social Psychology*, *47*, 1231–1236. https://doi.org/10.1016/j.jesp.2011.05.007

Firth, J., Solmi, M., Wootton, R. E., Vancampfort, D., Schuch, F. B., Hoare, E., Gilbody, S., Torous, J., Teasdale, S. B., Jackson, S. E., Smith, L., Eaton, M., Jacka, F. N., Veronese, N., Marx, W., Ashdown-Franks, G., Siskind, D., Sarris, J., Rosenbaum, S., … Stubbs, B. (2020). A meta-review of "lifestyle psychiatry": the role of exercise, smoking, diet and sleep in the prevention and treatment of mental disorders. *World Psychiatry*, *19*(3), 360–380. https://doi.org/10.1002/WPS.20773

Frumkin, H., Bratman, G. N., Breslow, S. J., Cochran, B., Kahn, P. H., Lawler, J. J., Levin, P. S., Tandon, P. S., Varanasi, U., Wolf, K. L., & Wood, S. A. (2017). Nature Contact and Human Health: A Research Agenda. *Environmental Health Perspectives*, *125*(7), 075001. https://doi.org/10.1289/EHP1663

Fusar-Poli, P., Correll, C. U., Arango, C., Berk, M., Patel, V., & Ioannidis, J. P. A. (2021). Preventive psychiatry: a blueprint for improving the mental health of young people. *World Psychiatry*, *20*(2), 200–221. https://doi.org/10.1002/WPS.20869

Gardner, B., Smith, L., Lorencatto, F., Hamer, M., & Biddle, S. J. H. (2016). How to reduce sitting time? A review of behaviour change strategies used in sedentary behaviour reduction interventions among adults. *Health Psychology Review*, *10*(1), 89–112. https://doi.org/10.1080/17437199.2015.1082146

Geisner, I. M., Neighbors, C., & Larimer, M. E. (2006). A randomized clinical trial of a brief, mailed intervention for symptoms of depression. *Journal of Consulting and Clinical Psychology*, *74*(2), 393–399. https://doi.org/10.1037/0022-006X.74.2.393

Goldberg, S. B., Tucker, R. P., Greene, P. A., Davidson, R. J., Wampold, B. E., Kearney, D. J., & Simpson, T. L. (2017). *Mindfulness-based interventions for psychiatric disorders: A systematic review and meta-analysis A R T I C L E I N F O*. https://doi.org/10.1016/j.cpr.2017.10.011

Gore, F. M., Bloem, P. J., Patton, G. C., Ferguson, J., Joseph, V., Coffey, C., & Mathers, C. D. (2011). Global burden of disease in young people aged 10-24 years: a systematic analysis. *The Lancet*, *377*(9783), 2093–2102. https://doi.org/10.1016/S0140-6736(11)60512-6

Grant, K. E., Compas, B. E., Thurm, A. E., McMahon, S. D., & Gipson, P. Y. (2004). Stressors and child and adolescent psychopathology: measurement issues and prospective effects. *Journal of Clinical Child and Adolescent Psychology : The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, *33*(2), 412–425. https://doi.org/10.1207/S15374424JCCP3302_23

Greco, L. A., Baer, R. A., & Smith, G. T. (2011). Assessing Mindfulness in Children and Adolescents: Development and Validation of the Child and Adolescent Mindfulness Measure (CAMM). *Psychological Assessment*, *23*(3), 606–614. https://doi.org/10.1037/a0022819

Greenwood, A., & Gatersleben, B. (2016). Let's go outside! Environmental restoration

amongst adolescents and the impact of friends and phones. *Journal of Environmental Psychology*, *48*, 131–139. https://doi.org/10.1016/j.jenvp.2016.09.007

Grierson, A. B., Hickie, I. B., Naismith, S. L., & Scott, J. (2016). The role of rumination in illness trajectories in youth: linking trans-diagnostic processes with clinical staging models. *Psychological Medicine*, *46*(12), 2467. https://doi.org/10.1017/S0033291716001392

Han, K.-T. (2018a). A review of self-report scales on restoration and/or restorativeness in the natural environment. *Journal of Leisure Research*, *49*(3–5), 151–176. https://doi.org/10.1080/00222216.2018.1505159

Han, K.-T. (2018b). A review of self-report scales on restoration and/or restorativeness in the natural environment. *Journal of Leisure Research*, *49*(3–5), 151–176. https://doi.org/10.1080/00222216.2018.1505159

Han, K. T. (2003). A reliable and valid self-rating measure of the restorative quality of natural environments. *Landscape and Urban Planning*, *64*(4), 209–232. https://doi.org/10.1016/S0169-2046(02)00241-4

Harper, N. J., Fernee, C. R., & Gabrielsen, L. E. (2021). Nature's Role in Outdoor Therapies: An Umbrella Review. *International Journal of Environmental Research and Public Health 2021, Vol. 18, Page 5117*, *18*(10), 5117. https://doi.org/10.3390/IJERPH18105117

Hartig, T., Jamner, L., Evans, G. W., Jamner, L. D., Davis, D. S., & Arling, T. G. (2003). Tracking restoration in natural and urban field settings SEE PROFILE Tracking restoration in natural and urban field settings. *Article in Journal of Environmental Psychology*, *23*, 109–123. https://doi.org/10.1016/S0272-4944(02)00109-3

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing and Planning Research*, *14*(4), 175–194. https://doi.org/10.1080/02815739708730435

Hartig, T., Mang, M., & Evans, G. W. (1991). Restorative Effects of Natural Environment Experiences: *Http://Dx.Doi.Org/10.1177/0013916591231001*, *23*(1), 3–26. https://doi.org/10.1177/0013916591231001

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014a). Nature and Health. *Annual Review of Public Health*, *35*(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014b). Nature and Health. *Annual*

*Review of Public Health*, *35*(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Hassan, A., Tao, J., Li, G., Jiang, M., Aii, L., Zhihui, J., Zongfang, L., & Qibing, C. (2018). Effects of Walking in Bamboo Forest and City Environments on Brainwave Activity in Young Adults. *Evidence-Based Complementary and Alternative Medicine*, *2018*, 1–9. https://doi.org/10.1155/2018/9653857

Hayhurst, J., Hunter, J. A., Kafka, S., & Boyes, M. (2015). Enhancing resilience in youth through a 10-day developmental voyage. *Http://Dx.Doi.Org/10.1080/14729679.2013.843143*, *15*(1), 40–52. https://doi.org/10.1080/14729679.2013.843143

Hertzog, M. (2008). Considerations in Determining Sample Size for Pilot Studies. *Research in Nursing & Health*, *31*(2), 180–191. https://doi.org/10.1002/nur.20247

Heymans, M. W., & Eekhout, I. (2019). *Applied missing data analysis with SPSS and (R) Studio.*

Hinman, R. S., Buchbinder, R., Craik, R. L., George, S. Z., Maher, C. G., & Riddle, D. L. (2015). Is this a clinical trial? And should it be registered? *Physical Therapy*, *95*(6), 810–814. https://doi.org/10.2522/ptj.2015.95.6.810

Hoare, E., Callaly, E., & Berk, M. (2020). Can Depression Be Prevented? If So, How? *JAMA Psychiatry*, *77*(11), 1095–1096. https://doi.org/10.1001/JAMAPSYCHIATRY.2020.1273

Hossain, M. M., Sultana, A., Ma, P., Fan, Q., Sharma, R., Purohit, N., & Sharmin, D. F. (2020). *Effects of natural environment on mental health: an umbrella review of systematic reviews and meta-analyses*. https://doi.org/10.31234/OSF.IO/4R3MH

Hunter, J. A., Hayhurst, J., Kafka, S., Boyes, M., Ruffman, T., O'Brien, K., & Stringer, M. (2013). Elevated self-esteem 12 months following a 10-day developmental voyage. *Journal of Applied Social Psychology*, *43*(9), 1956–1961. https://doi.org/10.1111/JASP.12132

Jacka, F. N., Mykletun, A., & Berk, M. (2012). Moving towards a population health approach to the primary prevention of common mental disorders. *BMC Medicine*, *10*(1), 149. https://doi.org/10.1186/1741-7015-10-149

Jackson, S. B., Stevenson, K. T., Larson, L. R., Nils Peterson, M., & Seekamp, E. Outdoor Activity Participation Improves Adolescents' Mental Health and Well-Being during the COVID-19 Pandemic. *International Journal of Environmental Research and Public*

*Health 2021, Vol. 18, Page 2506*, *18*(5), 2506. https://doi.org/10.3390/IJERPH18052506

Jackson, S. B., Stevenson, K. T., Larson, L. R., Peterson, M. N., & Seekamp, E. Connection to Nature Boosts Adolescents' Mental Well-Being during the COVID-19 Pandemic. *Sustainability 2021, Vol. 13, Page 12297*, *13*(21), 12297. https://doi.org/10.3390/SU132112297

Jacob, K. S., Bhugra, D., & Mann, A. H. (2002). A randomised controlled trial of an educational intervention for depression among asian women in primary care in the United Kingdom. *International Journal of Social Psychiatry*, *48*(2), 139–148. https://doi.org/10.1177/002076402128783190

Jakobsen, J. C., Gluud, C., Wetterslev, J., & Winkel, P. (2017). When and how should multiple imputation be used for handling missing data in randomised clinical trials - A practical guide with flowcharts. *BMC Medical Research Methodology*, *17*(1), 1–10. https://doi.org/10.1186/S12874-017-0442-1/TABLES/2

James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Accrombessi, M. M. K., … Murray, C. J. L. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 Diseases and Injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, *392*(10159), 1789–1858. https://doi.org/10.1016/S0140-6736(18)32279-7

Jennings, V., & Bamkole, O. (2019). The Relationship between Social Cohesion and Urban Green Space: An Avenue for Health Promotion. *International Journal of Environmental Research and Public Health 2019, Vol. 16, Page 452*, *16*(3), 452. https://doi.org/10.3390/IJERPH16030452

Johnsen, S. Å. K., & Rydstedt, L. W. (2013). Active use of the natural environment for emotion regulation. *Europe's Journal of Psychology*, *9*(4), 798–819. https://doi.org/10.5964/EJOP.V9I4.633

Johnson, J. G., Harris, E. S., Spitzer, R. L., & Williams, J. B. W. (2002). The Patient Health Questionnaire for Adolescents: Validation of an instrument for the assessment of mental disorders among adolescent primary care patients. *Journal of Adolescent Health*, *30*(3), 196–204. https://doi.org/10.1016/S1054-139X(01)00333-0

Jones, P. B. (2013). Adult mental health disorders and their age at onset. *British Journal of*

*Psychiatry*, *202*(s54), 5–10. https://doi.org/10.1192/bjp.bp.112.119164

Kabat-Zinn, J. (1994). Wherever you go ,There you are:Mindfulness meditation in Every-day Life.Hyperion. In *Hyperion*. Hachette Books. https://books.google.com/books/about/Wherever_You_Go_There_You_Are.html?id=-g-OSXrZeYYC

Kaplan, R., & Kaplan, S. (1989). *The Experience of Nature A Psychological Perspective*. Cambridge University Press.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. https://doi.org/https://doi.org/10.1016/0272-4944(95)90001-2

Kazdin, A. E. (2007). *Mediators and Mechanisms of Change in Psychotherapy Research*. https://doi.org/10.1146/annurev.clinpsy.3.022806.091432

Kechter, A., Black, D. S., Riggs, N. R., Warren, C. M., Ritt-Olson, A., Chou, C. P., & Pentz, M. A. (2019). Factors in the Perceived Stress Scale Differentially Associate with Mindfulness Disposition and Executive Function among Early Adolescents. *Journal of Child and Family Studies*, *28*(3), 814–821. https://doi.org/10.1007/S10826-018-01313-4/FIGURES/1

Keenan-Miller, D., Hammen, C. L., & Brennan, P. A. (2007). Health Outcomes Related to Early Adolescent Depression. *Journal of Adolescent Health*, *41*(3), 256–262. https://doi.org/10.1016/j.jadohealth.2007.03.015

Kellert, S. R., & Wilson, E. O. (1995). *The Biophilia Hypothesis*. Island Press. https://doi.org/https://doi.org/10.1177/027046769501500125

Kelz, C., Evans, G. W., & Röderer, K. (2015). The Restorative Effects of Redesigning the Schoolyard. *Environment and Behavior*, *47*(2), 119–139. https://doi.org/10.1177/0013916513510528

Kessler, R. C., Amminger, G. P., Aguilar-Gaxiola, S., Alonso, J., Lee, S., & Üstün, T. B. (2007). Age of onset of mental disorders: A review of recent literature. *Current Opinion in Psychiatry*, *20*(4), 359–364. https://doi.org/10.1097/YCO.0b013e32816ebc8c

Kirschbaum, C., Pirke, K.-M., & Hellhammer, D. H. (1993). The 'Trier Social Stress Test'-A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Ncuropsychobiology*, *28*, 76–81.

Korpela, K. M., Pasanen, T., Repo, V., Hartig, T., Staats, H., Mason, M., Alves, S., Fornara, F., Marks, T., Saini, S., Scopelliti, M., Soares, A. L., Stigsdotter, U. K., & Thompson, C.

W. (2018). Environmental strategies of affect regulation and their associations with subjective well-being. *Frontiers in Psychology*, *9*(APR), 562. https://doi.org/10.3389/FPSYG.2018.00562/BIBTEX

Kostova, Z., Levin, L., Lorberg, B., & Ziedonis, D. (2019). Mindfulness-Based Interventions for Adolescents with Mental Health Conditions: A Systematic Review of the Research Literature. *Journal of Child and Family Studies 2019 28:10*, *28*(10), 2633–2649. https://doi.org/10.1007/S10826-019-01477-7

Kotera, Y., Richardson, M., & Sheffield, D. (2020). Effects of Shinrin-Yoku (Forest Bathing) and Nature Therapy on Mental Health: a Systematic Review and Meta-analysis. *Journal of Mental Health and Addiction*, 1–24. https://doi.org/10.1007/s11469-020-00363-4

Kowalski, K. C., Crocker, P. R. E., Donen, R. M., & Honours, B. (2004). *The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual* (Vol. 87, Issue 1).

Kraemer, H. C. ., Wilson, G. ., Fairburn, C. G. ., & Agras, W. S. (2002). Mediators and Moderators of Treatment Effects in Randomized Clinical Trials Cite this paper Evidence Base Updat e: 50 Years of Research on Treat ment for Child and Adolescent Anxiet y Leslie Rit h-Najarian Evidence-Based Psychosocial Treat ment s for Phobic and Anxiet y Disorders in Children and Adolesce…. *Archives of General Psychiatry*, *59*(10), 877–883. www.archgenpsychiatry.com

Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, *16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kuby, A. K., McLean, N., & Allen, K. (2015). Validation of the Child and Adolescent Mindfulness Measure (CAMM) with Non-Clinical Adolescents. *Mindfulness*, *6*(6), 1448–1455. https://doi.org/10.1007/s12671-015-0418-3

Lahart, I., Darcy, P., Gidlow, C., & Calogiuri, G. (2019). The Effects of Green Exercise on Physical and Mental Wellbeing: A Systematic Review. *International Journal of Environmental Research and Public Health*, *16*(8), 1352. https://doi.org/10.3390/ijerph16081352

Largo-Wight, E., William Chen, W., Dodd, V., & Weiler, R. (2011). Healthy workplaces: The effects of nature contact at work on employee stress and health. *Public Health Reports*, *126*(SUPPL. 1), 124–126. https://doi.org/10.1177/00333549111260s116

Lee, I., Choi, H., Bang, K. S., Kim, S., Song, M. K., & Lee, B. (2017). Effects of Forest

Therapy on Depressive Symptoms among Adults: A Systematic Review. *International Journal of Environmental Research and Public Health 2017, Vol. 14, Page 321*, *14*(3), 321. https://doi.org/10.3390/IJERPH14030321

Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health*, *125*(2), 93–100. https://doi.org/10.1016/j.puhe.2010.09.005

Lee, Juyoung, Tsunetsugu, Y., Takayama, N., Park, B. J., Li, Q., Song, C., Komatsu, M., Ikei, H., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2014). Influence of forest therapy on cardiovascular relaxation in young adults. *Evidence-Based Complementary and Alternative Medicine*, *2014*. https://doi.org/10.1155/2014/834360

Mackinnon, D., & Luecken, L. (2008). How and for Whom? Mediation and Moderation in Health Psychology. *Health Psychology*, *27(2S)*(S99). https://doi.org/10.1037/0278-6133.27.2(Suppl.).S99

Mao, G. X., Lan, X. G., Cao, Y. B., Chen, Z. M., He, Z. H., Lv, Y. D., Wang, Y. Z., Hu, X. L., Wang, G. F., & Yan, J. (2012). Effects of short-term forest bathing on human health in a broad-leaved evergreen forest in Zhejiang Province, China. *Biomedical and Environmental Sciences*, *25*(3), 317–324. https://doi.org/10.3967/0895-3988.2012.03.010

Marselle, M. R. ., Irvine, K. N. ., Lorenzo-Arribas, A. ., & Warber, S. L. (2016). Does perceived restorativeness mediate the effects of perceived biodiversity and perceived naturalness on emotional well- being following group walks in nature? . *Journal of Environmental Psychology*, *46*, 217–232. https://doi.org/10.1016/j.jenvp.2016.04.008

Masterton, W., Carver, H., Parkes, T., & Park, K. (2020). Greenspace interventions for mental health in clinical and non-clinical populations: What works, for whom, and in what circumstances? *Health and Place*, *64*. https://doi.org/10.1016/j.healthplace.2020.102338

Mayer, F. S., Mcpherson Frantz, C., Bruehlman-Senecal, E., Dolliver, K., Bielagus, E., Doohan, C., Friedman, M., Kaplan, S., Keeler-Wolf, E., Luce, Z., Nazryan, D., Quay, L., Rock, M., Sytsma, S., Shauger, A., & Yager, M. (2009). Why Is Nature Beneficial? The Role of Connectedness to Nature. *Environment and Behavior*, *41*(5), 607–643. https://doi.org/10.1177/0013916508319745

McCormick, R. (2017). Does Access to Green Space Impact the Mental Well-being of Children: A Systematic Review. *Journal of Pediatric Nursing*, *37*, 3–7.

https://doi.org/10.1016/J.PEDN.2017.08.027

Mcewan, K., Giles, D., Kotera, Y., Basran, J., Giles, D., Clarke, F. J., Kotera, Y., Evans, G., Terebenina, O., Minou, L., Teeling, C., Wood, W., & Weil, D. (2021). *A Pragmatic Controlled Trial of Forest Bathing Compared with Compassionate Mind Training in the UK: Impacts on Self-Reported Wellbeing and Heart Rate Variability*. https://doi.org/10.3390/su13031380

McGorry, P. D., Purcell, R., Goldstone, S., & Amminger, G. P. (2011). Age of onset and timing of treatment for mental and substance use disorders: implications for preventive intervention strategies and models of care. *Current Opinion in Psychiatry*, *24*(4), 301–306. https://doi.org/10.1097/YCO.0B013E3283477A09

McKenzie, J. E. ., Brennan, S. E. ., Ryan, R. E., Thomson, H. J. ., Johnston, R. V. ., & Thomas, J. (2019). Defining the criteria for including studies and how they will be grouped for the synthesis. In J. P. T. . Higgins, J. . Thomas, J. . Chandler, M. . Cumpston, T. . Li, M. J. . Page, & V. A. Welch (Eds.), *Cochrane handbook for systematic reviews of interventions* (6.2, pp. 33–65). Cochrone. www.training.cochrane.org/handbook

McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *Journal of Positive Psychology*, *10*(6), 507–519. https://doi.org/10.1080/17439760.2014.994224

Merry, S. N., Hetrick, S. E., Cox, G. R., Brudevold-Iversen, T., Bir, J. J., & McDowell, H. (2011). Psychological and educational interventions for preventing depression in children and adolescents. In *Cochrane Database of Systematic Reviews* (pp. 1409–1685). John Wiley & Sons, Ltd. https://doi.org/10.1002/14651858.cd003380.pub3

Mikkelsen, K., Stojanovska, L., Polenakovic, M., Bosevski, M., & Apostolopoulos, V. (2017). Exercise and mental health. *Maturitas*, *106*, 48–56. https://doi.org/10.1016/J.MATURITAS.2017.09.003

Miyazaki, Y. (2018a). *Shinrin-yoku: The Japanese Way of Forest Bathing for Health and Relaxation*. Timber Press.

Miyazaki, Y. (2018b). *Shinrin-yoku: The Japanese Way of Forest Bathing for Health and Relaxation* . Timber Press. https://books.google.co.uk/books?hl=en&lr=&id=XX4-DwAAQBAJ&oi=fnd&pg=PT3&ots=Oh0A28bfGa&sig=Zh1GT0f1q02-L8RZRYfjqa-3VN8&redir_esc=y#v=onepage&q&f=false

Mohr, D. C., Spring, B., Freedland, E. K., Beckner, V., Arean, P., Hollon, S. D., Ockene, J.,

& Kaplan, R. (2009). *The Selection and Design of Control Conditions for Randomized Controlled Trials of Psychological Interventions*. https://doi.org/10.1159/000228248

Moss, S. (2012). *Natural Childhood*. http://www.friendsofhaileypark.org.uk/uploads/1/9/5/1/1951271/naturalchildhood_stephenmoss_nationaltrust.pdf

Mullen, S. (2018). Major depressive disorder in children and adolescents. *Ment Health Clin [Internet]*, *8*(6), 275–283. https://doi.org/10.9740/mhc.2018.11.275

Muñoz, R. F., Cuijpers, P., Smit, F., Barrera, A. Z., & Leykin, Y. (2010). Prevention of Major Depression. *Annual Review of Clinical Psychology*, *6*(1), 181–212. https://doi.org/10.1146/annurev-clinpsy-033109-132040

Muñoz, R. F., San, F. /, Hospital, F. G., Beardslee, W. R., & Leykin, Y. (2012). Major Depression Can Be Prevented. *American Psychologist*, *67*(4), 285. https://doi.org/10.1037/a0027666

Mygind, Laerke, Hartmeyer, R. D., & Mygind, E. (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*, 102–136. https://doi.org/10.31219/osf.io/wj2pg

Mygind, Lærke, Kjeldsted, E., Hartmeyer, R. D., Mygind, E., Bølling, M., & Bentsen, P. (2019). Immersive nature-experiences as health promotion interventions for healthy, vulnerable, and sick populations? A systematic review and appraisal of controlled studies. In *Frontiers in Psychology* (Vol. 10, Issue APR, p. 943). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2019.00943

Nandakumar, A. L., Vande Voort, J. L., Nakonezny, P. A., Orth, S. S., Romanowicz, M., Sonmez, A. I., Ward, J. A., Rackley, S. J., Huxsahl, J. E., & Croarkin, P. E. (2019). Psychometric Properties of the Patient Health Questionnaire-9 Modified for Major Depressive Disorder in Adolescents. *Journal of Child and Adolescent Psychopharmacology*, *29*(1), 34–40. https://doi.org/10.1089/cap.2018.0112

National Institute for Health and Care Excellence. (2019). *Depression in children and young people: identification and management [NG134]*. https://www.nice.org.uk/guidance/ng134

Nisbet, E. K., Zelenski, J. M., & Grandpierre, Z. (2019). Mindfulness in Nature Enhances Connectedness and Mood. *Ecopsychology*, *11*(2), 81–91. https://doi.org/10.1089/eco.2018.0061

Noordsy, D. L. (2019). *Lifestyle Psychiatry* . American Psychiatric Association Publishing. https://books.google.co.uk/books?hl=en&lr=&id=fJqRDwAAQBAJ&oi=fnd&pg=PP1&dq=lifestyle+psychiatry&ots=acgBapZ6CC&sig=Gum2zYQupNNvi9AsHX2JmpXdsjU&redir_esc=y#v=onepage&q=lifestyle psychiatry&f=false

Norwood, M. F., Lakhani, A., Fullagar, S., Maujean, 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. In *Landscape and Urban Planning* (Vol. 189, pp. 71–79). Elsevier B.V. https://doi.org/10.1016/j.landurbplan.2019.04.007

Olivos-Jara, P., Segura-Fernández, R., Rubio-Pérez, C., & Felipe-García, B. (2020). Biophilia and Biophobia as Emotional Attribution to Nature in Children of 5 Years Old. *Frontiers in Psychology*, *11*, 511. https://doi.org/10.3389/FPSYG.2020.00511/BIBTEX

Osgood, C. E. ., Suci, G. J. ., & Tannenbaum. P. H. (1957). *The measurement of meaning* . University of Illinois press. https://www.press.uillinois.edu/books/catalog/32mtm7sx9780252745393.html

Overbey, T. A., Diekmann, F., & Lekies, K. S. (2021). Nature-based interventions for vulnerable youth: a scoping review. *International Journal of Environmental Health Research*. https://doi.org/10.1080/09603123.2021.1998390/FORMAT/EPUB

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*. https://doi.org/10.1136/BMJ.N71

Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine*, *15*(1), 18–26. https://doi.org/10.1007/s12199-009-0086-9

Park, Bum Jin, Furuya, K., Kasetani, T., Takayama, N., Kagawa, T., & Miyazaki, Y. (2011). Relationship between psychological responses and physical environments in forest settings. *Landscape and Urban Planning*, *102*(1), 24–32. https://doi.org/10.1016/j.landurbplan.2011.03.005

Passmore, H. A., & Howell, A. J. (2014). Nature involvement increases hedonic and eudaimonic well-being: A two-week experimental study. *Ecopsychology*, *6*(3), 148–154.

https://doi.org/10.1089/eco.2014.0023

Patalay, P., & Gage, S. H. (2019). Changes in millennial adolescent mental health and health-related behaviours over 10 years: a population cohort comparison study. *International Journal of Epidemiology*, *48*(5), 1650–1664. https://doi.org/10.1093/IJE/DYZ006

Pearson, D. G., & Craig, T. (2014). The great outdoors? Exploring the mental health benefits of natural environments. *Frontiers in Psychology*, *0*, 1178. https://doi.org/10.3389/FPSYG.2014.01178

Petito, A., Pop, T. L., Namazova-Baranova, L., Mestrovic, J., Nigri, L., Vural, M., Sacco, M., Giardino, I., Ferrara, P., & Pettoello-Mantovani, M. (2020). The Burden of Depression in Adolescents and the Importance of Early Recognition. *The Journal of Pediatrics*, *218*, 265-267.e1. https://doi.org/10.1016/J.JPEDS.2019.12.003

Piotrowski, M. C., Lunsford, J., & Gaynes, B. N. (2021). Lifestyle psychiatry for depression and anxiety: Beyond diet and exercise. *Lifestyle Medicine*, *2*(1), e21. https://doi.org/10.1002/LIM2.21

Putra, I. G. N. E., Astell-Burt, T., Cliff, D. P., Vella, S. A., & Feng, X. (2021). Association between caregiver perceived green space quality and the development of prosocial behaviour from childhood to adolescence: Latent class trajectory and multilevel longitudinal analyses of Australian children over 10 years. *Journal of Environmental Psychology*, *74*, 101579. https://doi.org/10.1016/J.JENVP.2021.101579

Putra, I. G. N. E., Astell-Burt, T., Cliff, D. P., Vella, S. A., John, E. E., & Feng, X. (2020). The Relationship Between Green Space and Prosocial Behaviour Among Children and Adolescents: A Systematic Review. *Frontiers in Psychology*, *0*, 859. https://doi.org/10.3389/FPSYG.2020.00859

Racine, N., McArthur, B. A., Cooke, J. E., Eirich, R., Zhu, J., & Madigan, S. (2021). Global Prevalence of Depressive and Anxiety Symptoms in Children and Adolescents During COVID-19: A Meta-analysis. *JAMA Pediatrics*, *175*(11), 1142–1150. https://doi.org/10.1001/JAMAPEDIATRICS.2021.2482

Read, A., Mazzucchelli, T. G., & Kane, R. T. (2016). A preliminary evaluation of a single session behavioural activation intervention to improve well-being and prevent depression in carers. *Clinical Psychologist*, *20*(1), 36–45. https://doi.org/10.1111/CP.12084

Richardson, M. (2019). Beyond Restoration: Considering Emotion Regulation in Natural Well-Being. *Ecopsychology*, *11*(2), 123–129.

https://doi.org/10.1089/ECO.2019.0012/ASSET/IMAGES/LARGE/FIGURE1.JPEG

Richardson, M., Hunt, A., Hinds, J., Bragg, R., Fido, D., Petronzi, D., Barbett, L., Clitherow, T., & White, M. (2019). A measure of nature connectedness for children and adults: Validation, performance, and insights. *Sustainability (Switzerland)*, *11*(12), 3250. https://doi.org/10.3390/SU11123250

Richardson, M., Mcewan, K., & Sheffield, D. (2016). Joy and Calm: How an Evolutionary Functional Model of Affect Regulation Informs Positive Emotions in Nature Coping with Pain View project Pain in People with Dementia: a Systematic Review of the Effectiveness of Observational/Behavioural Pain Assessment Tools in the UK View project. *Evolutionary Psychological Science*, *2*(4), 308–320. https://doi.org/10.1007/s40806-016-0065-5

Roberts, A., Hinds, J., & Camic, P. M. (2020a). Nature activities and wellbeing in children and young people: a systematic literature review. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 298–318. https://doi.org/10.1080/14729679.2019.1660195

Roberts, A., Hinds, J., & Camic, P. M. (2020b). Nature activities and wellbeing in children and young people: a systematic literature review. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 298–318. https://doi.org/10.1080/14729679.2019.1660195

Roberts, A., Hinds, J., & Camic, P. M. (2020c). Nature activities and wellbeing in children and young people: a systematic literature review. *Journal of Adventure Education and Outdoor Learning*, *20*(4), 298–318. https://doi.org/10.1080/14729679.2019.1660195

Rodriguez-Ayllon, M., Cadenas-Sánchez, C., Fernando Estévez-López, ·, Muñoz, N. E., Mora-Gonzalez, J., Migueles, J. H., Molina-García, P., Henriksson, H., Mena-Molina, A., Martínez-Vizcaíno, V., Catena, A., Löf, M., Kirk, ·, Erickson, I., David, ·, Lubans, R., Francisco, ·, Ortega, B., & Esteban-Cornejo, I. (2019). SYSTEMATIC REVIEW Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*, *49*(9), 1383–1410. https://doi.org/10.1007/s40279-019-01099-5

Rogers, A. E., Caruso, C. C., & Aldrich, M. S. (1993). Reliability of sleep diaries for assessment of sleep/wake patterns. *Nursing Research*, *42*(6), 368–371. https://doi.org/10.1097/00006199-199311000-00010

Rogerson, M., Wood, C., Pretty, J., Schoenmakers, P., Bloomfield, D., & Barton, J. (2020). Regular Doses of Nature: The Efficacy of Green Exercise Interventions for Mental Wellbeing. *International Journal of Environmental Research and Public Health*, *17*(5),

1526. https://doi.org/10.3390/ijerph17051526

Rosenberg, M. (1965). *Society and the adolescent self-image.* University Press. https://doi.org/10.1007/s12671-015-0407-6

Salleh, M. R. (2008). Life Event, Stress and Illness. *The Malaysian Journal of Medical Sciences : MJMS*, *15*(4), 9. /pmc/articles/PMC3341916/

Sawyer, S. M., Azzopardi, P. S., Wickremarathne, D., & Patton, G. C. (2018). The age of adolescence. *The Lancet Child & Adolescent Health*, *2*(3), 223–228. https://doi.org/10.1016/S2352-4642(18)30022-1

Scarf, D., Hayhurst, J. G., Riordan, B. C., Boyes, M., Ruffman, T., & Hunter, J. A. (2017). Increasing resilience in adolescents: The importance of social connectedness in adventure education programmes. *Australasian Psychiatry*, *25*(2), 154–156. https://doi.org/10.1177/1039856216671668

Scarf, D., Moradi, S., McGaw, K., Hewitt, J., Hayhurst, J. G., Boyes, M., Ruffman, T., & Hunter, J. A. (2016). Somewhere I belong: Long-term increases in adolescents' resilience are predicted by perceived belonging to the in-group. *British Journal of Social Psychology*, *55*(3), 588–599. https://doi.org/10.1111/bjso.12151

Schuch, F., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P., Reichert, T., Bagatini, N. C., Bgeginski, R., & Stubbs, B. (2017). Physical activity and sedentary behavior in people with major depressive disorder: A systematic review and meta-analysis. *Journal of Affective Disorders*, *210*, 139–150. https://doi.org/10.1016/J.JAD.2016.10.050

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health Benefits from Nature Experiences Depend on Dose. *Scientific Reports*, *6*(1), 1–10. https://doi.org/10.1038/srep28551

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*, 1–32. https://doi.org/10.1146/ANNUREV.CLINPSY.3.022806.091415

Shin, J. C., Parab, K. V., An, R., & Grigsby-Toussaint, D. S. (2020). Greenspace exposure and sleep: A systematic review. *Environmental Research*, *182*. https://reader.elsevier.com/reader/sd/pii/S0013935119308771?token=1ECAD41092FA6E1B51D31BBEFC0D571BE5271AC6552C0A1FC6655247950B1795FC705A4AC234DBEE07FAF64070B0D41B&originRegion=eu-west-1&originCreation=20211014143815

Shin, W. S., & Oh, H. K. (1996). The influence of the forest program on depression level.

*Journal of Korean Society of Forest Science*, *85*(4), 586–595. https://www.koreascience.or.kr/article/JAKO199616247607311.pdf

Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. *Frontiers in Ecology and the Environment*, *14*(2), 94–101. https://doi.org/10.1002/fee.1225

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., Salazar de Pablo, G., Il Shin, J., Kirkbride, J. B., Jones, P., Kim, J. H., Kim, J. Y., Carvalho, A. F., Seeman, M. V., Correll, C. U., & Fusar-Poli, P. (2021). Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Molecular Psychiatry 2021*, *17*, 1–15. https://doi.org/10.1038/s41380-021-01161-7

Song, C., Ikei, H., Igarashi, M., Miwa, M., Takagaki, M., & Miyazaki, Y. (2014). Physiological and psychological responses of young males during spring-time walks in urban parks. *Journal of Physiological Anthropology*, *33*(1). https://doi.org/10.1186/1880-6805-33-8

Song, C., Ikei, H., Igarashi, M., Takagaki, M., & Miyazaki, Y. (2015). Physiological and psychological effects of a walk in Urban parks in fall. *International Journal of Environmental Research and Public Health*, *12*(11), 14216–14228. https://doi.org/10.3390/ijerph121114216

Song, C., Joung, D., Ikei, H., Igarashi, M., Aga, M., Park, B. J., Miwa, M., Takagaki, M., & Miyazaki, Y. (2013). Physiological and psychological effects of walking on young males in urban parks in winter. *Journal of Physiological Anthropology*, *32*(1). https://doi.org/10.1186/1880-6805-32-18

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine*, *166*(10), 1092–1097. https://doi.org/10.1001/archinte.166.10.1092

Stanton, K., & Watson, D. (2014). Positive and Negative Affective Dysfunction in Psychopathology. *Social and Personality Psychology Compass*, *8*(9), 555–567. https://doi.org/10.1111/SPC3.12132

Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Wood, A. M., & Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ*, *338*(7713), 157–160. https://doi.org/10.1136/BMJ.B2393

Stevenson, M. P., Schilhab, T., & Bentsen, P. (2018). Attention Restoration Theory II: a

systematic review to clarify attention processes affected by exposure to natural environments. In *Journal of Toxicology and Environmental Health - Part B: Critical Reviews* (Vol. 21, Issue 4, pp. 227–268). Taylor and Francis Inc. https://doi.org/10.1080/10937404.2018.1505571

Stockings, E. A., Degenhardt, L., Dobbins, T., Lee, Y. Y., Erskine, H. E., Whiteford, H. A., & Patton, G. (2016). Preventing depression and anxiety in young people: a review of the joint efficacy of universal, selective and indicated prevention. *Psychological Medicine*, *46*(1), 11–26. https://doi.org/10.1017/S0033291715001725

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*, 103971. https://doi.org/10.1016/J.LANDURBPLAN.2020.103971

Takayama, N., Korpela, K., Lee, J., Morikawa, T., Tsunetsugu, Y., Park, B.-J., Li, Q., Tyrväinen, L., Miyazaki, Y., & Kagawa, T. (2011). Emotional, Restorative and Vitalizing Effects of Forest and Urban Environments at Four Sites in Japan. *Int. J. Environ. Res. Public Health*, *11*, 11. https://doi.org/10.3390/ijerph110707207

Tambs, K., & Røysamb, E. (2014). Selection of questions to short-form versions of original psychometric instruments in MoBa. *Norsk Epidemiologi*, *24*(1–2), 195–201. https://doi.org/10.5324/nje.v24i1-2.1822

Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., Parkinson, J., Secker, J., & Stewart-Brown, S. (2007). The Warwick-Dinburgh mental well-being scale (WEMWBS): Development and UK validation. *Health and Quality of Life Outcomes*, *5*, 63. https://doi.org/10.1186/1477-7525-5-63

Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A Process for Systematically Reviewing the Literature: Providing the Research Evidence for Public Health Nursing Interventions. *Worldviews on Evidence-Based Nursing*, *1*(3), 176–184. https://doi.org/10.1111/J.1524-475X.2004.04006.X

Tiirikainen, K., Haravuori, H., Ranta, K., Kaltiala-Heino, R., & Marttunen, M. (2019). Psychometric properties of the 7-item Generalized Anxiety Disorder Scale (GAD-7) in a large representative sample of Finnish adolescents. *Psychiatry Research*, *272*, 30–35. https://doi.org/10.1016/j.psychres.2018.12.004

Tillmann, S., Clark, A. F., & Gilliland, J. A. (2018). Children and nature: Linking accessibility of natural environments and children's health-related quality of life.

*International Journal of Environmental Research and Public Health*, *15*(6). https://doi.org/10.3390/ijerph15061072

Tillmann, S., Tobin, D., Avison, W., & Gilliland, J. (2018a). Mental health benefits of interactions with nature in children and teenagers: A systematic review. *Journal of Epidemiology and Community Health*, 958–966. https://doi.org/10.1136/jech-2018-210436

Tillmann, S., Tobin, D., Avison, W., & Gilliland, J. (2018b). Mental health benefits of interactions with nature in children and teenagers: A systematic review. *Journal of Epidemiology and Community Health*, *72*(10), 958. https://doi.org/10.1136/jech-2018-210436

Tilov, B., Dzhambov, A., & Dimitrova, D. (2017). *Social cohesion mediates the association between urban greenspace and mental health in youth*. https://apps.webofknowledge.com/full_record.do?product=WOS&search_mode=CombineSearches&qid=6&SID=D3wstEbazaQiv6gaF7C&page=5&doc=219

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination Reconsidered: A Psychometric Analysis. In *Cognitive Therapy and Research* (Vol. 27, Issue 3).

Tsunetsugu, Y., Lee, J., Park, B.-J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013a). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape and Urban Planning*, *113*, 90–93. https://doi.org/10.1016/j.landurbplan.2013.01.014

Tsunetsugu, Y., Lee, J., Park, B. J., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013b). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape and Urban Planning*, *113*, 90–93. https://doi.org/10.1016/j.landurbplan.2013.01.014

Tursi, M. F. D. S., Baes, C. V. W., Camacho, F. R. D. B., Tofoli, S. M. D. C., & Juruena, M. F. (2013). Effectiveness of psychoeducation for depression: a systematic review. *Australian & New Zealand Journal of Psychiatry*, *47*(11), 1019–1031. https://doi.org/10.1177/0004867413491154

Ulrich, R. (1981). Natural Versus Urban Scenes: Some Psychophysiological Effects. *Environment and Behavior*, *13*(5), 523–556. https://journals.sagepub.com/doi/pdf/10.1177/0013916581135001

Ulrich, R. S. (1983). Aesthetic and Affective Response to Natural Environment. *Behavior and the Natural Environment*, 85–125. https://doi.org/10.1007/978-1-4613-3539-9_4

Ulrich, R. S. (1993). Biophilia, biophobia, and natural landscapes Design Guidelines View project Healthcare Architecture View project. *The Biophilia Hypothesis, 7*, 73–137. https://www.researchgate.net/publication/284655696

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991a). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991b). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Van Bronswijk, S., & Beijers, L. (2018). *Effectiveness of psychotherapy for treatment-resistant depression: A meta-analysis and meta-regression Personalized and precision mental healthcare: special interest group View project Interpersoonlijke psychotherapie View project*. https://doi.org/10.1017/S003329171800199X

Van Gordon, W., Shonin, E., & Richardson, M. (2018). Mindfulness and Nature. *Mindfulness*, *9*(5), 1655–1658. https://doi.org/10.1007/s12671-018-0883-6

Vanaken, G. J., & Danckaerts, M. (2018). Impact of green space exposure on children's and adolescents' mental health: A systematic review. In *International Journal of Environmental Research and Public Health* (Vol. 15, Issue 12). MDPI AG. https://doi.org/10.3390/ijerph15122668

Wang, X., Rodiek, S., Wu, C., Chen, Y., & Li, Y. (2016). Stress recovery and restorative effects of viewing different urban park scenes in Shanghai, China. *Urban Forestry & Urban Greening*, *15*, 112–122. https://doi.org/10.1016/j.ufug.2015.12.003

Watkins, E. ., & Roberts, H. (2020). Reflecting on rumination: Consequences, causes, mechanisms and treatment of rumination. *Behaviour Research and Therapy*, *127*, 103573. https://doi.org/10.1016/J.BRAT.2020.103573

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. . *Psychological Bulletin*, *134*(2), 163. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1032.5493&rep=rep1&type=pdf

White, M. P., Alcock, I., Grellier, J., Wheeler, B. W., Hartig, T., Warber, S. L., Bone, A., Depledge, M. H., & Fleming, L. E. (2019). Spending at least 120 minutes a week in

nature is associated with good health and wellbeing. *Scientific Reports*, *9*(1), 1–11. https://doi.org/10.1038/s41598-019-44097-3

Wilson, E. O. (1984). *Biophilia*. Harvard University Press. https://www.degruyter.com/document/doi/10.4159/9780674045231/html

Wong, V. W. H., Ho, F. Y. Y., Shi, N. K., Sarris, J., Chung, K. F., & Yeung, W. F. (2021). Lifestyle medicine for depression: A meta-analysis of randomized controlled trials. *Journal of Affective Disorders*, *284*, 203–216. https://doi.org/10.1016/J.JAD.2021.02.012

Wood, C., Angus, C., Pretty, J., Sandercock, G., & Barton, J. (2013). A randomised control trial of physical activity in a perceived environment on self-esteem and mood in UK adolescents. *International Journal of Environmental Health Research*, *23*(4), 311–320. https://doi.org/10.1080/09603123.2012.733935

Wood, C., Gladwell, V., & Barton, J. (2014). A Repeated Measures Experiment of School Playing Environment to Increase Physical Activity and Enhance Self-Esteem in UK School Children. *PLoS ONE*, *9*(9), e108701. https://doi.org/10.1371/journal.pone.0108701

World Health Organization. (2021a). *Adolescent mental health*. https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health

World Health Organization. (2021b). *Depression*. https://www.who.int/news-room/fact-sheets/detail/depression

Ystgaard, M. (1993). *Vulnerable Youth and Social Support*. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Ystgaard+M.+Sårbar+ungdom+og+sosial+støtte.+En+tilnærming+til+forebygging+av+psykisk+stress+og+selvmord.+Oslo%3A+Senter+for+sosialt+nettverk+og+helse%2C+1993.&btnG=#d=gs_cit&u=%252Fscholar%253Fq%253Dinfo%253

Zaman, R., Hankir, A., & Jemni, M. (2019). LIFESTYLE FACTORS AND MENTAL HEALTH. *Psychiatria Danubina*, *31*, 217–220.

Zhang, Y., Mavoa, S., Zhao, J., Raphael, D., & Smith, M. (2020a). The association between green space and adolescents mental well-being: A systematic review. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 18, pp. 1–26). MDPI AG. https://doi.org/10.3390/ijerph17186640

Zhang, Y., Mavoa, S., Zhao, J., Raphael, D., & Smith, M. (2020b). The Association between Green Space and Adolescents' Mental Well-Being: A Systematic Review. *International*

*Journal of Environmental Research and Public Health*, *17*(18), 6640. https://doi.org/10.3390/ijerph17186640

# Appendices

## Appendix A

## Recruitment Strategy

### Contact with Schools

Schools across the counties of Devon, Somerset and Cornwall were contacted through direct contact with SENDCOs or Psychology teachers via email (Figure A1) and via written correspondence. Further meetings via video conference or telephone were then set up in order to discuss the research further.

**Figure A1**

*Email Sent to Schools to aid Recruitment*

I hope this email finds you well.

I am currently looking for schools in Somerset to support my doctoral research looking at supporting the mental health of adolescents through a nature intervention. I would be grateful if you could read the attached letter and let me know if this will be something of interest to you.

I feel that this piece of research is extremely current in the context of COVID-19. New data is suggesting that probable mental health difficulties in adolescent populations have increased from 10% to 16% which I'm sure you will share as a concern. Such an intervention could help to buffer against this by mitigating stress and boosting mood, encouraging adolescents to keep fit and improving attention in the context of heightened levels of anxiety, enabling them to concentrate better at school. As such, I am hopeful that anyone who takes part in the study will experience some level of benefit.

I look forward to hearing from you.

Kind Regards

**Letter to Schools to Aid Recruitment**

16 March 2021

**Recruitment for Participation in Research**

Dear Headteacher/ SENCO

I am currently undertaking a Doctorate in Clinical Psychology at the University of Exeter and I am employed by Somerset NHS Foundation Trust. As part of my research thesis I am hoping to carry out a research study considering the benefits of nature on wellbeing in an adolescent population.

I am writing to enquire as to whether you would be in a position to consider supporting this piece of research by supporting with recruitment from your school. I have started to recruit adolescent and plan to carry out the research until June 2021. Please see below for an overview of the research.

The aim of the project is to explore whether contact with nature can be used as a lifestyle intervention in adolescents who are experiencing symptoms of depression. Research shows that contact with nature promotes mental health and wellbeing in children and adolescents by improving mood, physical health and self-esteem. It is also believed to lead to the restoration of mental fatigue, leading to greater attention potential.

This study aims to test more specifically whether contact with nature will improve mood, anxiety and wellbeing outcomes in adolescents experiencing at least mild symptoms of depression, age 14-18. A secondary aim is to test for any key change mechanisms according to pre-existing theory.

Participants will either follow a nature programme or wait-list control. The programme will be delivered by the researcher and consist of a 20-minute virtual education session. Participants in the intervention condition will be asked to complete online questionnaires on the day then will be advised to have as much contact with nature over a two-week period, following which the questionnaires will be repeated. Participants on in wait-list control condition will be asked to go about their life as normal and complete the questionnaires only, following the same time frame. They will have the opportunity to receive the intervention at the end of the study. The study has full ethical approval from the University of Exeter Research Ethics Committee.

I feel that this piece of research is extremely current in the context of COVID-19. New data is suggesting that probable mental health difficulties in adolescent populations have increased from 10% to 16% which I'm sure you will share as a concern. Such an intervention could help to buffer against this by mitigating stress and boosting mood, encouraging adolescents to keep fit and improving attention in the context of heightened levels of anxiety, enabling them to concentrate better at school. As such, I am hopeful that anyone who takes part in the study will experience some level of benefit.

In terms of your involvement as a school, I would be asking for your help in recruiting adolescents by sharing the details of the study to your mailing list. Whilst I am a clinically trained professional and would be directing adolescents to their GP, if I had any concerns about their wellbeing it would also be helpful to have a point of contact within your school with whom I can contact to share my concerns and relevant information with.

I would be grateful if you could consider supporting this piece of research and let me know if this would be of interest to you. I am happy to be contacted with any further questions you may have.

I look forward to hearing from you.

Kind Regards

**Poster Advertisements**

The poster advertisements below were given to schools who were happy to support the study in order to send out to their pupils. One was aimed at adolescents (Figure A2) and the other at their parents (Figure A3). I also provided a smaller advert for schools to add to their social media (Figure A4).

**Figure A2**

*Advert Aimed at Adolescents*

**Figure A3**

*Advert Aimed at Parents*

CEDAR

## A study looking at the impact of 'being in nature' on wellbeing in young people.

**Is your child 14-18?**

**They will earn a £5 amazon voucher and an additional chance to win one of three £50 amazon vouchers for their time!**

### What's Involved?

- Completing an initial question about their mood
- Completing online questionnaires and a computer task
- Attending an interactive webinar session on the benefits of nature
- Getting out in nature over a two week period

### What's In It for My Child?


- A £5 amazon voucher and an additional chance to win one of three £50 amazon vouchers .
- A chance to learn about the benefits of nature on health and wellbeing
- Their participation will also help to further understand how nature can help with the wellbeing of young people

### How do I get involved?

If you are interested in your child taking part in this study, please email the researcher

UNIVERSITY OF EXETER

**Figure A4**

*Advert for School to Upload to Social Media*

CEDAR

A study looking at the impact of 'being in nature' on wellbeing in young people.

**Are you age 14-24?**

**You could earn a £5 amazon voucher and an additional chance to win one of three £50 amazon vouchers for your time!**

If you're interested, please contact: [redacted]

**Social Media**

Adverts were posted to various forms of social media, including Reddit, Twitter, LinkedIn, Facebook and Instagram (Figure A5).

**Figure A5**

*Example Post to Support Recruitment using Instagram*

**Appendix B**

**Positive and Negative Affect Schedule- Child- Short Form (Ebesutani et al., 2012).**

Below are a list of words that describe different feelings and emotions. Read each item and list a number from the scale below next to each word.

Put the number that fits with **how you have felt over the past week.**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Very slightly or Not at all | A little | Moderately | Quite a Bit | Extremely |

1) Cheerful _____
2) Lively _____
3) Happy _____
4) Joyful _____
5) Proud _____
6) Miserable _____
7) Mad _____
8) Afraid _____
9) Scared _____
10) Sad _____

**Appendix C**

**Patient Health Questionnaire Modified for Teens (Johnson et al., 2002).**

**Over the last 2 weeks, how often have you been bothered by any of the following problems?**

| | **Not at all** | **Several days** | **More than half the days** | **Nearly every day** |
|---|---|---|---|---|
| 1. Little interest or pleasure in doing things? | 0 | 1 | 2 | 3 |
| 2. Feeling down, depressed, irritable or hopeless? | 0 | 1 | 2 | 3 |
| 3. Trouble falling asleep, or staying asleep, or sleeping too much? | 0 | 1 | 2 | 3 |
| 4. Feeling tired or having little energy? | 0 | 1 | 2 | 3 |
| 5. Poor appetite, weight loss, or overeating? | 0 | 1 | 2 | 3 |
| 6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down | 0 | 1 | 2 | 3 |
| 7. Trouble concentrating on things like school work, reading, or watching TV? | 0 | 1 | 2 | 3 |
| 8. Moving or speaking so slowly that other people could have noticed? Or the opposite, being so fidgety or restless that you have been moving around a lot more than usual? | 0 | 1 | 2 | 3 |

**Appendix D**

**General Anxiety Disorder 7-item Scale (Spitzer et al., 2006).**

Over the last 2 weeks, how often have you been bothered by the following problems?

| | Not at all | Several days | More than half the days | Nearly every day |
|---|---|---|---|---|
| 1. Feeling nervous, anxious or on edge | 0 | 1 | 2 | 3 |
| 2. Not being able to stop or control worrying | 0 | 1 | 2 | 3 |
| 3. Worrying too much about different things | 0 | 1 | 2 | 3 |
| 4. Trouble relaxing | 0 | 1 | 2 | 3 |
| 5. Being so restless that it is hard to sit still 0 1 | 0 | 1 | 2 | 3 |
| 6. Becoming easily annoyed or irritable | 0 | 1 | 2 | 3 |
| 7. Feeling afraid as if something awful might happen Not at all. | 0 | 1 | 2 | 3 |

**Appendix E**

**Warwick-Edinburgh Mental Wellbeing Scale (Tennant et al., 2007).**

| STATEMENTS | None of the time | Rarely | Some of the time | Often | All of the time |
|---|---|---|---|---|---|
| I've been feeling optimistic about the future | 1 | 2 | 3 | 4 | 5 |
| I've been useful | 1 | 2 | 3 | 4 | 5 |
| I've been feeling relaxed | 1 | 2 | 3 | 4 | 5 |
| I've had energy to spare | 1 | 2 | 3 | 4 | 5 |
| I've been dealing with problems well | 1 | 2 | 3 | 4 | 5 |
| I've been thinking clearly | 1 | 2 | 3 | 4 | 5 |
| I've been feeling good about myself | 1 | 2 | 3 | 4 | 5 |
| I've been feeling close to other people | 1 | 2 | 3 | 4 | 5 |
| I've been feeling confident | 1 | 2 | 3 | 4 | 5 |
| I've been able to make up my own mind about things | 1 | 2 | 3 | 4 | 5 |
| I've been feeling loved | 1 | 2 | 3 | 4 | 5 |
| I've been interested in things | 1 | 2 | 3 | 4 | 5 |
| I've been feeling cheerful | 1 | 2 | 3 | 4 | 5 |

Warwick–Edinburgh Mental Well-being Scale (WEMWBS)

**Appendix F**

**Perceived Stress Scale (Cohen et al., 1983)**

**The questions in this scale ask you about your feelings and thoughts** during the last month/last two weeks**. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.**

**0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often**

| | | | | | |
|---|---|---|---|---|---|
| In the last month, how often have you been upset because of something that happened unexpectedly? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you felt that you were unable to control the important things in your life? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you felt nervous and "stressed"? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you felt confident about your ability to handle your personal problems? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you felt that things were going your way? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you found that you could not cope with all the things that you had to do? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you been able to control irritations in your life? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you felt that you were on top of things? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you been angered because of things that were outside of your control? | 0 | 1 | 2 | 3 | 4 |
| In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? | | | | | |

**Appendix G**

**Nature Connection Index (Richardson et al., 2019).**

The following questions are about you and nature. By nature we mean all types of natural environment and all the plants and animals living in them. Nature can be close to where you live in towns; the countryside or wilderness areas further away.

**Please tell us how often you agree with each of the following statements, by putting a tick in the relevant box.**

By nature I mean all different types of natural environment and the things that live in them. It can be close to where you live or further away, and includes green spaces in towns and cities (such as your own and other people's gardens, parks, playing fields and allotments); the countryside (such as farmland, woodland, hills and mountains); and watery places (such as streams, canals, rivers, lakes, the coast and the sea.)

| | Completely Disagree | Strongly Disagree | Disagree | Neither agree or disagree | Agree | Strongly Agree | Completely Agree |
|---|---|---|---|---|---|---|---|
| **1. I always find beauty in nature** | | | | | | | |
| **2. I always treat nature with respect** | | | | | | | |
| **3. Being in nature makes me very happy** | | | | | | | |
| **4. Spending time in nature is very important to me** | | | | | | | |
| **5. I find being in nature really amazing** | | | | | | | |
| **6. I feel part of nature** | | | | | | | |

**Appendix H**

**Child and Adolescent Mindfulness Measure (Greco et al., 2011).**

| | *Never True* | *Rarely True* | *Sometimes True* | *Often True* | *Always True* |
|---|---|---|---|---|---|
| 1. I get upset with myself for having feelings that don't make sense. | *0* | *1* | *2* | *3* | *4* |
| 2. At school, I walk from class to class without noticing what I'm doing. | *0* | *1* | *2* | *3* | *4* |
| 3. I keep myself busy so I don't notice my thoughts or feelings. | *0* | *1* | *2* | *3* | *4* |
| 4. I tell myself that I shouldn't feel the way I'm feeling. | *0* | *1* | *2* | *3* | *4* |
| 5. I push away thoughts that I don't like. | *0* | *1* | *2* | *3* | *4* |
| 6. It's hard for me to pay attention to only one thing at a time. | *0* | *1* | *2* | *3* | *4* |
| 7. I get upset with myself for having certain thoughts. | *0* | *1* | *2* | *3* | *4* |
| 8. I think about things that have happened in the past instead of thinking about things that are happening right now. | *0* | *1* | *2* | *3* | *4* |
| 9. I think that some of my feelings are bad and that I shouldn't have them. | *0* | *1* | *2* | *3* | *4* |
| 10. I stop myself from having feelings that I don't like. | *0* | *1* | *2* | *3* | *4* |

**Appendix I**

**Ruminative Response Scale-Short Form (Treynor et al., 2003).**

Please read each of the items below and indicate whether you almost never, sometimes, often, or almost always think or do each one when you feel down, sad, or depressed. Please indicate what you *generally* do, not what you think you should do.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| almost never | sometimes | often | almost always |

1. Think “What am I doing to deserve this?”
2. Analyse recent events to try to understand why you are sad/depressed
3. Think “Why do I always react this way?”
4. Go away by yourself and think about why you feel this way
5. Write down what you are thinking about and analyse it
6. Think about a recent situation, wishing it had gone better
7. Think “Why do I have problems other people don’t have?”
8. Think “Why can’t I handle things better?”
9. Analyse your personality to try to understand why you are depressed
10. Go someplace alone to think about your feelings

**Appendix J**

**Shortened Rosenburg Self-Esteem Scale (Tambs & Røysamb, 2014)**

Please read each statement and record a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past two weeks. There are no right or wrong answers. Do not spend too much time on any one statement.

0 = strongly disagree 1= disagree 2= agree 3= strongly agree

I take a positive attitude towards myself
I certainly feel useless at times
I feel I do not have much to be proud of
I feel that I am a person of worth, at lease on an equal plane with others

**Appendix K**

**Physical Activity Questionnaire for Adolescents (Kowalski et al., 2004)**

We are trying to find out about your level of physical activity from **the last 7 days (in the last week)** .

This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like skipping, running, climbing, and others.

There are no right and wrong answers — this is not a test.

Please answer all the questions as honestly and accurately as you can — this is very important.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)?

If yes, how many times? (Mark only one answer.)

| | No | 1-2 | 3-4 | 5-6 | 7+ |
|---|---|---|---|---|---|
| a. Skipping | | | | | |
| b. Rowing/Canoeing | | | | | |
| c. Rollerskating | | | | | |
| d. Tag | | | | | |
| e. Walking for Exercise | | | | | |
| f. Cycling | | | | | |
| g. Jogging or Running | | | | | |
| h. Aerobics | | | | | |
| i. Swimming | | | | | |
| j. Baseball/Softball/Rounders | | | | | |
| k. Dance | | | | | |
| l. Football | | | | | |
| m. Badminton | | | | | |
| n. Skateboarding | | | | | |
| o. Rugby | | | | | |
| p. Lacrose | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| q. Volleyball | | | | | |
| r. Hockey | | | | | |
| s. Basketball | | | | | |
| t. Ice Skating | | | | | |
| v. Tennis | | | | | |
| Other (please specify) | | | | | |

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

I don't do PE
Hardly ever
Sometimes
Quite often
Always

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Check one only.)

Sat down (talking/ reading/ doing schoolwork)
Stood around or walked around
Ran or played a little bit
Ran around and played quite a bit
Ran and played hard most of the time

4. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only.)

None
1 time last week
2 or 3 times last week
4 times last week
5 times last week

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)

None
1 time last week
2 or 3 times last week
4 or 5 last week
6 or 7 times last week

6. On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)

None
1 time
2 — 3 times
4 — 5 times
6 or more times

7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

a. All or most of my free time was spent doing things that involve little physical effort
b. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports/went running/swimming/bike riding/did aerobics)
c. I often (3 — 4 times last week) did physical things in my free time
d. I quite often (5 — 6 times last week) did physical things in my free time
e. I very often (7 or more times last week) did physical things in my free time

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

| | None | A Little Bit | Medium | Often | Very Often |
|---|---|---|---|---|---|
| Monday | | | | | |
| Tuesday | | | | | |
| Wednesday | | | | | |
| Thursday | | | | | |
| Friday | | | | | |
| Saturday | | | | | |
| Sunday | | | | | |

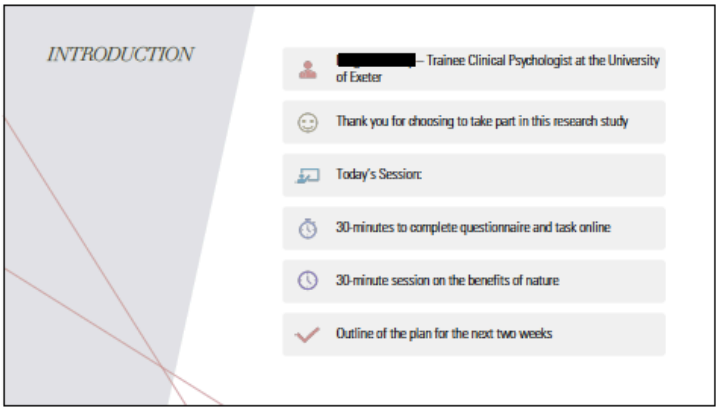
9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes
No

**Appendix L**

**Psychoeducation Session**


1




2

## GETTING THE MOST OUT OF TODAY

Microphones off please

Raising your hand to ask questions or if you see the hands up sign next to a question

Interactive as possible

3

## FOR TAKING PART...

- 4 Course Credits on SONA or £5 amazon voucher
- Entry into a prize draw for one of 3 x £50 Amazon Vouchers

Prize draw will take place in September 2021

4

2/25/22

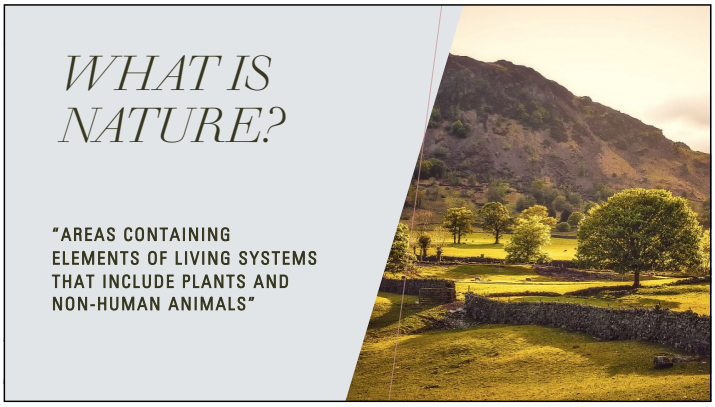

QUESTIONNAIRE AND TASK
GORILLA LINK
www.gorilla.sc

5

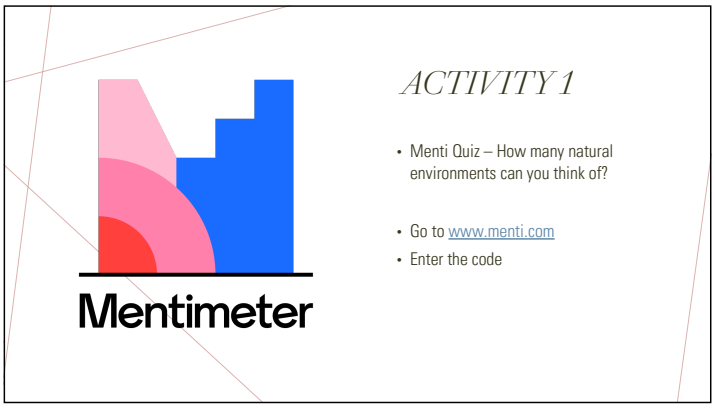

WHAT AM I HEAR TO TALK ABOUT?
Benefits of being in nature
Why is it important?
• Research shows it is good for our health and wellbeing
• There are lots of ways in which it helps!

6

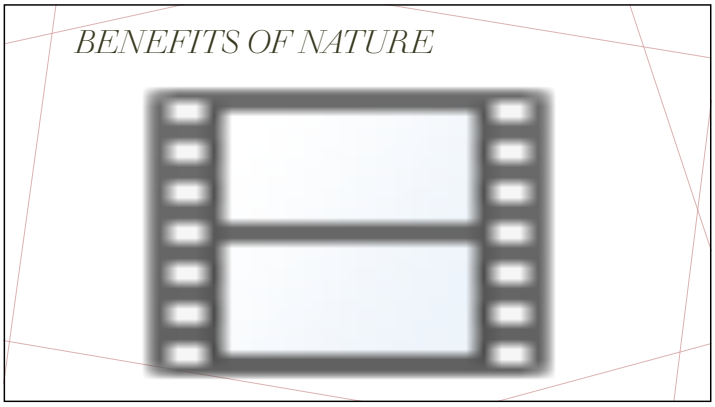
2/25/22


WHAT IS NATURE?
"AREAS CONTAINING ELEMENTS OF LIVING SYSTEMS THAT INCLUDE PLANTS AND NON-HUMAN ANIMALS"

7


Mentimeter
ACTIVITY 1
• Menti Quiz – How many natural environments can you think of?
• Go to www.menti.com
• Enter the code

8




9


10

## *BIOPHILIA*

"Love of Living Systems"

A basic human need to be in nature

Humans function well in response to natural environments as an adaptive response

11

## *RECOVERY FROM STRESS*

- Fight or Flight response
  - Hands up if you've heard of it?
- Body's response to fear
- Caveman faced with a predator would have either had to 1) Flee the situation

Or 2) Attempt to fight it

12

2/25/22

## *MODERN TIMES...*

- Fight or flight response goes off when there is a threat
- Its like a smoke detector, warning us to danger

It has become oversensitised, like going off every time we burn toast!

But its very important as it "prepares us for action"

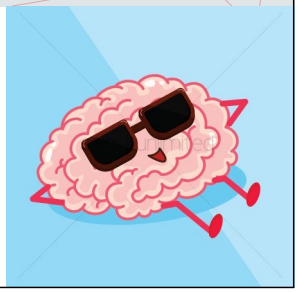
13

## *NATURE ON STRESS*

Impact of fight or flight response on our body

Being in nature can help us to recover from this response quicker by having the opposite effect

It can also cause a shift towards a positive emotional state



14

2/25/22

## ATTENTION

Nature helps to improve our attention

Engages our 'involuntary attention' as we pay attention in a less effortful way

Allows for our 'directed attention' resources to be replenished meaning that we can pay better attention to things

15

## GETTING THE MOST OUT OF NATURE

- Immerse ourselves so that we can really experience it
- Easiest way is to use our senses
- Identifying the types of nature around you

What can you:


Hear


Smell


See

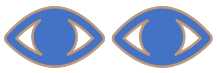

Touch

16

## *ACTIVITY 2*

Pay attention to your current environment

1) What can you see?
2) What can you hear? (close your eyes if you can)
3) What can you touch?
4) What can you smell?



17

## *HOW TO DO THIS IN NATURE*

- What kinds of nature can you see? What does the ground look like beneath you? What colours are there?
- Can you identify any sounds in nature? Are they near or far away?
- Carefully touch something (that isn't poisonous!) – how does it feel? How would you describe it to someone?
- What does the floor feel like beneath your feet?
- What can you smell outside?

18

2/25/22

## ACTIVITY 3- NATURE VIDEO

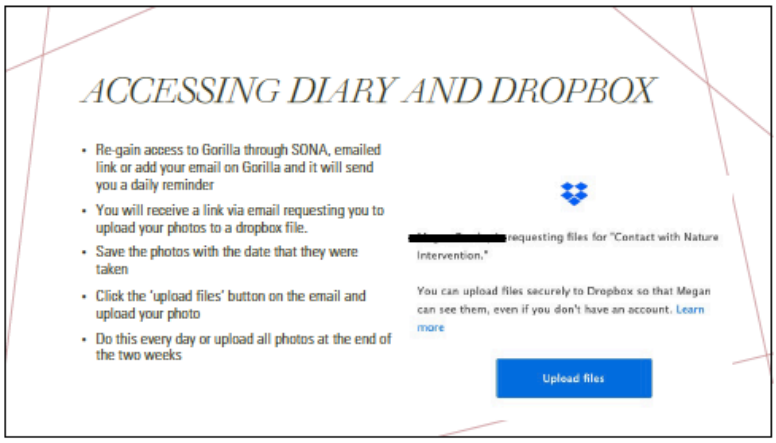
https://www.youtube.com/watch?v=478TeAxm12g&ab_channel=4KRelaxationChannel

19

## PLAN FOR THE NEXT TWO WEEKS

- Spend as much time in nature as you can for the next two weeks
  - At least 120 minutes across the week
  - Minimum 30 minutes
  - Take a photo of your environment!
- Each day complete the daily diary and upload photo to drop box.
- At the end of the two week's you will be sent a link to complete the questionnaires and task again
- You will be asked to do the same four weeks later

20


ACCESSING DIARY AND DROPBOX
• Re-gain access to Gorilla through SONA, emailed link or add your email on Gorilla and it will send you a daily reminder
• You will receive a link via email requesting you to upload your photos to a dropbox file.
• Save the photos with the date that they were taken
• Click the 'upload files' button on the email and upload your photo
• Do this every day or upload all photos at the end of the two weeks
[redacted] requesting files for "Contact with Nature Intervention."
You can upload files securely to Dropbox so that Megan can see them, even if you don't have an account. Learn more
Upload files

21


ANY QUESTIONS?

22

**Appendix M**

**Daily Diary**

**Nature Contact**

1. Have you been out in nature today? (By nature we mean all types of natural environment, nature can be close to where you live in towns; the countryside or wilderness areas further away).

Yes ☐ No ☐

If yes:

a. Describe where you went (e.g. park, river)

b. How long did you spend there (minutes)?

c. Did you go on your own or with someone else?

Own ☐ Someone Else ☐

d. If someone else who did you go with?

_____

**Sleep:**

2. At what time did you go to bed last night? _____
3. After settling down, how long did it take you to fall asleep? _____
4. After falling asleep, about how many times did you wake up in the night? _____
5. After falling asleep, for how long were you awake during the night in total? _____
6. At what time did you finally wake up? _____
7. At what time did you get up? _____
8. How would you rate the quality of your sleep last night?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Very Poor | | | | Very Good |

**Appendix N**

**Demographics Questionnaire**

Study ID:

Information About You

1.
Date of birth __ / __ / ____ (dd/mm/yyyy)

2.
What is your gender?

☐ Female
☐ Male
☐ Non-Binary
☐ Other _____

3. How would you describe your ethnic origin?

☐ White ☐ Mixed or multiple ethnic groups ☐ Asian or Asian British
☐ Black, African, Caribbean or Black British ☐ Other ethnic group

4.
What school year are you in?

☐ Year 9 ☐ Year 10 ☐ Year 11

5.
Have you got any current mental health disorders that you have been diagnosed with by a professional or medical doctor.

□a Depression
□b Bipolar disorder (manic depression)
□c Schizophrenia or psychosis
□d Eating disorder
□e Generalised Anxiety disorder
□f Panic disorder
□g Obsessive compulsive disorder
□h Post traumatic stress disorder
□i Phobia
□j ADD/ADHD
□k Personality disorder
□n Other, namely: [ ]
□o None of these disorders

6. Are you currently receiving psychological treatment for any of the above?

☐ Yes ☐ No

7. Do you **currently** suffer from any medical problems which require treatment or affect your daily life?

☐ Yes ☐ No

**If yes**, please specify diagnosis, age at diagnosis _____

8.
Do you own a dog?

☐ Yes ☐ No

## Appendix O

## Ethics Application Letter of Approval

Application ID: **eCLESPsy002003 v4.2**
Title: **Contact with nature as a lifestyle intervention in adolescents with depressive symptomology.**

cation has been reviewed by the CLES Psychology Ethics Committee.

The outcome of the decision is: **Favourable**

**Potential Outcomes**

| | |
|---|---|
| ***Favourable:*** | The application has been granted ethical approval by the Committee. The application will be flagged as Closed in the system. To view it again, please select 'view completed'. |
| ***Favourable, with conditions:*** | The application has been granted ethical approval by the Committee **conditional** on certain conditions being met. Please log in to your application (click 'view completed') to view these conditions in the Comments tab. You do not need to resubmit. |
| ***Provisional:*** | You have **not** been granted ethical approval. The application needs to be amended in light of the Committee's comments and re-submitted for Ethical review. |
| ***Unfavourable:*** | You have **not** been granted ethical approval. The application has been **rejected** by the Committee. The application needs to be amended in light of the Committee's comments and resubmitted / or you need to complete a new application. |

Please view your application here and respond to comments as required. You can download your outcome letter by clicking on the 'PDF' button on your eEthics Dashboard.

If you have any queries please contact the CLES Psychology Ethics Chair:
**Nick Moberly** n.j.moberly@exeter.ac.uk

Kind regards,
CLES Psychology Ethics

**Appendix P**

**Participant Pack**

## Participant Information Sheet for Participants age 14 to 18

**Participant Information Sheet**

**Title of Project:** Contact with nature as a lifestyle intervention in young people.
**Researcher name:** xxxxxxxxxxx

**Invitation and brief summary:**
Thank you for your interest in this study. The current study will test whether education about the benefits of being in nature and spending time outside can be used to help your overall wellbeing and functioning if you are experiencing symptoms of low mood. Please take time to consider the information carefully and to discuss it with family or friends if you wish, or to ask the researcher questions. In order to participate in this study you will also need consent from your parent or guardian if you are under age 16.

**Purpose of the research:**
This research is looking into new ways of supporting the wellbeing of adolescents who are experiencing symptoms of low mood. We know that helping people to carry out positive lifestyle behaviours can be helpful for improving overall wellbeing and being in nature is one example of a positive behaviour that is thought to be beneficial in keeping us well. However, we do not yet know exactly how, or the reasons why, nature has such good effects on wellbeing. In addition we don't know whether the effect is different for young people who are currently experiencing low mood. In this

research, we provide brief education about how contact with nature may help you in keeping well, and encourage you to spend more time in contact with nature. This will allow us to see whether spending more time in nature is beneficial and to explore the reasons why this might be.

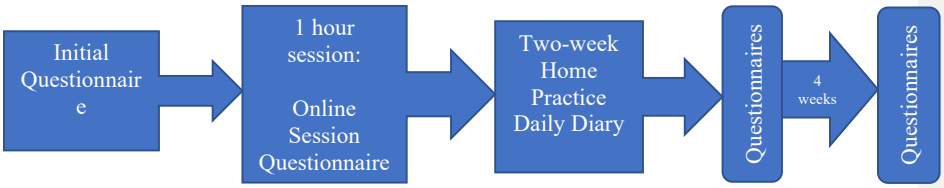
**Why have I been asked to take part?**

You have been asked to help with this research as your school have agreed to help us in finding young people willing to take part. This does not mean you have to do it, it is entirely your decision.

**What would taking part involve?**

If you wish to take part in this study you will need to sign and return the consent form and provide your contact address, phone number and GP details. If you are under 16 you parent/guardian will need to sign a consent form as well.

You will then be asked to complete a screening questionnaire about your mood and a demographic questionnaire (questions about age, race, health status etc). If you are able to take part you will then be put into one of two groups at random (in a process that is like flipping a coin). One group will complete a virtual education session on Microsoft Teams and will be asked to complete questionnaires at the start, a brief daily diary for two weeks, questionnaires at the end of two weeks and one more time after a further four weeks. The education session will last 1 hour, with time to complete the questionnaires. During the two week period you will be asked to go out in nature as much as you can (for at least 30 minutes a week). The second group will be asked to complete questionnaires over the same time period. All questionnaires will be completed online.




**What are the possible benefits of taking part?**

Whilst we cannot promise any specific benefits from taking part in the study, it may be a chance for you to learn more about the benefits of nature. Taking part will also help to further understand how nature can help with our wellbeing. This will make an important contribution to the study of science and to help others in future. To say thank you for taking part you will also receive a £5 amazon voucher for your time.

**What are the possible disadvantages and risks of taking part?**

As part of the study, you will be asked some questions about your mood, feelings and behaviours. Whilst is unlikely that this will upset you, some of these questions might be sensitive or difficult to answer. We always say that you do not have to answer any questions if you do not wish, and if you

were to feel upset we will be able to give you information on sources of support online/in your community. If we feel that further support might be helpful for you after completing the questionnaires, we will contact you and give you all right information. If at any point we are worried about your wellbeing or safety from others, we may need to contact your GP, your school or your parents. This is so we can help you and make sure you get the right help. We will always try and speak with you before we do this.

**What will happen if I don't want to carry on with the study?**
If you don't wish to continue with the study you can stop taking part at any time, without having to give a reason. To do this you will need to contact the researcher using the details below.

**Can I withdraw my data?**
Your study data will be anonymised before it is analysed for research reports. If you choose to end the study early you can also ask that your data (i.e. questionnaire answers) be destroyed. You can also choose to withdraw your data once you have completed the study up until the end of December 2021. After this time it cannot be withdrawn from the results of the study. To withdraw your data you will need to contact the researcher using the details below.

**How will my information be kept confidential?**
The University of Exeter processes personal data for the purposes of carrying out research in the public interest. The University tries to be transparent (clear) about how your personal data is used and this information sheet should provide a clear explanation of this. If you do have any queries about the University's processing of your personal data that cannot be resolved by the research team, further information may be obtained from the University's Data Protection Officer by emailing dataprotection@exeter.ac.uk or at www.exeter.ac.uk/dataprotection
Data will be collected using online questionnaires which will be anonymised and only identifiable by a unique code. This code will be linked to your personal data so that we are able to contact you with any concerns. Data that identifies you will be stored on a secure server, password protected and separate to study data. It will only be accessible by myself and my research supervisors. Data will be kept for 3 years after the research has taken place and then it will be destroyed.

There may be times when we have to break confidentiality. This would be if we were concerned about your mood or your safety. In these cases we would want to help by contacting your GP to make sure you are offered the right support. We may also pass this information onto your school so that you are able to get additional support and we may inform your parents (if you are under 16) of our concerns and that we have contacted your GP. In these instances we will always try and speak to you before we do, unless we have immediate concerns.

**Will I receive any payment for taking part?**

To say thank-you for taking part in this study you will receive a £5 amazon voucher. Everyone who completes all of the study will also be entered into a prize draw for a chance to win one of three £50 amazon vouchers. The prize draw will take place in July 2021 and winners will be selected at random.

**What will happen to the results of this study?**

Once the data has been analysed, we intend to publish the results in an academic journal. Our reports use data without any personal identifiable information attached and typically focuses on group differences (e.g. the contact with nature group vs education as usual). You will not be named in this.

**Who is organising and funding this study?**

The study is being carried out by Megan Rowley, Trainee Clinical Psychologist for a research thesis as part of a Doctorate in Clinical Psychology at the University of Exeter. This work is being completed under the supervision of Dr Matthew Owens-Solari. Allocation of research funds will be provided by The Postgraduate Research Training Support Grant (RTSG).

**Who has reviewed this study?**

This project has been reviewed by the Psychology Research Ethics Committee at the University of Exeter eCLESPsy002003 v4.2.

**Further information and contact details**

If you have further information or wish to take part. Please contact the researcher on the details below:

xxxxxxxxxxx

*If you are not happy with any aspect of the project and wish to complain, please contact either:*

Xxxxxxxxxxx Research Supervisor

*Or Department of Ethics or Ethics Committee Chair:*

Dr Nick Moberly, Chair of Psychology Ethics Committee

N.J.Moberly@exeter.ac.uk

Gail Seymour, Research Ethics and Governance Manager

g.m.seymour@exeter.ac.uk, 01392 726621

Thank you for your interest in this project.

## Parent and Guardian Information Sheet for Parents of Participants 14-16 Years of Age

**Parent and Guardian Information Sheet**

**Title of Project:** Contact with nature as a lifestyle intervention in young people.
**Researcher name:** xxxxxxxxxxx

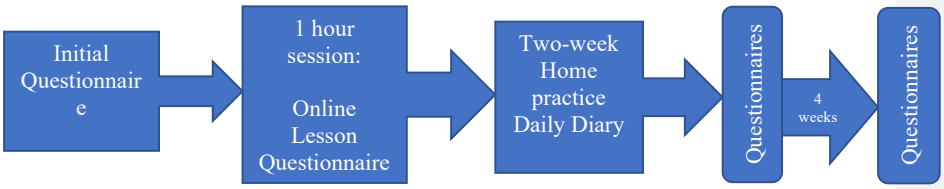
**Brief summary:**
The current study aims to offer education about the benefits of being in nature and explore whether being in nature can be used to help overall wellbeing and functioning in adolescents experiencing any symptoms of low mood. If you child is under the age of 16, they will also need your consent to participate.

**Purpose of the research:**
This research is looking into novel ways of supporting the wellbeing of adolescents who are experiencing symptoms of low mood. We know that helping people to carry out positive lifestyle behaviours can be helpful for improving overall wellbeing and being in nature is one example of a positive behaviour that is thought to be beneficial in keeping us well. However, we do not yet know exactly how, or the reasons why, nature has such good effects on wellbeing. In addition we don't know whether the effect is different for young people who are currently experiencing low mood. In this research, we provide brief education about how contact with nature may help adolescents in keeping well, and encourage them to spend more time in contact with nature. This will allow us to see whether spending more time in nature is beneficial and to explore the reasons why this might be.

**Why has my child been approached and do they have to take part?**
Your child has been approached for this research as their school (name of school) have agreed to help us in finding adolescents willing to take part. It is completely up to your child whether they wish to participate in this study, it is entirely voluntary. This decision to take part or not will have no implication on their academic career.

**What would happen to my child agrees to take part?**

If your child agrees to join, you and he/she will be asked to sign a consent form and provide their contact details, phone number and GP details. They will be asked to complete an initial questionnaire about their mood to identify if they are eligible to participate. If able to participate your child will be randomly assigned to one of two groups (like tossing a coin). One group will complete an online education session on Microsoft Teams and will be asked to complete questionnaires at the start, a brief daily diary for two weeks, questionnaires at the end of two weeks and one more time after a further four weeks. The education session will last one hour, including time to complete the questionnaires. During the two-week period they will be asked to go out in nature as much as possible (for at least 30 minutes a week). The second group will be asked to complete questionnaires over the same time period. All questionnaires will be completed online.




**What will be my involvement?**

If your child is under 16, you will need to agree that he/she can take part in the study. If you have any questions you can contact the researcher on the details at the end of this form. We will run every aspect of the study and you don't need to participate.

**What are the possible benefits of taking part?**

Whilst we cannot promise any specific benefits from taking part in the study, it may be an opportunity for your child to learn more about the benefits of contact with nature. Your child's participation will also help to further understand the role of being in nature on wellbeing, making a valuable contribution to science. Our aim is that this research will help others in the future. To say thank you for their participation your child will receive a £5 Amazon voucher. On completion of the study they will also be entered into a prize draw for one of three £50 amazon vouchers which will take place in July 2021.

**What are the possible disadvantages and risks of taking part?**

As part of the study, your child will be asked some questions about your mood, feelings and behaviours. Whilst is unlikely that this will cause anyone distress some of these questions might be sensitive or difficult to answer. We always say that participants do not have to answer any questions if you do not wish. If your child were to feel upset at any point there will be information on how they can contact the researcher or support services online. If we feel that you or your child may benefit from further support after completing the questionnaires, we will contact yourself and your child and signpost them to other sources of support. This would likely involve us recommending that you make an appointment to see the GP about a referral to a specialist service. In the unlikely event that we

have any concerns about your child's safety, either to themselves or from others, we have a legal duty to report this the relevant service and to your child's GP. We may also contact their school to consider whether any additional support can be offered.

**What will happen if my child doesn't want to carry on with the study?**
If your child does not wish to continue with the study it is possible to stop taking part at any time, without having to give a reason. If your child wishes to withdraw they will need to contact the researcher using the details below.

**Can my child withdraw their data?**
If your child chooses to end the study early they can also ask that their data (i.e. questionnaire answers) be destroyed. They can also choose to withdraw their data once they have completed the study up until the end of December 2021. After this time it cannot be withdrawn from the results of the study. To withdraw their data you or your child will need to contact the researcher using the details below.

**How will the information be kept confidential?**
The University of Exeter processes personal data for the purposes of carrying out research in the public interest. The University will endeavor to be transparent about its processing of your personal data and this information sheet should provide a clear explanation of this. If you do have any queries about the University's processing of your personal data that cannot be resolved by the research team, further information may be obtained from the University's Data Protection Officer by emailing dataprotection@exeter.ac.uk or at www.exeter.ac.uk/dataprotection
Data will be collected using online questionnaires which will be anonymised and only identifiable by a unique code. This code will be linked to their personal data so that we are able to contact them or you with any concerns. Data that identifies yours and your child's name will be stored on a secure server, password protected and separate to study data. It will only be accessible by myself and my research supervisors. Data will be kept for 3 years after the research has taken place and then it will be destroyed.

There may be times when we have to break confidentiality. This would be if we were concerned about your child's levels of mood (high levels of distress) and/or if they disclose that they feel at risk of harm. In these cases we would want to help by contacting your child's GP to make sure they have the right support in place. We will contact you first in order to gain your consent for this. We may also contact your child's school to make people aware of our concerns and that we have contacted the GP. In these instances we will always try and speak to your child about who we wish to contact as well.

**What will happen to the results of this study?**
Once the data has been analysed, we intend to disseminate the results in an academic journal. Our reports use data without any personal identifiable information attached and typically focuses on group

differences (e.g. the contact with nature group vs education as usual). Your child will not be named in this.

**Who is organising and funding this study?**

The study is being carried out by Megan Rowley, Trainee Clinical Psychologist for a research thesis as part of a Doctorate in Clinical Psychology at the University of Exeter. This work is being completed under the supervision of Dr Matthew Owens-Solari. Allocation of research funds will be provided by The Postgraduate Research Training Support Grant (RTSG).

**Who has reviewed this study?**

This project has been reviewed by the Psychology Research Ethics Committee at the University of Exeter eCLESPsy002003 v4.2.

**Further information and contact details**

If you have further information or wish to take part. Please contact the researcher on the details below:
xxxxxxxxxxx

*If you are not happy with any aspect of the project and wish to complain, please contact either:*
Xxxxxxxxxxx Research Supervisor

*Or Department of Ethics or Ethics Committee Chair:*
Dr Nick Moberly, Chair of Psychology Ethics Committee
N.J.Moberly@exeter.ac.uk

Gail Seymour, Research Ethics and Governance Manager
g.m.seymour@exeter.ac.uk, 01392 726621

Thank you for your interest in this project and taking time to consider your child taking part.

## Participant Information Sheet for Participants 18 to 24 Years of Age

**Participant Information Sheet**

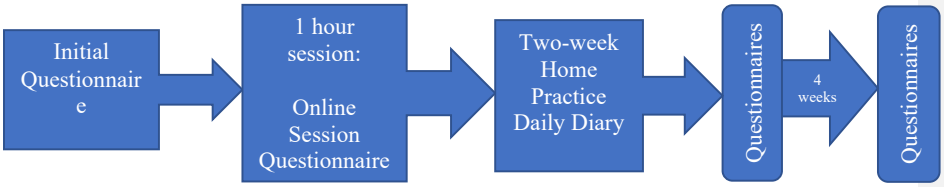
**Title of Project:** Contact with nature as a lifestyle intervention in young people
**Researcher name:** xxxxxxxxxxx

**Invitation and brief summary:**
Thank you for your interest in this study. The current study will test whether education about the benefits of being in nature and spending time outside can be used to help your overall wellbeing and functioning if you are experiencing symptoms of low mood. Please take time to consider the information carefully, or to ask the researcher questions.

**Purpose of the research:**
This research is looking into new ways of supporting the wellbeing of adolescents who are experiencing any symptoms of low mood. We know that helping people to carry out positive lifestyle behaviours can be helpful for improving overall wellbeing and being in nature is one example of a positive behaviour that is thought to be beneficial in keeping us well. However, we do not yet know exactly how, or the reasons why, nature has such good effects on wellbeing. In addition we don't know whether the effect is different for young people who are currently experiencing low mood. In this research, we provide brief education about how contact with nature may help you in keeping well, and encourage you to spend more time in contact with nature. This will allow us to see whether spending more time in nature is beneficial and to explore the reasons why this might be.

**What would taking part involve?**
If you wish to take part in this study you will need to sign and return the consent form and provide your contact address, phone number and GP details.

You will then be asked to complete a screening questionnaire about your mood and a demographic questionnaire (questions about age, race, health status etc). If you are able to take part you will then be put into one of two groups at random. One group will complete a virtual education session on Microsoft Teams and will be asked to complete questionnaires at the start, a brief daily diary for two weeks, questionnaires at the end of two weeks and one more time after a further four weeks. The education session will last 1 hour, with time to complete the questionnaires. During the two-week period you will be asked to go out in nature as much as you can (for at least 30 minutes a week). The second group will be asked to complete questionnaires over the same time period. All questionnaires will be completed online.




**What are the possible benefits of taking part?**

Whilst we cannot promise any specific benefits from taking part in the study, it may be a chance for you to learn more about the benefits of nature. Taking part will also help to further understand how nature can help with our wellbeing. This will make an important contribution to the study of science and to help others in future.

**What are the possible disadvantages and risks of taking part?**

As part of the study, you will be asked some questions about your mood, feelings and behaviours. Whilst is unlikely that this will upset you, some of these questions might be sensitive or difficult to answer. We always say that you do not have to answer any questions if you do not wish, and if you were to feel upset we will be able to give you information on sources of support online/in your community. If we feel that further support might be helpful for you after completing the questionnaires, we will contact you and give you all right information. If at any point we are worried about your wellbeing or safety from others, we may need to contact your GP. This is so we can help you and make sure you get the right help. We will always try and speak with you before we do this.

**What will happen if I don't want to carry on with the study?**

If you don't wish to continue with the study you can stop taking part at any time, without having to give a reason. To do this you will need to contact the researcher using the details below.

**Can I withdraw my data?**

Your study data will be anonymised before it is analysed for research reports. If you choose to end the study early you can also ask that your data (i.e. questionnaire answers) be destroyed. You can

also choose to withdraw your data once you have completed the study up until the end of December 2021. After this time it cannot be withdrawn from the results of the study. To withdraw your data you will need to contact the researcher using the details below.

**How will my information be kept confidential?**

The University of Exeter processes personal data for the purposes of carrying out research in the public interest. The University tries to be transparent (clear) about how your personal data is used and this information sheet should provide a clear explanation of this. If you do have any queries about the University's processing of your personal data that cannot be resolved by the research team, further information may be obtained from the University's Data Protection Officer by emailing dataprotection@exeter.ac.uk or at www.exeter.ac.uk/dataprotection

Data will be collected using online questionnaires which will be anonymised and only identifiable by a unique code. This code will be linked to your personal data so that we are able to contact you with any concerns. Data that identifies you will be stored on a secure server, password protected and separate to study data. It will only be accessible by myself and my research supervisors. Data will be kept for 3 years after the research has taken place and then it will be destroyed.

There may be times when we have to break confidentiality. This would be if we were concerned about your mood or your safety. In these cases we would want to help by contacting your GP to make sure you are offered the right support. In this instance we will always try and speak to you before we do, unless we have immediate concerns.

**Will I receive any payment for taking part?**

To say thank-you for taking part in this study you will receive a £5 amazon voucher. Everyone who completes all of the study will also be entered into a prize draw for a chance to win one of three £50 amazon vouchers. The prize draw will take place in July 2021 and winners will be selected at random.

**What will happen to the results of this study?**

Once the data has been analysed, we intend to publish the results in an academic journal. Our reports use data without any personal identifiable information attached and typically focuses on group differences (e.g. the contact with nature group vs education as usual). You will not be named in this.

**Who is organising and funding this study?**

The study is being carried out by Megan Rowley, Trainee Clinical Psychologist for a research thesis as part of a Doctorate in Clinical Psychology at the University of Exeter. This work is being completed under the supervision of Dr Matthew Owens-Solari. Allocation of research funds will be provided by The Postgraduate Research Training Support Grant (RTSG).

**Who has reviewed this study?**

This project has been reviewed by the Psychology Research Ethics Committee at the University of Exeter (eCLESPsy002003 v4.2)

**Further information and contact details**

If you have further information or wish to take part. Please contact the researcher on the details below:

xxxxxxxxxxx

*If you are not happy with any aspect of the project and wish to complain, please contact either:*

xxxxxxxxxxx

Research Supervisor

*Or Department of Ethics or Ethics Committee Chair:*

Dr Nick Moberly, Chair of Psychology Ethics Committee

N.J.Moberly@exeter.ac.uk

Gail Seymour, Research Ethics and Governance Manager

g.m.seymour@exeter.ac.uk, 01392 726621

Thank you for your interest in this project.

NATURE AND MENTAL WELLBEING IN ADOLESCENCE

**Participant Consent Form**

**CONSENT FORM**

**Title of Project:** Contact with nature as a lifestyle intervention in adolescents.

**Name of Researcher:** xxxxxxxxxxx

Please read statements and **initial box** (right click and select "add text")

1. I confirm that I have read the information sheet dated 05/02/21 version 3 for the above project. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my legal rights being affected. ☐
3. I understand that relevant sections of the data collected during the study may be looked at by members of the research team, individuals from the University of Exeter, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my data. ☐
4. I understand that anonymised questionnaire responses used for the purpose of the study data may be published at the end of the study but will not identify me as an individual. ☐
5. I understand that information may be passed onto my GP, school or parents (if under age 16) if there are immediate concerns about my safety or the safety of others. ☐
6. I agree to take part in the above project. ☐

Please initial the boxes above and sign your name below using an electronic signature if possible:

| Name of Participant | Date | Signature |
|---|---|---|

**Please Turn Over**

**Your Contact Details**

Contact address……

……Postcode ……

Email Address ……

Home phone …… Mobile phone ……

GP Name and Surgery: ……

How would you like us to contact you?

(To tick the box please double click the grey box, select default value as ticked, then select ok)

☐ **Email** ☐**Home Phone** ☐**Mobile Phone**

***For completion by the researcher***

| | | |
|---|---|---|
| Name of Researcher | Date | Signature |

*When completed: 1 copy for participant; 1 copy for researcher/project file*

## Parent and Guardian Consent Form for Parents of Participants 14 to 16 Years of Age

**PARENTAL/LEGAL GUARDIAN* CONSENT FORM**

**Title of Project:** Contact with nature as a lifestyle intervention in adolescents.

**Name of Researcher:** xxxxxxxxxxx

Please read statements and **initial box** (right click and select "add text")

**Consent for your child's participation:**

1. I confirm that I have read the information sheet dated 05/02/21 Version 3 for the above project and agree that the researchers can contact me and my child to be invited to take part in the research study. ☐

2. I understand that my child's data will be anonymised and will not be able to be identified but will be accessible by members of the research team, and individuals from the University of Exeter where it is relevant. ☐

3. I understand that my details will be kept secure in a locked location and only accessible by members of the research team. ☐

4. I understand that the researcher may need to contact the family GP if my child is reporting high levels of depression or anxiety, but that the researcher will contact me to discuss this first. ☐

If you agree to you and your child being contacted, please initial the boxes above and sign your name below using an electronic signature if possible:

Title:…… Name: ……

Relationship to volunteer ……

Signed…… Date ……./……../…

*** This form must be signed by a parent/legal guardian- someone who are has legal responsibility to look after the volunteer. It cannot be signed by any other relative unless they are formally recognised as the child's legal guardian.**

**Please Turn Over**

**Your Contact Details**

Contact address……

……Postcode ……..

Email Address ……

Home phone …… Mobile phone ……..

How would you like us to contact you?

(To tick the box please double click the grey box, select default value as ticked, then select ok)

☐ **Email** ☐ **Home Phone** ☐ **Mobile Phone**

*When completed: 1 copy for participant; 1 copy for researcher/project file*

## Appendix Q

## List of Support Services

If you need further help or support, alongside contacting your GP, you can also contact:

| | |
|---|---|
| **Samaritans**<br>A safe place for you to talk any time you like, in your own way – about whatever's getting to you. | **Website:** www.samaritans.org<br>**Contact number:** 116 123 |
| **Childline**<br>Provides help for anyone under 19 in the UK with any issue they're going through. | **Website:** www.childline.org.uk<br>**Contact number: 0800 1111** |
| **Shout**<br>A free and confidential 24/7 text support service. | **Website:** www.giveusashout.org<br>**Text:** 85258 |
| **Young Minds**<br>Children and young people's mental health charity which provides lots of resources on mental health. | **Website:** www.youngminds.org.uk |
| **Kooth**<br>An online mental wellbeing community that provides free, safe and anonymous support | **Website:** www.kooth.com |
| **Ditch the Label**<br>Youth organisation offering support with mental health and bullying. | **Website:** https://www.ditchthelabel.org |

| | |
|---|---|
| **The Mix**<br>Free confidential helpline for under 25's who need help but don't know where to turn | **Website:** www.themix.org.uk<br><br>**Contact number:** 0808 808 4994 |

## Appendix R

## Participant Debrief Form

**Debrief Form**

**Title of Project:** Contact with nature as a lifestyle intervention in young people.

**Researcher name:** xxxxxxxxxxx

Thank you for taking part in this study.

This study aimed to understand whether an educational intervention on the benefits of nature and spending more time in nature was helpful for young people. Specifically, we are looking at the impact on mood, mental health and wellbeing. We also aimed to understand how the intervention is likely to help people and for whom/ under which conditions the intervention is likely to work.

Research suggests that nature can be helpful for multiple aspects of health, including mental health, wellbeing and stress. This is thought to be due to an evolutionary need to connect to nature, improving stress and improving our attention. However, many people do not know exactly how helpful nature is to wellbeing and less research has looked into this using young people.

We wanted to see whether the intervention led to improvements in mood and wellbeing and this was compared to those who did not do the intervention. Through the questionnaires and measures taken, we aimed to test any key mechanisms of change (how the intervention works) in line with the theories suggested above.

Your participation will help the understanding of the benefits of a nature intervention on mood and wellbeing, and they key mechanisms, which has received little research in the past. In turn, this knowledge may help to develop future treatments aimed at improving the mental health and wellbeing outcomes of young adults.

**Please turn over**

Any information you have provided during this study will be kept strictly confidential, for use only by the research team. If you have any questions about this study, please contact the research via email:

xxxxxxxxxxx
Trainee Clinical Psychologist

Further questions or concerns about the study can be addressed to the research supervisor or Chair of the Ethics Committee, School of Psychology, University of Exeter:

xxxxxxxxxxx
Research Supervisor
M.Owens-Solari@exeter.ac.uk

Dr Nicholas Moberly, Chair of Psychology Ethics Committee
N.J.Moberly@exeter.ac.uk

If taking part in this study has raised any concerns for you, or you find yourself feeling at all distressed as a result of participating in this study then we advise you to seek support your GP.

Alternatively, other sources of support include:

| | |
|---|---|
| SAMARITANS<br>**Samaritans**<br>A safe place for you to talk any time you like, in your own way – about whatever's getting to you. | **Website:** www.samaritans.org<br>**Contact number:** 116 123 |
| childline<br>**Childline**<br>Provides help for anyone under 19 in the UK with any issue they're going through. | **Website:** www.childline.org.uk<br>**Contact number: 0800 1111** |

| | |
|---|---|
| **Shout**<br>A free and confidential 24/7 text support service. | **Website:** www.giveusashout.org<br><br>**Text:** 85258 |
| **Young Minds**<br>Children and young people's mental health charity which provides lots of resources on mental health. | **Website:** www.youngminds.org.uk |
| **Kooth**<br>An online mental wellbeing community that provides free, safe and anonymous support | **Website:** www.kooth.com |
| **Ditch the Label**<br>Youth organisation offering support with mental health and bullying. | **Website:** https://www.ditchthelabel.org |
| **The Mix**<br>Free confidential helpline for under 25's who need help but don't know where to turn | **Website:** www.themix.org.uk<br><br>**Contact number:** 0808 808 4994 |

**Thank you again for taking part in this study.**

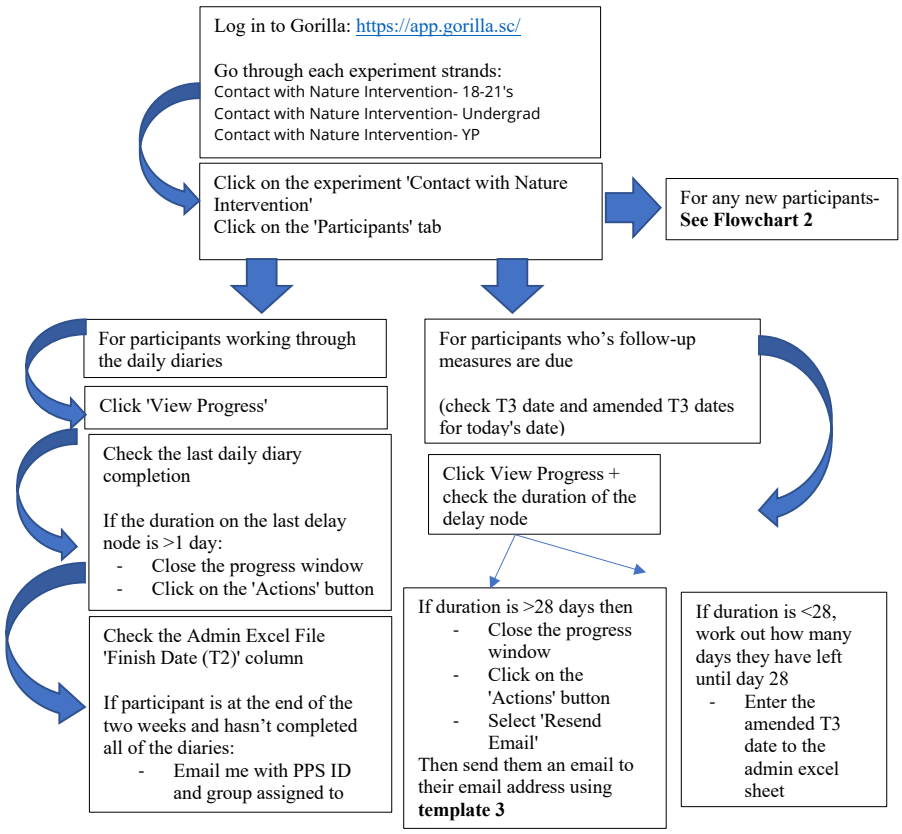
## Appendix S

## Use of Research Interns

To support the research, two third year psychology students volunteered as research interns. I worked closely with them in the recruitment and intervention stage, providing bi-weekly support and supervision. They were supported to aid recruitment through contacting schools which I provided a script for. They helped to identify when new participants had started the intervention and to monitor the flow of participants through the 2-week intervention on a daily basis. I developed flow charts (Figure R1) to ensure that a set process was followed and created a system that enabled us to keep track of participants and for the interns to flag up any participants who needed prompting to complete their daily diaries. I provided training in how to use the Gorilla platform and training on delivering the intervention. The interns were then able to deliver the intervention to control participants at the end of the study. Meetings were used to review tasks and support the interns with these, they also provided a space for us to discuss the research and the opportunity for the interns to ask any questions about the study, enabling them to develop an understanding of doctoral level research.

**Figure S1**

*Example Flow Chart to Support Research Interns with Monitoring of Participants*



**Appendix T**

**Dissemination Statement**

The study findings will be disseminated through journal publication, presentation and feedback to interested parties.

**Journal Publication.** The study will be submitted for publication in the International Journal of Environmental Research and Public Health. See Appendix T for a copy of the instructions for authors.

**Presentation.** On the 25th of April 2022, the study findings will be disseminated via a presentation to my cohort, for peer review, as part of the Doctorate in Clinical Psychology programme.

**Feedback.** Where participants and participating schools have informed me that they would like to receive the results of the study, feedback on the results will be provided.

**Appendix U**

**Copy of Instructions for Authors from the Intended Journal for Publication**

**International Journal of Environmental Research and Public Health**

Submission Checklist
Please:

1. read the **Aims & Scope** to gain an overview and assess if your manuscript is suitable for this journal;
2. use the **Microsoft Word template** or **LaTeX template** or **Free Format Submission** to prepare your manuscript;
3. make sure that issues about **publication ethics**, **research ethics**, **copyright**, **authorship**, **figure formats**, **data** and **references format** have been appropriately considered;
4. Ensure that all authors have approved the content of the submitted manuscript.
5. Authors are encouraged to add a **biography** (optional) to the submission and publish it.

Manuscript Submission Overview

Types of Publications

*IJERPH* has no restrictions on the length of manuscripts, provided that the text is concise and comprehensive. Full experimental details must be provided so that the results can be reproduced. *IJERPH* requires that authors publish all experimental controls and make full datasets available where possible (see the guidelines on **Supplementary Materials** and references to unpublished data).

Manuscripts submitted to *IJERPH* should neither be published previously nor be under consideration for publication in another journal. The main article types are as follows:

- *Articles:* Original research manuscripts. The journal considers all original research manuscripts provided that the work reports scientifically sound experiments and provides a substantial amount of new information. Authors should not unnecessarily divide their work into several related manuscripts, although short *Communications* of preliminary, but significant, results will be considered. The quality and impact of the study will be considered during peer review. Articles should have a main text of around 3000 words at minimum.
- *Reviews:* These provide concise and precise updates on the latest progress made in a given area of research. Systematic reviews should follow the PRISMA **guidelines.** The main text of review papers should be around 4000 words at minimum.
- *Case reports:* Case reports present detailed information on the symptoms, signs, diagnosis, treatment (including all types of interventions), and outcomes of an individual patient. Case reports usually describe new or uncommon conditions that serve to enhance medical care or highlight diagnostic approaches.

Submission Process

Manuscripts for *IJERPH* should be submitted online at **susy.mdpi.com**. The submitting author, who is generally the corresponding author, is responsible for the manuscript during the submission and peer-review process. The submitting author must ensure that all eligible co-authors have been included in the author list (read the **criteria to qualify for authorship**) and that they have all read and approved the submitted version of the manuscript. To submit your manuscript, register and log in to the **submission website**. Once you have registered, **click here to go to the submission form for *IJERPH***. All co-authors can see the manuscript details in the submission system, if they register and log in using the e-mail address provided during manuscript submission.

Accepted File Formats

Authors must use the **Microsoft Word template** or **LaTeX template** to prepare their manuscript. Using the template file will substantially shorten the time to complete copy-editing and publication of accepted manuscripts. The total amount of data for all files must not exceed 120 MB. If this is a problem, please contact the Editorial Office **ijerph@mdpi.com**. Accepted file formats are:

- *Microsoft Word:* Manuscripts prepared in Microsoft Word must be converted into a single file before submission. When preparing manuscripts in Microsoft Word, the ***IJERPH* Microsoft Word template file** must be used. Please insert your graphics (schemes, figures, *etc.*) in the main text after the paragraph of its first citation.
- *LaTeX:* Manuscripts prepared in LaTeX must be collated into one ZIP folder (including all source files and images, so that the Editorial Office can recompile the submitted PDF). When preparing manuscripts in LaTeX, please use the ***IJERPH* LaTeX template files**. You can now also use the online application **writeLaTeX** to submit articles directly to *IJERPH*. The MDPI LaTeX template file should be selected from the **writeLaTeX template gallery**.
- *Supplementary files:* May be any format, but it is recommended that you use common, non-proprietary formats where possible (see **below** for further details).

**Disclaimer: Usage of these templates is exclusively intended for submission to the journal for peer-review, and strictly limited to this purpose and it cannot be used for posting online on preprint servers or other websites.**

Free Format Submission

*IJERPH* now accepts free format submission:

- We do not have strict formatting requirements, but all manuscripts must contain the required sections: Author Information, Abstract, Keywords, Introduction, Materials & Methods, Results, Conclusions, Figures and Tables with Captions, Funding Information, Author Contributions, Conflict of Interest and other Ethics Statements. Check the Journal ***Instructions for Authors*** for more details.
- Your references may be in any style, provided that you use the consistent formatting throughout. It is essential to include author(s) name(s), journal or book title, article or chapter title (where required), year of publication, volume and issue (where appropriate) and pagination. DOI numbers (Digital Object Identifier) are not

mandatory but highly encouraged. The bibliography software package *EndNote*, ***Zotero***, *Mendeley*, *Reference Manager* are recommended.

- When your manuscript reaches the revision stage, you will be requested to format the manuscript according to the journal guidelines.

Cover Letter

A cover letter must be included with each manuscript submission. It should be concise and explain why the content of the paper is significant, placing the findings in the context of existing work. It should explain why the manuscript fits the scope of the journal.

Any prior submissions of the manuscript to MDPI journals must be acknowledged. If this is the case, it is strongly recommended that the previous manuscript ID is provided in the submission system, which will ease your current submission process. The names of proposed and excluded reviewers should be provided in the submission system, not in the cover letter.

All cover letters are required to include the statements:

- We confirm that neither the manuscript nor any parts of its content are currently under consideration or published in another journal.
- All authors have approved the manuscript and agree with its submission to (journal name).

Author Biography

Authors are encouraged to add a biography (maximum 150 words) to the submission and publish it. This should be a single paragraph and should contain the following points:

1. Authors' full names followed by current positions;
2. Education background including institution information and year of graduation (type and level of degree received);
3. Work experience;
4. Current and previous research interests;
5. Memberships of professional societies and awards received.

Note for Authors Funded by the National Institutes of Health (NIH)

This journal automatically deposits papers to PubMed Central after publication of an issue. Authors do not need to separately submit their papers through the NIH Manuscript Submission System (NIHMS, **http://nihms.nih.gov/**).

**[Return to top]**

## Manuscript Preparation

General Considerations

- **Research manuscripts** should comprise:
    - **Front matter**: Title, Author list, Affiliations, Abstract, Keywords
    - **Research manuscript sections**: Introduction, Materials and Methods, Results, Discussion, Conclusions.

  - **Back matter**: Supplementary Materials, Acknowledgments, Author Contributions, Conflicts of Interest, **References**.
- **Review manuscripts** should comprise the **front matter**, literature review sections and the **back matter**. The template file can also be used to prepare the front and back matter of your review manuscript. It is not necessary to follow the remaining structure. Structured reviews and meta-analyses should use the same structure as research articles and ensure they conform to the **PRISMA** guidelines.
- **Case reports** should include a succinct introduction about the general medical condition or relevant symptoms that will be discussed in the case report; the case presentation including all of the relevant de-identified demographic and descriptive information about the patient(s), and a description of the symptoms, diagnosis, treatment, and outcome; a discussion providing context and any necessary explanation of specific treatment decisions; a conclusion briefly outlining the take-home message and the lessons learned.
- **Graphical Abstract:**

  A graphical abstract (GA) is an image that appears alongside the text abstract in the Table of Contents. In addition to summarizing the content, it should represent the topic of the article in an attention-grabbing way. Moreover, it should not be exactly the same as the Figure in the paper or just a simple superposition of several subfigures. Note that the GA must be original and unpublished artwork. Any postage stamps, currency from any country, or trademarked items should not be included in it.

  The GA should be a high-quality illustration or diagram in any of the following formats: PNG, JPEG, TIFF, or SVG. Written text in a GA should be clear and easy to read, using one of the following fonts: Times, Arial, Courier, Helvetica, Ubuntu or Calibri.

  The minimum required size for the GA is 560 × 1100 pixels (height × width). The size should be of high quality in order to reproduce well.
- **Acronyms/Abbreviations/Initialisms** should be defined the first time they appear in each of three sections: the abstract; the main text; the first figure or table. When defined for the first time, the acronym/abbreviation/initialism should be added in parentheses after the written-out form.
- **SI Units** (International System of Units) should be used. Imperial, US customary and other units should be converted to SI units whenever possible.
- **Accession numbers** of RNA, DNA and protein sequences used in the manuscript should be provided in the Materials and Methods section. Also see the section on **Deposition of Sequences and of Expression Data**.
- **Equations:** If you are using Word, please use either the Microsoft Equation Editor or the MathType add-on. Equations should be editable by the editorial office and not appear in a picture format.
- **Research Data and supplementary materials:** Note that publication of your manuscript implies that you must make all materials, data, and protocols associated with the publication available to readers. Disclose at the submission stage any restrictions on the availability of materials or information. Read the information about **Supplementary Materials** and Data Deposit for additional guidelines.

- **Preregistration:** Where authors have preregistered studies or analysis plans, links to the preregistration must be provided in the manuscript.
- **Guidelines and standards:** MDPI follows standards and guidelines for certain types of research. See **https://www.mdpi.com/editorial_process** for further information.

Front Matter

These sections should appear in all manuscript types

- **Title:** The title of your manuscript should be concise, specific and relevant. It should identify if the study reports (human or animal) trial data, or is a systematic review, meta-analysis or replication study. When gene or protein names are included, the abbreviated name rather than full name should be used. Please do not include abbreviated or short forms of the title, such as a running title or head. These will be removed by our Editorial Office.
- **Author List and Affiliations:** Authors' full first and last names must be provided. The initials of any middle names can be added. The PubMed/MEDLINE standard format is used for affiliations: complete address information including city, zip code, state/province, and country. At least one author should be designated as corresponding author, and his or her email address and other details should be included at the end of the affiliation section. Please read the **criteria to qualify for authorship**.
- **Abstract:** The abstract should be a total of about 200 words maximum. The abstract should be a single paragraph and should follow the style of structured abstracts, but without headings: 1) Background: Place the question addressed in a broad context and highlight the purpose of the study; 2) Methods: Describe briefly the main methods or treatments applied. Include any relevant preregistration numbers, and species and strains of any animals used. 3) Results: Summarize the article's main findings; and 4) Conclusion: Indicate the main conclusions or interpretations. The abstract should be an objective representation of the article: it must not contain results which are not presented and substantiated in the main text and should not exaggerate the main conclusions.
- **Keywords:** Three to ten pertinent keywords need to be added after the abstract. We recommend that the keywords are specific to the article, yet reasonably common within the subject discipline.

Research Manuscript Sections

- **Introduction:** The introduction should briefly place the study in a broad context and highlight why it is important. It should define the purpose of the work and its significance, including specific hypotheses being tested. The current state of the research field should be reviewed carefully and key publications cited. Please highlight controversial and diverging hypotheses when necessary. Finally, briefly mention the main aim of the work and highlight the main conclusions. Keep the introduction comprehensible to scientists working outside the topic of the paper.
- **Materials and Methods:** They should be described with sufficient detail to allow others to replicate and build on published results. New methods and protocols should be described in detail while well-established methods can be briefly described and

appropriately cited. Give the name and version of any software used and make clear whether computer code used is available. Include any pre-registration codes.

- **Results:** Provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.
- **Discussion:** Authors should discuss the results and how they can be interpreted in perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible and limitations of the work highlighted. Future research directions may also be mentioned. This section may be combined with Results.
- **Conclusions:** This section is mandatory.
- **Patents:** This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

Back Matter

- **Supplementary Materials:** Describe any supplementary material published online alongside the manuscript (figure, tables, video, spreadsheets, etc.). Please indicate the name and title of each element as follows Figure S1: title, Table S1: title, etc.
- **Funding:** All sources of funding of the study should be disclosed. Clearly indicate grants that you have received in support of your research work and if you received funds to cover publication costs. Note that some funders will not refund article processing charges (APC) if the funder and grant number are not clearly and correctly identified in the paper. Funding information can be entered separately into the submission system by the authors during submission of their manuscript. Such funding information, if available, will be deposited to FundRef if the manuscript is finally published.
  Please add: "This research received no external funding" or "This research was funded by [name of funder] grant number [xxx]" and "The APC was funded by [XXX]" in this section. Check carefully that the details given are accurate and use the standard spelling of funding agency names at https://search.crossref.org/funding, any errors may affect your future funding.
- **Acknowledgments:** In this section you can acknowledge any support given which is not covered by the author contribution or funding sections. This may include administrative and technical support, or donations in kind (e.g., materials used for experiments).
- **Author Contributions:** Each author is expected to have made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; or have drafted the work or substantively revised it; AND has approved the submitted version (and version substantially edited by journal staff that involves the author's contribution to the study); AND agrees to be personally accountable for the author's own contributions and for ensuring that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and documented in the literature.
  For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used

"Conceptualization, X.X. and Y.Y.; Methodology, X.X.; Software, X.X.; Validation, X.X., Y.Y. and Z.Z.; Formal Analysis, X.X.; Investigation, X.X.; Resources, X.X.; Data Curation, X.X.; Writing – Original Draft Preparation, X.X.; Writing – Review & Editing, X.X.; Visualization, X.X.; Supervision, X.X.; Project Administration, X.X.; Funding Acquisition, Y.Y.", please turn to the **CRediT taxonomy** for the term explanation. For more background on CRediT, see **here**. "**Authorship must include and be limited to those who have contributed substantially to the work. Please read the section concerning the criteria to qualify for authorship carefully**".

- **Institutional Review Board Statement:** In this section, please add the Institutional Review Board Statement and approval number for studies involving humans or animals. Please note that the Editorial Office might ask you for further information. Please add "The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of NAME OF INSTITUTE (protocol code XXX and date of approval)." OR "Ethical review and approval were waived for this study, due to REASON (please provide a detailed justification)." OR "Not applicable" for studies not involving humans or animals. You might also choose to exclude this statement if the study did not involve humans or animals.
- **Informed Consent Statement:** Any research article describing a study involving humans should contain this statement. Please add "Informed consent was obtained from all subjects involved in the study." OR "Patient consent was waived due to REASON (please provide a detailed justification)." OR "Not applicable" for studies not involving humans. You might also choose to exclude this statement if the study did not involve humans.
  Written informed consent for publication must be obtained from participating patients who can be identified (including by the patients themselves). Please state "Written informed consent has been obtained from the patient(s) to publish this paper" if applicable.
- **Data Availability Statement:** In this section, please provide details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study. Please refer to suggested Data Availability Statements in section "**MDPI Research Data Policies**". You might choose to exclude this statement if the study did not report any data.
- **Conflicts of Interest:** Authors must identify and declare any personal circumstances or interest that may be perceived as influencing the representation or interpretation of reported research results. If there is no conflict of interest, please state "The authors declare no conflict of interest." Any role of the funding sponsors in the choice of research project; design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript; or in the decision to publish the results must be declared in this section. Any projects funded by industry must pay special attention to the full declaration of funder involvement. If there is no role, please state "The sponsors had no role in the design, execution, interpretation, or writing of the study". For more details please see **Conflict of Interest**.
- **References:** References must be numbered in order of appearance in the text (including table captions and figure legends) and listed individually at the end of the manuscript. We recommend preparing the references with a bibliography software package, such as **EndNote**, **ReferenceManager** or **Zotero** to avoid typing mistakes

and duplicated references. We encourage citations to data, computer code and other citable research material. If available online, you may use reference style 9. below.

- Citations and References in Supplementary files are permitted provided that they also appear in the main text and in the reference list.

In the text, reference numbers should be placed in square brackets [ ], and placed before the punctuation; for example [1], [1–3] or [1,3]. For embedded citations in the text with pagination, use both parentheses and brackets to indicate the reference number and page numbers; for example [5] (p. 10). or [6] (pp. 101–105).

The reference list should include the full title, as recommended by the ACS style guide. Style files for **Endnote** and **Zotero** are available.

References should be described as follows, depending on the type of work:

 Journal Articles:
1. Author 1, A.B.; Author 2, C.D. Title of the article. *Abbreviated Journal Name* **Year**, *Volume*, page range.
 Books and Book Chapters:
2. Author 1, A.; Author 2, B. *Book Title*, 3rd ed.; Publisher: Publisher Location, Country, Year; pp. 154–196.
3. Author 1, A.; Author 2, B. Title of the chapter. In *Book Title*, 2nd ed.; Editor 1, A., Editor 2, B., Eds.; Publisher: Publisher Location, Country, Year; Volume 3, pp. 154–196.
 Unpublished materials intended for publication:
4. Author 1, A.B.; Author 2, C. Title of Unpublished Work (optional). Correspondence Affiliation, City, State, Country. year, *status* (*manuscript in preparation*; *to be submitted*).
5. Author 1, A.B.; Author 2, C. Title of Unpublished Work. *Abbreviated Journal Name* year, *phrase indicating stage of publication* (*submitted*; *accepted*; *in press*).
 Unpublished materials not intended for publication:
6. Author 1, A.B. (Affiliation, City, State, Country); Author 2, C. (Affiliation, City, State, Country). Phase describing the material, year. (phase: Personal communication; Private communication; Unpublished work; etc.)
 Conference Proceedings:
7. Author 1, A.B.; Author 2, C.D.; Author 3, E.F. Title of Presentation. In *Title of the Collected Work* (if available), Proceedings of the Name of the Conference, Location of Conference, Country, Date of Conference; Editor 1, Editor 2, Eds. (if available); Publisher: City, Country, Year (if available); Abstract Number (optional), Pagination (optional).
 Thesis:
8. Author 1, A.B. Title of Thesis. Level of Thesis, Degree-Granting University, Location of University, Date of Completion.
 Websites:
9. Title of Site. Available online: URL (accessed on Day Month Year).
Unlike published works, websites may change over time or disappear, so we encourage you create an archive of the cited website using a service such as **WebCite**. Archived websites should be cited using the link provided as follows:
10. Title of Site. URL (archived on Day Month Year).
See the **Reference List and Citations Guide** for more detailed information.

## Preparing Figures, Schemes and Tables

- File for Figures and Schemes must be provided during submission in a single zip archive and at a sufficiently high resolution (minimum 1000 pixels width/height, or a resolution of 300 dpi or higher). Common formats are accepted, however, TIFF, JPEG, EPS and PDF are preferred.
- *IJERPH* can publish multimedia files in articles or as supplementary materials. Please contact the editorial office for further information.
- All Figures, Schemes and Tables should be inserted into the main text close to their first citation and must be numbered following their number of appearance (Figure 1, Scheme I, Figure 2, Scheme II, Table 1, *etc.*).
- All Figures, Schemes and Tables should have a short explanatory title and caption.
- All table columns should have an explanatory heading. To facilitate the copy-editing of larger tables, smaller fonts may be used, but no less than 8 pt. in size. Authors should use the Table option of Microsoft Word to create tables.
- Authors are encouraged to prepare figures and schemes in color (RGB at 8-bit per channel). There is no additional cost for publishing full color graphics.

## Supplementary Materials, Data Deposit and Software Source Code

*MDPI Research Data Policies*

MDPI is committed to supporting open scientific exchange and enabling our authors to achieve best practices in sharing and archiving research data. We encourage all authors of articles published in MDPI journals to share their research data. Individual journal guidelines can be found at the journal 'Instructions for Authors' page. Data sharing policies concern the minimal dataset that supports the central findings of a published study. Generated data should be publicly available and cited in accordance with journal guidelines.

MDPI data policies are informed by **TOP Guidelines** and **FAIR Principles**.

Where ethical, legal or privacy issues are present, data should not be shared. The authors should make any limitations clear in the Data Availability Statement upon submission. Authors should ensure that data shared are in accordance with consent provided by participants on the use of confidential data.

Data Availability Statements provide details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study.

Below are suggested Data Availability Statements:

- Data available in a publicly accessible repository
  The data presented in this study are openly available in [repository name e.g., FigShare] at [**doi**], reference number [reference number].
- Data available in a publicly accessible repository that does not issue DOIs
  Publicly available datasets were analyzed in this study. This data can be found here: [link/accession number]

- Data available on request due to restrictions eg privacy or ethical
  The data presented in this study are available on request from the corresponding author. The data are not publicly available due to [insert reason here]
- 3rd Party Data
  Restrictions apply to the availability of these data. Data was obtained from [third party] and are available [from the authors / at URL] with the permission of [third party].
- Data sharing not applicable
  No new data were created or analyzed in this study. Data sharing is not applicable to this article.
- Data is contained within the article or supplementary material
  The data presented in this study are available in [insert article or supplementary material here]

Data citation:

- [dataset] Authors. Year. Dataset title; Data repository or archive; Version (if any); Persistent identifier (e.g., DOI).

*Computer Code and Software*

For work where novel computer code was developed, authors should release the code either by depositing in a recognized, public repository such as **GitHub** or uploading as supplementary information to the publication. The name, version, corporation and location information for all software used should be clearly indicated. Please include all the parameters used to run software/programs analyses.

*Supplementary Material*

Additional data and files can be uploaded as "Supplementary Files" during the manuscript submission process. The supplementary files will also be available to the referees as part of the peer-review process. Any file format is acceptable; however, we recommend that common, non-proprietary formats are used where possible.

*References in Supplementary Files*

Citations and References in Supplementary files are permitted provided that they also appear in the reference list of the main text.

*Unpublished Data*

Restrictions on data availability should be noted during submission and in the manuscript. "Data not shown" should be avoided: authors are encouraged to publish all observations related to the submitted manuscript as Supplementary Material. "Unpublished data" intended for publication in a manuscript that is either planned, "in preparation" or "submitted" but not yet accepted, should be cited in the text and a reference should be added in the References section. "Personal Communication" should also be cited in the text and reference added in the References section. (see also the MDPI reference list and citations style guide).

*Remote Hosting and Large Data Sets*

Data may be deposited with specialized service providers or institutional/subject repositories, preferably those that use the DataCite mechanism. Large data sets and files greater than 60

MB must be deposited in this way. For a list of other repositories specialized in scientific and experimental data, please consult **databib.org** or **re3data.org**. The data repository name, link to the data set (URL) and accession number, doi or handle number of the data set must be provided in the paper. The journal **Data** also accepts submissions of data set papers.

*Deposition of Sequences and of Expression Data*

New sequence information must be deposited to the appropriate database prior to submission of the manuscript. Accession numbers provided by the database should be included in the submitted manuscript. Manuscripts will not be published until the accession number is provided.

- *New nucleic acid sequences* must be deposited in one of the following databases: **GenBank**, **EMBL**, or **DDBJ**. Sequences should be submitted to only one database.
- *New high throughput sequencing (HTS) datasets* (RNA-seq, ChIP-Seq, degradome analysis, …) must be deposited either in the **GEO database** or in the NCBI's **Sequence Read Archive (SRA)**.
- *New microarray data* must be deposited either in the **GEO** or the **ArrayExpress** databases.The "Minimal Information About a Microarray Experiment" (MIAME) guidelines published by the Microarray Gene Expression Data Society must be followed.
- *New protein sequences* obtained by protein sequencing must be submitted to UniProt (submission tool **SPIN**). Annotated protein structure and its reference sequence must be submitted to **RCSB of Protein Data Bank**.

All sequence names and the accession numbers provided by the databases must be provided in the Materials and Methods section of the article.

*Deposition of Proteomics Data*

Methods used to generate the proteomics data should be described in detail and we encourage authors to adhere to the "**Minimum Information About a Proteomics Experiment**". All generated mass spectrometry raw data must be deposited in the appropriate public database such as **ProteomeXchange**, **PRIDE** or **jPOST**. At the time of submission, please include all relevant information in the materials and methods section, such as repository where the data was submitted and link, data set identifier, username and password needed to access the data.

## Research and Publication Ethics

### Research Ethics

#### Research Involving Human Subjects

When reporting on research that involves human subjects, human material, human tissues, or human data, authors must declare that the investigations were carried out following the rules of the Declaration of Helsinki of 1975 (**https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/**), revised in 2013. According to point 23 of this declaration, an approval from the local institutional review board (IRB) or other appropriate ethics committee must be obtained before undertaking the research to confirm the study meets

national and international guidelines. As a minimum, a statement including the project identification code, date of approval, and name of the ethics committee or institutional review board must be stated in Section 'Institutional Review Board Statement' of the article.

Example of an ethical statement: "All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of XXX (Project identification code)."

For non-interventional studies (e.g. surveys, questionnaires, social media research), all participants must be fully informed if the anonymity is assured, why the research is being conducted, how their data will be used and if there are any risks associated. As with all research involving humans, ethical approval from an appropriate ethics committee must be obtained prior to conducting the study. If ethical approval is not required, authors must either provide an exemption from the ethics committee or are encouraged to cite the local or national legislation that indicates ethics approval is not required for this type of study. Where a study has been granted exemption, the name of the ethics committee which provided this should be stated in Section 'Institutional Review Board Statement' with a full explanation regarding why ethical approval was not required.

A written informed consent for publication must be obtained from participating patients. Data relating to individual participants must be described in detail, but private information identifying participants need not be included unless the identifiable materials are of relevance to the research (for example, photographs of participants' faces that show a particular symptom). Patients' initials or other personal identifiers must not appear in any images. For manuscripts that include any case details, personal information, and/or images of patients, authors must obtain signed informed consent for publication from patients (or their relatives/guardians) before submitting to an MDPI journal. Patient details must be anonymized as far as possible, e.g., do not mention specific age, ethnicity, or occupation where they are not relevant to the conclusions. A **template permission form** is available to download. A blank version of the form used to obtain permission (without the patient names or signature) must be uploaded with your submission. Editors reserve the right to reject any submission that does not meet these requirements.

You may refer to our sample form and provide an appropriate form after consulting with your affiliated institution. For the purposes of publishing in MDPI journals, a consent, permission, or release form should include unlimited permission for publication in all formats (including print, electronic, and online), in sublicensed and reprinted versions (including translations and derived works), and in other works and products under open access license. To respect patients' and any other individual's privacy, please do not send signed forms. The journal reserves the right to ask authors to provide signed forms if necessary.

If the study reports research involving vulnerable groups, an additional check may be performed. The submitted manuscript will be scrutinized by the editorial office and upon request, documentary evidence (blank consent forms and any related discussion documents from the ethics board) must be supplied. Additionally, when studies describe groups by race, ethnicity, gender, disability, disease, etc., explanation regarding why such categorization was needed must be clearly stated in the article.

Ethical Guidelines for the Use of Animals in Research

The editors will require that the benefits potentially derived from any research causing harm to animals are significant in relation to any cost endured by animals, and that procedures followed are unlikely to cause offense to the majority of readers. Authors should particularly ensure that their research complies with the commonly-accepted '3Rs [1]':

- Replacement of animals by alternatives wherever possible,
- Reduction in number of animals used, and
- Refinement of experimental conditions and procedures to minimize the harm to animals.

Authors must include details on housing, husbandry and pain management in their manuscript.

For further guidance authors should refer to the Code of Practice for the Housing and Care of Animals Used in Scientific Procedures [2], American Association for Laboratory Animal Science [3] or European Animal Research Association [4].

If national legislation requires it, studies involving vertebrates or higher invertebrates must only be carried out after obtaining approval from the appropriate ethics committee. As a minimum, the project identification code, date of approval and name of the ethics committee or institutional review board should be stated in Section 'Institutional Review Board Statement'. Research procedures must be carried out in accordance with national and institutional regulations. Statements on animal welfare should confirm that the study complied with all relevant legislation. Clinical studies involving animals and interventions outside of routine care require ethics committee oversight as per the American Veterinary Medical Association. If the study involved client-owned animals, informed client consent must be obtained and certified in the manuscript report of the research. Owners must be fully informed if there are any risks associated with the procedures and that the research will be published. If available, a high standard of veterinary care must be provided. Authors are responsible for correctness of the statements provided in the manuscript.

If ethical approval is not required by national laws, authors must provide an exemption from the ethics committee, if one is available. Where a study has been granted exemption, the name of the ethics committee that provided this should be stated in Section 'Institutional Review Board Statement' with a full explanation on why the ethical approval was not required.

If no animal ethics committee is available to review applications, authors should be aware that the ethics of their research will be evaluated by reviewers and editors. Authors should provide a statement justifying the work from an ethical perspective, using the same utilitarian framework that is used by ethics committees. Authors may be asked to provide this even if they have received ethical approval.

MDPI endorses the ARRIVE guidelines (**arriveguidelines.org/**) for reporting experiments using live animals. Authors and reviewers must use the ARRIVE guidelines as a checklist, which can be found at **https://arriveguidelines.org/sites/arrive/files/documents/ARRIVE%20Compliance%20Questionnaire.pdf**. Editors reserve the right to ask for the checklist and to reject submissions that do not adhere to these guidelines, to reject submissions based on ethical or

animal welfare concerns or if the procedure described does not appear to be justified by the value of the work presented.

1. NSW Department of Primary Industries and Animal Research Review Panel. Three Rs. Available online: **https://www.animalethics.org.au/three-rs**
2. Home Office. Animals (Scientific Procedures) Act 1986. Code of Practice for the Housing and Care of Animals Bred, Supplied or Used for Scientific Purposes. Available online: **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/388535/CoPanimalsWeb.pdf**
3. American Association for Laboratory Animal Science. The Scientific Basis for Regulation of Animal Care and Use. Available online: **https://www.aalas.org/about-aalas/position-papers/scientific-basis-for-regulation-of-animal-care-and-use**
4. European Animal Research Association. EU regulations on animal research. Available online: **https://www.eara.eu/animal-research-law**

Research Involving Cell Lines

Methods sections for submissions reporting on research with cell lines should state the origin of any cell lines. For established cell lines the provenance should be stated and references must also be given to either a published paper or to a commercial source. If previously unpublished *de novo* cell lines were used, including those gifted from another laboratory, details of institutional review board or ethics committee approval must be given, and confirmation of written informed consent must be provided if the line is of human origin.

An example of Ethical Statements:

The HCT116 cell line was obtained from XXXX. The $MLH1^{+}$ cell line was provided by XXXXX, Ltd. The DLD-1 cell line was obtained from Dr. XXXX. The DR-GFP and SA-GFP reporter plasmids were obtained from Dr. XXX and the Rad51K133A expression vector was obtained from Dr. XXXX.

Research Involving Plants

Experimental research on plants (either cultivated or wild) including collection of plant material, must comply with institutional, national, or international guidelines. We recommend that authors comply with the **Convention on Biological Diversity** and the **Convention on the Trade in Endangered Species of Wild Fauna and Flora**.

For each submitted manuscript supporting genetic information and origin must be provided. For research manuscripts involving rare and non-model plants (other than, e.g., *Arabidopsis thaliana, Nicotiana benthamiana, Oryza sativa*, or many other typical model plants), voucher specimens must be deposited in an accessible herbarium or museum. Vouchers may be requested for review by future investigators to verify the identity of the material used in the study (especially if taxonomic rearrangements occur in the future). They should include details of the populations sampled on the site of collection (GPS coordinates), date of collection, and document the part(s) used in the study where appropriate. For rare, threatened or endangered species this can be waived but it is necessary for the author to describe this in the cover letter.

Editors reserve the rights to reject any submission that does not meet these requirements.

An example of Ethical Statements:

*Torenia fournieri* plants were used in this study. White-flowered Crown White (CrW) and violet-flowered Crown Violet (CrV) cultivars selected from 'Crown Mix' (XXX Company, City, Country) were kindly provided by Dr. XXX (XXX Institute, City, Country).

*Arabidopis* mutant lines (SALKxxxx, SAILxxxx,…) were kindly provided by Dr. XXX , institute, city, country).

Clinical Trials Registration

*Registration*

MDPI follows the International Committee of Medical Journal Editors (ICMJE) **guidelines** which require and recommend registration of clinical trials in a public trials registry at or before the time of first patient enrollment as a condition of consideration for publication.

Purely observational studies do not require registration. A clinical trial not only refers to studies that take place in a hospital or involve pharmaceuticals, but also refer to all studies which involve participant randomization and group classification in the context of the intervention under assessment.

Authors are strongly encouraged to pre-register clinical trials with an international clinical trials register and cite a reference to the registration in the Methods section. Suitable databases include **clinicaltrials.gov**, **the EU Clinical Trials Register** and those listed by the World Health Organisation **International Clinical Trials Registry Platform**.

Approval to conduct a study from an independent local, regional, or national review body is not equivalent to prospective clinical trial registration. MDPI reserves the right to decline any paper without trial registration for further peer-review. However, if the study protocol has been published before the enrolment, the registration can be waived with correct citation of the published protocol.

*CONSORT Statement*

MDPI requires a completed CONSORT 2010 **checklist** and **flow diagram** as a condition of submission when reporting the results of a randomized trial. Templates for these can be found here or on the CONSORT website (**http://www.consort-statement.org**) which also describes several CONSORT checklist extensions for different designs and types of data beyond two group parallel trials. At minimum, your article should report the content addressed by each item of the checklist.

Sex and Gender in Research

We encourage our authors to follow the **'Sex and Gender Equity in Research – SAGER – guidelines'** and to include sex and gender considerations where relevant. Authors should use the terms sex (biological attribute) and gender (shaped by social and cultural circumstances) carefully in order to avoid confusing both terms. Article titles and/or abstracts should indicate clearly what sex(es) the study applies to. Authors should also describe in the background, whether sex and/or gender differences may be expected; report how sex and/or gender were accounted for in the design of the study; provide disaggregated data by sex and/or gender, where appropriate; and discuss respective results. If a sex and/or gender analysis was not conducted, the rationale should be given in the Discussion. We suggest that our authors consult the full **guidelines** before submission.

Borders and Territories

Potential disputes over borders and territories may have particular relevance for authors in describing their research or in an author or editor correspondence address, and should be respected. Content decisions are an editorial matter and where there is a potential or perceived dispute or complaint, the editorial team will attempt to find a resolution that satisfies parties involved.

MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Publication Ethics Statement

*IJERPH* is a member of the Committee on Publication Ethics (**COPE**). We fully adhere to its **Code of Conduct** and to its **Best Practice Guidelines**.

The editors of this journal enforce a rigorous peer-review process together with strict ethical policies and standards to ensure to add high quality scientific works to the field of scholarly publication. Unfortunately, cases of plagiarism, data falsification, image manipulation, inappropriate authorship credit, and the like, do arise. The editors of *IJERPH* take such publishing ethics issues very seriously and are trained to proceed in such cases with a zero tolerance policy.

Authors wishing to publish their papers in *IJERPH* must abide to the following:

- Any facts that might be perceived as a possible conflict of interest of the author(s) must be disclosed in the paper prior to submission.
- Authors should accurately present their research findings and include an objective discussion of the significance of their findings.
- Data and methods used in the research need to be presented in sufficient detail in the paper, so that other researchers can replicate the work.
- Raw data should preferably be publicly deposited by the authors before submission of their manuscript. Authors need to at least have the raw data readily available for presentation to the referees and the editors of the journal, if requested. Authors need to ensure appropriate measures are taken so that raw data is retained in full for a reasonable time after publication.
- Simultaneous submission of manuscripts to more than one journal is not tolerated.
- The journal accepts exact translations of previously published work. All submissions of translations must conform with our **policies on translations**.
- If errors and inaccuracies are found by the authors after publication of their paper, they need to be promptly communicated to the editors of this journal so that appropriate actions can be taken. Please refer to our **policy regarding Updating Published Papers**.
- Your manuscript should not contain any information that has already been published. If you include already published figures or images, please obtain the necessary permission from the copyright holder to publish under the CC-BY license. For further information, see the **Rights and Permissions** page.
- Plagiarism, data fabrication and image manipulation are not tolerated.

- **Plagiarism is not acceptable** in *IJERPH* submissions.

  Plagiarism includes copying text, ideas, images, or data from another source, even from your own publications, without giving any credit to the original source.

  Reuse of text that is copied from another source must be between quotes and the original source must be cited. If a study's design or the manuscript's structure or language has been inspired by previous works, these works must be explicitly cited.

  All MDPI submissions are checked for plagiarism using the industry standard software iThenticate. If plagiarism is detected during the peer review process, the manuscript may be rejected. If plagiarism is detected after publication, an investigation will take place and action taken in accordance with our policies.

- **Image files must not be manipulated or adjusted in any way** that could lead to misinterpretation of the information provided by the original image.

  Irregular manipulation includes: 1) introduction, enhancement, moving, or removing features from the original image; 2) grouping of images that should obviously be presented separately (e.g., from different parts of the same gel, or from different gels); or 3) modifying the contrast, brightness or color balance to obscure, eliminate or enhance some information.

  If irregular image manipulation is identified and confirmed during the peer review process, we may reject the manuscript. If irregular image manipulation is identified and confirmed after publication, we may correct or retract the paper.

Our in-house editors will investigate any allegations of publication misconduct and may contact the authors' institutions or funders if necessary. If evidence of misconduct is found, appropriate action will be taken to correct or retract the publication. Authors are expected to comply with the best ethical publication practices when publishing with MDPI.

Citation Policy

Authors should ensure that where material is taken from other sources (including their own published writing) the source is clearly cited and that where appropriate permission is obtained.

Authors should not engage in excessive self-citation of their own work.

Authors should not copy references from other publications if they have not read the cited work.

Authors should not preferentially cite their own or their friends', peers', or institution's publications.

Authors should not cite advertisements or advertorial material.

In accordance with COPE guidelines, we expect that "original wording taken directly from publications by other researchers should appear in quotation marks with the appropriate

citations." This condition also applies to an author's own work. COPE have produced a discussion document on **citation manipulation** with recommendations for best practice.

### Reviewer Suggestions

During the submission process, please suggest three potential reviewers with the appropriate expertise to review the manuscript. The editors will not necessarily approach these referees. Please provide detailed contact information (address, homepage, phone, e-mail address). The proposed referees should neither be current collaborators of the co-authors nor have published with any of the co-authors of the manuscript within the last five years. Proposed reviewers should be from different institutions to the authors. You may identify appropriate Editorial Board members of the journal as potential reviewers. You may suggest reviewers from among the authors that you frequently cite in your paper.

### English Corrections

To facilitate proper peer-reviewing of your manuscript, it is essential that it is submitted in grammatically correct English. Advice on some specific language points can be found **here**.

If you are not a native English speaker, we recommend that you have your manuscript professionally edited before submission or read by a native English-speaking colleague. This can be carried out by MDPI's **English editing service**. Professional editing will enable reviewers and future readers to more easily read and assess the content of submitted manuscripts. All accepted manuscripts undergo language editing, however **an additional fee will be charged** to authors if very extensive English corrections must be made by the Editorial Office: pricing is according to the service **here**.

### Preprints and Conference Papers

*IJERPH* accepts submissions that have previously been made available as preprints provided that they have not undergone peer review. A preprint is a draft version of a paper made available online before submission to a journal.

MDPI operates ***Preprints***, a preprint server to which submitted papers can be uploaded directly after completing journal submission. Note that *Preprints* operates independently of the journal and posting a preprint does not affect the peer review process. Check the *Preprints* **instructions for authors** for further information.

Expanded and high-quality conference papers can be considered as articles if they fulfill the following requirements: (1) the paper should be expanded to the size of a research article; (2) the conference paper should be cited and noted on the first page of the paper; (3) if the authors do not hold the copyright of the published conference paper, authors should seek the appropriate permission from the copyright holder; (4) authors are asked to disclose that it is conference paper in their cover letter and include a statement on what has been changed compared to the original conference paper. *IJERPH* does not publish pilot studies or studies with inadequate statistical power.

Unpublished conference papers that do not meet the above conditions are recommended to be submitted to the **Proceedings Series journals**.

## Authorship

MDPI follows the International Committee of Medical Journal Editors (**ICMJE**) guidelines which state that, in order to qualify for authorship of a manuscript, the following criteria should be observed:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Those who contributed to the work but do not qualify for authorship should be listed in the acknowledgments. More detailed guidance on authorship is given by the **International Council of Medical Journal Editors (ICMJE)**.

Any change to the author list should be approved by all authors including any who have been removed from the list. The corresponding author should act as a point of contact between the editor and the other authors and should keep co-authors informed and involve them in major decisions about the publication. We reserve the right to request confirmation that all authors meet the authorship conditions.

For more details about authorship please check **MDPI ethics website**.

## Reviewers Recommendation

Authors can recommend potential reviewers. Journal editors will check to make sure there are no conflicts of interest before contacting those reviewers, and will not consider those with competing interests. Reviewers are asked to declare any conflicts of interest. Authors can also enter the names of potential peer reviewers they wish to exclude from consideration in the peer review of their manuscript, during the initial submission progress. The editorial team will respect these requests so long as this does not interfere with the objective and thorough assessment of the submission.

## Editorial Independence

### Lack of Interference With Editorial Decisions

Editorial independence is of utmost importance and MDPI does not interfere with editorial decisions. All articles published by MDPI are peer reviewed and assessed by our independent editorial boards, and MDPI staff are not involved in decisions to accept manuscripts. When making an editorial decision, we expect the academic editor to make their decision based only upon:

- The suitability of selected reviewers;
- Adequacy of reviewer comments and author response;
- Overall scientific quality of the paper.

In all of our journals, in every aspect of operation, MDPI policies are informed by the mission to make science and research findings open and accessible as widely and rapidly as possible.

Editors and Editorial Staff as Authors

Editorial staff or editors shall not be involved in processing their own academic work. Submissions authored by editorial staff/editors will be assigned to at least two independent outside reviewers. Decisions will be made by other Editorial Board Members who do not have a conflict of interest with the author. Journal staff are not involved in the processing of their own work submitted to any MDPI journals.

## Conflict of Interests

According to The International Committee of Medical Journal Editors, "Authors should avoid entering into agreements with study sponsors, both for-profit and non-profit, that interfere with authors' access to all of the study's data or that interfere with their ability to analyze and interpret the data and to prepare and publish manuscripts independently when and where they choose."

All authors must disclose all relationships or interests that could inappropriately influence or bias their work. Examples of potential conflicts of interest include but are not limited to financial interests (such as membership, employment, consultancies, stocks/shares ownership, honoraria, grants or other funding, paid expert testimonies and patent-licensing arrangements) and non-financial interests (such as personal or professional relationships, affiliations, personal beliefs).

Authors can disclose potential conflicts of interest via the online submission system during the submission process. Declarations regarding conflicts of interest can also be collected via the **MDPI disclosure form**. The corresponding author must include a summary statement in the manuscript in a separate section "Conflicts of Interest" placed just before the reference list. The statement should reflect all the collected potential conflict of interest disclosures in the form.

See below for examples of disclosures:

Conflicts of Interest: Author A has received research grants from Company A. Author B has received a speaker honorarium from Company X and owns stocks in Company Y. Author C has been involved as a consultant and expert witness in Company Z. Author D is the inventor of patent X.

If no conflicts exist, the authors should state:

Conflicts of Interest: The authors declare no conflicts of interest.

*IJERPH* will not consider manuscripts for publication that report tobacco research funded, in whole or in part, by a tobacco company or tobacco industry organization or affiliate. For non-tobacco related research funded by the tobacco industry or research funded by the e-cigarette industry and pharmaceutical industry, authors should disclose any potential conflicts of interest based on **The New International Journal of Environmental Research and Public Health (IJERPH) Policy Concerning Tobacco Company Funding**.

## Editorial Procedures and Peer-Review

*Initial Checks*

All submitted manuscripts received by the Editorial Office will be checked by a professional in-house *Managing Editor* to determine whether they are properly prepared and whether they follow the ethical policies of the journal, including those for human and animal experimentation. Manuscripts that do not fit the journal's ethics policy or do not meet the standards of the journal will be rejected before peer-review. Manuscripts that are not properly prepared will be returned to the authors for revision and resubmission. After these checks, the *Managing Editor* will consult the journals' *Editor-in-Chief* or *Associate Editors* to determine whether the manuscript fits the scope of the journal and whether it is scientifically sound. No judgment on the potential impact of the work will be made at this stage. Reject decisions at this stage will be verified by the *Editor-in-Chief*.

*Peer-Review*

Once a manuscript passes the initial checks, it will be assigned to at least two independent experts for peer-review. A single-blind review is applied, where authors' identities are known to reviewers. Peer review comments are confidential and will only be disclosed with the express agreement of the reviewer.

In the case of regular submissions, in-house assistant editors will invite experts, including recommendations by an academic editor. These experts may also include *Editorial Board Members* and Guest Editors of the journal. Potential reviewers suggested by the authors may also be considered. Reviewers should not have published with any of the co-authors during the past five years and should not currently work or collaborate with any of the institutions of the co-authors of the submitted manuscript.

*Optional Open Peer-Review*

The journal operates optional open peer-review: *Authors are given the option for all review reports and editorial decisions to be published alongside their manuscript. In addition, reviewers can sign their review, i.e., identify themselves in the published review reports.* Authors can alter their choice for open review at any time before publication, but once the paper has been published changes will only be made at the discretion of the *Publisher* and *Editor-in-Chief*. We encourage authors to take advantage of this opportunity as proof of the rigorous process employed in publishing their research. To guarantee impartial refereeing, the names of referees will be revealed only if the referees agree to do so, and after a paper has been accepted for publication.

*Editorial Decision and Revision*

All the articles, reviews and communications published in MDPI journals go through the peer-review process and receive at least two reviews. The in-house editor will communicate the decision of the academic editor, which will be one of the following:

- *Accept after Minor Revisions*:
  The paper is in principle accepted after revision based on the reviewer's comments. Authors are given five days for minor revisions.
- *Reconsider after Major Revisions*:
  The acceptance of the manuscript would depend on the revisions. The author needs to provide a point by point response or provide a rebuttal if some of the reviewer's comments cannot be revised. Usually, only one round of major revisions is allowed.

Authors will be asked to resubmit the revised paper within a suitable time frame, and the revised version will be returned to the reviewer for further comments.

- *Reject and Encourage Resubmission*:
  If additional experiments are needed to support the conclusions, the manuscript will be rejected and the authors will be encouraged to re-submit the paper once further experiments have been conducted.
- *Reject*:
  The article has serious flaws, and/or makes no original significant contribution. No offer of resubmission to the journal is provided.

All reviewer comments should be responded to in a point-by-point fashion. Where the authors disagree with a reviewer, they must provide a clear response.

*Author Appeals*

Authors may appeal a rejection by sending an e-mail to the Editorial Office of the journal. The appeal must provide a detailed justification, including point-by-point responses to the reviewers' and/or Editor's comments. The *Managing Editor* of the journal will forward the manuscript and related information (including the identities of the referees) to the Editor-in-Chief, Associate Editor, or Editorial Board member. The academic Editor being consulted will be asked to give an advisory recommendation on the manuscript and may recommend acceptance, further peer-review, or uphold the original rejection decision. A reject decision at this stage is final and cannot be reversed.

In the case of a special issue, the *Managing Editor* of the journal will forward the manuscript and related information (including the identities of the referees) to the *Editor-in-Chief* who will be asked to give an advisory recommendation on the manuscript and may recommend acceptance, further peer-review, or uphold the original rejection decision. A reject decision at this stage will be final and cannot be reversed.

*Production and Publication*

Once accepted, the manuscript will undergo professional copy-editing, English editing, proofreading by the authors, final corrections, pagination, and, publication on the **www.mdpi.com** website.

## Promoting Equity, Diversity and Inclusiveness Within MDPI Journals

Our Managing Editors encourage the Editors-in-Chief and Associate Editors to appoint diverse expert Editorial Boards. This is also reflective in our multi-national and inclusive workplace. We are proud to create equal opportunities without regard to gender, ethnicity, sexual orientation, age, religion, or socio-economic status. There is no place for discrimination in our workplace and editors of MDPI journals are to uphold these principles in high regard.

## Resource Identification Initiative

To improve the reproducibility of scientific research, the **Resource Identification Initiative** aims to provide unique persistent identifiers for key biological resources, including antibodies, cell lines, model organisms and tools.

We encourage authors to include unique identifiers - RRIDs- provided by the **Resource Identification Portal** in the dedicated section of the manuscript.

To help authors quickly find the correct identifiers for their materials, there is a single **website** where all resource types can be found and a 'cite this' button next to each resource, that contains a proper citation text that should be included in the methods section of the manuscript.