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Nature Based Interventions for Human Health and Wellbeing

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Abstract

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Background. Nature exposure is beneficial to human health and wellbeing, but the evidence base for nature-based interventions (NBI) is still developing. Heterogeneous naming conventions, study designs, and intervention contexts create difficulty in accessing and assessing the evidence for such programming. While NBI have been utilized in a wide array of human populations, no interventions have been reported among clinical health professions students. **Aims.** The objectives of this dissertation project were to review the existing body of NBI literature exploring health and wellbeing outcomes, and to conduct a feasibility trial of forest bathing, a type of NBI, among clinical students. Specifically, this study aimed to: *(Aim 1)* conduct a scoping review to (1) identify the different nomenclature used to define NBI, (2) describe the NBI utilized and the contexts in which they occurred, and (3) describe the methodologies used in studies of NBI; *(Aim 2)* assess the feasibility of implementing a pilot forest bathing intervention for stress management among clinical health professions students; and *(Aim 3)* assess the preliminary effectiveness of a pilot forest bathing intervention for stress management among clinical health professions students. **Methods.** *(Aim 1)* A scoping review was conducted following a prospectively published protocol and adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews. We searched PubMed, Web of Science, Scopus, and ProQuest Dissertations and Theses Global for studies on NBI in humans. Dual independent screening and single-author data abstraction were conducted. *(Aims 2 and 3)* A single-arm feasibility trial of a six-week forest bathing intervention was conducted. Proctored, self-guided sessions were held on weekday afternoons in a local arboretum. The protocol was prospectively registered and CONSORT reporting guidelines were followed. Participants were clinical students enrolled in a public university in the United States. Aim 2 used qualitative (surveys, focus group, and researcher observation) and quantitative (surveys) methods to assess the feasibility of implementing the program. Aim 3 used quantitative survey data to explore preliminary effectiveness measures: perceived stress, attitudes toward spending time in nature (TSN), self-efficacy TSN, and intentions TSN. **Results.** *(Aim 1)* A total of 406 papers comprising 416 reported studies were included. Multi-day programs, repeated short-session programs, and single short-session programs comprised the sample. NBI were reported in 36 countries and published as dissertations and peer-reviewed papers in 160 journals. 155 unique NBI names were reported. *(Aim 2)* 413 students were invited to participate in the program, and 13 students enrolled. Seven individuals participated in at least one session; of those attending at least once, five (71.4%) attended at least five of the six sessions. Measures and data collection methods were well-received and reliably reported. Interpersonal commitment was a primary facilitator to participation, and time constraints were a key barrier. *(Aim 3)* Participants reported positive affective impacts during 63.6% (n=21) of

sessions, and present stress declined significantly over a single 40-minute session (p=0.0007). Over the course of the study and into follow-up, stress decreased by half of a point on the Perceived Stress-10 scale per week (p=0.0308). Participating enrollees and non-participating enrollees may have differed on baseline perceived stress, baseline positive attitudes TSN, and time spent in nature in the week prior to enrollment.
Conclusion. *(Aim 1)* Taken on the whole, NBI are highly diverse in design and reporting. The field of research would be strengthened by the development of (1) consistent naming conventions and (2) NBI-specific reporting guidelines (i.e., a checklist). *(Aims 2 and 3)* While recruitment proved challenging in this population, preliminary evidence suggests that forest bathing or other NBI may be acceptable and beneficial for clinical students experiencing stress. Further feasibility work should explore weekend-based NBI programming offering guided activities.

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Chapter 1. Introduction and Background

Exposure to the natural environment is supportive of human health and wellbeing. Systematic, scoping, and other literature reviews have found positive impacts of nature exposure on immunological health,[1] psychophysiological stress,[2] cardiovascular function,[3] and anxiety and depression.[4] While the causal pathways linking nature to health outcomes remain unclear, potential contributors include inhalation of the biogenic volatile organic compounds present in natural spaces,[5] humans' evolutionary need to interact with biodiversity,[6,7] and interrupting rumination.[8]

Passive nature exposure, such as living in a neighborhood with an abundance of trees, can also provide benefits. Across the United States, adult obesity rates are lower in counties with greater per-capita forest coverage.[9] In cities, urban tree canopy can reduce excess environmental heat, promote active living (e.g., walking or biking to work), and contribute to social cohesion and improved birth outcomes.[10] Even indirect natural access, such as a scenic view through a hospital window, has been linked with improved self-rated physical and mental health.[11]

Since the onset of the COVID-19 pandemic, outdoor natural spaces have also served as critical public infrastructure for individuals seeking safe recreation spaces.[12] While many government bodies initially restricted individual movement and access to public spaces,[13] natural outdoor spaces ultimately saw increases in use beyond pre-pandemic levels.[14] The pandemic era also saw an increase in nature novices spending time outdoors,[15] exposing more people to nature's benefits in a time of high distress.[16]

Nature Exposure as Intervention

The concept of nature exposure as a therapeutic approach dates back millennia. Accounts of solo wilderness experiences comprise key highlights in the lore of early spiritual leaders seeking clarity and enlightenment, such as Jesus and Buddha.[17] During the Roman Empire, open-air baths were used to treat rheumatic and other ailments.[18] In the late 19th century, bouts of "fresh air" exposure experiences were implemented for children living in industrial urban environments.[19] While the Japanese term "Shinrin-yoku" (or forest bathing) was not created until 1982,[20] the practice of immersing oneself in the sensory experience of the forested environment was rooted in centuries-old customs. In a 1914 lecture to the British Medical Association, naturalist J. Arthur Thomson spoke of "the way in which Nature ministers to our minds, all more or less diseased by the rush and racket of civilization, and helps to steady and enrich our lives."[21]

In the late 1980s, nature-based interventions (NBI) first appeared in the peer reviewed literature in the form of wilderness therapy for youth with psychiatric and behavioral problems.[22,23] Further NBI exploration carried through the 1990s, followed by rapid expansion from the early 2000s to the present day. NBI have evolved into a diverse field, with interventions targeting a multitude of psychological, physiological, cognitive, and other wellbeing outcomes, targeting an array of human populations worldwide; utilizing nearly all types of natural environments, employing different study design features and assessment techniques, and varying in nature dose (i.e., frequency of exposure, duration of exposure, intensity of exposure). The broad range of modern NBI include adaptive gardening for older adults with dementia;[24] nature-based adventure therapy for individuals experiencing homelessness;[25] ocean sailing for young adults with cancer;[26] community-led outdoor running events;[27] forest therapy for

fatigued office workers;[28] and nature-based art therapy for non-disabled children whose siblings have disabilities.[29]

Need 1: Comprehensive and Rigorous Evidence Synthesis

Preliminary review of the body of research reveals heterogeneity in nearly every feature of NBI intervention design, execution, and reporting. As NBI research rapidly grows in popularity, it is crucial to understand current practices, synthesize findings across the broad scope of NBI literature, and generate recommendations for future development aimed toward firm research rigor, advancement of science, and visibility of the field.

Of the myriad evidence synthesis methodologies,[30] systematic and scoping reviews are popular and robust techniques for characterizing the available data on a topic. Generally, systematic reviews are appropriate for deeply exploring a narrow topic, while scoping reviews are useful for exploring a broader topic with less depth than a systematic review.[31] With the aim to synthesize a broad range of evidence across a diversity of naming conventions, environmental settings, duration and frequency of nature exposure, population exposed, outcomes explored, and methods of exploration, a scoping review process is most appropriate.

While evidence synthesis works are imperative in understanding the body of literature on a given topic, careful consideration must be given to avoid the production of unnecessary reviews.[32] The proposed scoping review is warranted as, to date, no scoping reviews have been conducted of NBI literature both (1) to synthesize the broad scope of interventions across diverse settings, populations, study designs, and methodologies; and (2) while following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR).[33]

Need 2: Applications Among Clinical Health Professions Students

Stress is prevalent among health professions program (HPP) students,[34,35] and it carries significant risk to health and academic performance.[36,37] HPP disciplines include, but are not limited to, medicine, nursing, pharmacy, dentistry, physical therapy, and occupational therapy. In medical programs in the United States alone, 95,475 students are currently enrolled.[38] Broadening the definition of HPP students to include such disciplines as nursing, dentistry, and physical therapy, the issue of HPP-related stress impacts hundreds of thousands of students at any point in time. While experiences vary between HPP disciplines and throughout the course of a degree program,[39,40] commonly reported stressors include rigorous academic course loads, routine exposure to human suffering in the clinical setting, and financial strain.[37,41] Unmanaged stress can result in adverse outcomes such as the development of chronic disease, mental health disorders, professional burnout, and suicidality.[36,37,42] In addition to the time limitations and financial constraints that may provide barriers to treatment, stigma can inhibit HPP students from seeking mental health support when needed.[43] While this population reports higher degrees of coping capabilities than their same-age peers, they nonetheless report higher levels of stress;[44] therefore, additional coping supports tailored to the unique needs, barriers, and preferences of HPP students should be developed and disseminated.

Coping Strategies and Interventions

Coping strategies represent a variety of mechanisms to mitigate the impacts of forces causing stress and other discomforts. A wide array of coping strategies have been reported among HPP students, including, but not limited to: 1) strategies to transfer stress energy into productive activity, such as exercise; 2) strategies to distract from

stress energy, such as playing video games; and 3) strategies to make sense of the stress, such as talking to a friend.[34,45] While personal resilience and coping skills modulate perceived stress, and medical students report greater resilience and coping skills than their peers, stress levels in this population nonetheless exceed their peers, thus indicating the need for additional support.[44]

Although lifestyle interventions have shown promise in reducing HPP student stress, several methodological challenges exist. For example, while mindfulness, yoga, and journaling interventions have been rated highly by participants and generally resulted in improvements to perceived stress, attrition and program adherence have proven problematic.[46-49] In addition, small sample sizes and heterogeneous study designs further challenge generalizability and the establishment of conclusive support for such interventions. Furthermore, while curriculum-embedded and other institutional interventions are likely potent in impacting HPP student stress, activities outside of the academic environment may more strongly impact well-being.[50]

Forest Bathing for Stress Management

The forest environment's numerous health benefits have been measured across the body's various physiological and psychological systems.[1,3,51-57] For example, research has identified multiple mechanisms related to nature's healing properties, implicating such factors as the volatile organic compounds emitted from plant life, the clean air resulting from pollution mitigation processes, and the evolutionary necessity for humans to interact with the natural environment.[5,6,58] Nature further provides a venue for health-promoting physical activity,[59] and such activities may reduce stress-inducing rumination.[60] Consistent with *vis medicatrix naturae*, or the human body's propensity for healing itself within the context of the natural environment,[61,62] research suggests

that forest exposure contributes to a recalibration of physiological and psychological systems toward ideal levels.[53]

Nature-based interventions, including forest bathing, have shown benefit for the treatment of existing ailments and the prevention of potential health problems.[54,61] Forest bathing, or Shinrin-yoku, involves spending time in a forested setting while engaging the five senses.[53,63,64] It is this combination of nature exposure with mindfulness practices that uniquely situates forest bathing to attenuate stress.[65] Some forest bathing programs are self-guided and solitary, while others involve the guidance of a trained interventionist. Forest bathing interventions have been linked to improvements in stress and affect in as little as 15 minutes,[66] and have been shown to be effective for both prevention and treatment of physical and mental health issues.[54,67]

To the authors' knowledge, no nature-based interventions in this population have been reported in the peer-reviewed literature; thus, considering the dearth of evidence and potential for benefit, a feasibility study is warranted.

Specific Aims

Aim 1: To conduct a scoping review to 1) identify the different nomenclature used to define NBI, 2) describe the NBI utilized and the contexts in which they occurred, and 3) describe the methodologies and measurement tools used in studies of NBI.

Aim 2: To assess the feasibility of implementing a pilot forest bathing intervention for stress management among clinical health professions students.

Aim 3: To assess the preliminary effectiveness of a pilot forest bathing intervention for stress management among clinical health professions students.

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Chapter 2. Context, Classification, and Study Methodologies in Research into Nature-Based Therapies: A Scoping Review

Abstract

Introduction

While nature-based interventions (NBI) have been increasingly used to improve human health and quality of life, NBI study terminology, designs, and measures vary greatly. Such miscellany causes difficulty in assessing the efficacy of NBI overall. This scoping review (1) ascertains the terminology used to identify NBI, (2) describes the interventions and their contexts, and (3) describes the methodologies and measurement tools used in NBI studies.

Methods and Analysis

The protocol for this study was prospectively registered and published. Study methods followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols Extension for Scoping Reviews. We searched PubMed, Web of Science, Scopus, and ProQuest Dissertations and Theses Global for studies on NBI in humans, as well as cross-referencing for published and unpublished (masters theses and dissertations) articles. Databases were searched from inception to date of search. Eligible studies used intervention or observational designs, explored human health and well-being outcomes, and provided an English-language abstract. Animal-based therapies and virtual-reality therapies involving simulated nature were excluded unless an eligible comparator was present. Dual independent screening and single-author data abstraction were conducted.

Results

A total of 406 papers comprising 416 reported studies were included. Multi-day programs, repeated short-session programs, and single short-session programs comprised the sample. NBI were reported in 36 countries and published as dissertations and peer-reviewed papers in 160 journals. 155 unique NBI names were reported. An array of physiological, psychological, and wellbeing outcomes were assessed.

Conclusions

Reported NBI were diverse in naming convention, design, setting, and target outcome. Recommendations for improved NBI reporting were discussed.

Introduction

Nature-based interventions (NBI) have been increasingly used over recent decades to address a wide array of health and quality of life outcomes.[1-6] Among the NBI reported in the peer-reviewed literature, settings range from remote wilderness[7] to urban parks[8] to water bodies.[9] Activities encompass sedentary activity, such as seated meditation,[10] low-to-moderate-intensity activity, such as walking,[11] and vigorous-intensity activity such as running. NBI may target efforts on particular age groups, genders, income levels,[12] physical abilities, or clinical diagnoses.[13] Some NBI are guided while others are unguided. Some activities recur, while others are one-time events. As researchers seek to harness the healing properties of nature through NBI, understanding the diverse landscape of NBI literature is of increasing importance.

With intervention diversity however comes challenges to synthesizing the overall evidence. Previous narrative, scoping, and systematic reviews have assessed NBI silos, such as NBIs in institutional settings,[14] the effects of forest bathing on cortisol[15] or mental health,[16] and the interactions between nature and the health of children.[17] While such reviews are crucial in building the evidence base relating to NBI, the vast heterogeneity of NBI approaches have not been fully reported and their implications established.

To the best of the authors' knowledge, no previous scoping review following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols Extension for Scoping Reviews (PRISMA-ScR) has been conducted to compile a thorough description of the NBI literature, including, but not limited to, nomenclature, intervention design, and outcome measurement. Given the former, the purpose of this scoping review is to: (1) ascertain the terminology used to identify NBI, (2) describe

NBI interventions and their contexts, and (3) describe the methodologies and measurement tools used in NBI studies.

Methods

Study processes followed the guidelines established by the PRISMA-ScR,[18] with reporting checklist included as Appendix A. In advance of data collection, the protocol was registered in Open Science Framework (https://osf.io/mtzc8) and published in a peer-reviewed journal.[19]

Eligibility Criteria

Eligible articles reported on NBI and reported physical and mental health outcomes. Inclusion and exclusion criteria are outlined in Table 1 using the Population, Intervention, Comparison, Outcome, Study Design/Setting (PICOS) framework. The target population included any human group irrespective of age, gender, or health status. Any comparator activities were eligible, as were any health or quality of life outcomes. Interventions must have occurred in a natural setting, including but not limited, to parks, trails, and forests. Virtual reality and animal-based studies were excluded unless an eligible comparator was present (e.g., virtual reality nature versus true nature). As this study aimed to assess the reporting of individual interventions, evidence synthesis studies such as systematic reviews were not eligible for inclusion. No limits were placed on the date of publication; rather, databases were searched from date of inception to the search date. Studies were not excluded due to language of publication, so long as an English-language abstract was available.

Data Sources

Four databases were searched: PubMed, Web of Science, Scopus, and ProQuest Dissertations and Theses. Search strategies included words to describe types of nature,

types of interventions, types of outcomes, and the human study population. The search strategy was developed by the first author in collaboration with a health sciences librarian at West Virginia University and the other authors. Final search strings are provided in Appendix B.

The first author conducted database searches on June 3, 2022; all databases were searched from the date of inception to the search date. Search results were imported into EndNote V.20, with a separate folder designated for each source database. The records from each of the source files were then merged into one file. The first author removed duplicates first using EndNote's internal deduplication tool and then through manual review. The first author then imported the deduplicated records into Rayyan for study screening.

Study Selection

The screening process is outlined in Appendix C. Prior to study selection, a selection guidance document was developed and reviewed by the two selecting authors (SIM and CGA). Using Rayyan, these two authors independently screened results using titles and abstracts. Screening results were reviewed and reconciled by consensus. If necessary, full-text articles were retrieved using (1) the library subscriptions of the authors' academic library, (2) Google search (review of first page of results), and (3) inter-library loan. Upon review of full-text articles during the data abstraction phase, some articles were found to not meet study parameters and were thus excluded. A list of all excluded studies, including reasons for exclusion, is available in Appendix D.

Challenges in Defining Nature and Nature-Based Interventions

During the selection process, the need arose to more clearly delineate the terms "nature" and "nature-based interventions." Therefore, the following revised guidelines

were used to determine eligibility for inclusion: (1) eligible NBI must have occurred outdoors, however, merely spending time outdoors or interacting with natural features were not sufficient criterion for inclusion, (2) for ineligible studies, nature had to be a primary component of the intervention or program as evidenced by the study rationale (i.e., exposure provided because spending time in the natural environment may be beneficial for health), setting (i.e., described or defined using clear nature-related terms), and/or outcomes (e.g., use of nature relatedness surveys, interview responses citing the impact of nature).

Treatment of Non-English Language Papers

The search criteria included articles with English-language abstracts. Eight eligible articles were identified with English-language abstracts but non-English-language articles. The first author emailed the corresponding author of each paper to request an English-language copy, but none were provided. For consistency in translation, all foreign language documents were uploaded to Google Translate. Four of the articles were successfully translated and were included in this scoping review. Four of the articles were not able to be translated correctly via Google Translate and were thus excluded.

Treatment of Studies Reported in Both Dissertations/Theses and Peer-Reviewed Articles

Upon discovery that a study was published in both the peer-reviewed literature and a dissertation or thesis, study personnel preferentially coded the peer-reviewed account and removed the dissertation/thesis as a duplicate. In rare instances wherein the titles were identical, however, we could not ensure which copy was removed by the deduplication process.

Data Abstraction

The codebook was developed (Appendix E) and a data input form built in Qualtrics. Dual independent coding was initially planned; however, due to the large number of included studies and the time-intensive coding process, one author coded all studies (SIM) and another author (CGA) reviewed the coded data.

Synthesis Plan

Coded data were exported from Qualtrics into Microsoft Excel for analysis. The Analyze Data feature was used to generate counts and percentages of coded items. Upon review of the data, the first author manually created columns to further categorize certain data, including but not limited, to publication year categorization by 5-year intervals, intervention categorization (broadly inspired by Shanahan et al.'s Delphi expert elicitation study),[4] and dose type. Clarivate's Journal Citation Reports were referenced, with publisher and 5-year impact factors recorded for each article. NVivo 12 was used to generate a word cloud of reported NBI nomenclature.

Findings were grouped into three categories for discussion: context, classification, and methodologies. Context referred to the social and environmental settings in which interventions took place, in addition to publication characteristics (e.g., peer reviewed versus dissertation, journal features). Classification focused on naming conventions and dosage characteristics. Methodologies included study design features (e.g., randomization, theoretical frameworks, incentives, target populations) and exploration of quantitative and qualitative measurement approaches.

Results

Search Results

The initial search identified 26,530 records (Appendix D). After duplicates were removed, 15,496 records remained. Title and abstract screening identified 709 potentially eligible articles. A total of 406 papers were included in the review, comprising 416 individual studies.

Findings

Context

Nature-based interventions were primarily reported in peer-reviewed articles (80.8%, n=338) (Table 2) as opposed to theses and dissertations (19.2%, n=80) (Table 3). Note that some publications included more than one study in a single document; thus, a total of 329 distinct articles and 77 theses and dissertation documents were published. The first eligible NBI were reported in three dissertations in 1981,[20-22] followed by a peer-reviewed article in 1988.[23] Since the onset of NBI research, the frequency of reported studies has steadily increased through the end of the review period (Figure 1), with 76 studies reported in 2021.

Studies were conducted globally, with 36 countries represented. Most frequently represented were the United States (31.0%, n=129), United Kingdom (13.0%, n=54), South Korea (7.0%, n=29), Japan (6.7%, n=28), and Canada (6.5%, n=27). Four studies reported on NBI conducted across multiple countries.

NBI were published in 160 peer-reviewed journals, with most published in the International Journal of Environmental Research and Public Health (17.9%, n=59). Urban Forestry & Urban Greening followed at 4.6% (n=15), then Sustainability with 2.7% (n=9). Of the 160 journals, 116 (72.5%) published only one NBI article, and 25 (15.6%) published only two NBI articles. The Journal Citation Reports 5-Year Impact Factor was available for 210 studies, with a mean impact factor of 3.5 (SD=1.9), median

of 3.1, and range of 0.4 – 10.3. Most of the 160 journals were published by Taylor & Francis (20.6%, n=33), followed by Sage Publications (9.4%, n=15), Elsevier (10.6%, n=17), Springer (6.9%, n=11), Wiley (5.6%, n=9), and MDPI (5.0%, n=8). Most of the studies, however, were published by MDPI (25.5%, n=82), Elsevier (13.7%, n=44), Taylor & Francis (7.8%, n=25), and Springer 5.6%, n=18).

Natural environments were categorized using Bratman et al.'s scheme.[24] Urban green environments, such as neighborhood parks, were most commonly used for NBI (43.3%, n=180). Forests and woodlands were also popular sites (26.7%, n=111), followed by wilderness (20.0%, n=83), water bodies (12.5%, n=52), unspecified/other (10.3%, n=43), countryside/farmland (4.1%, n=17), and desert (1.0%, n=4) (Figure 2). Note that many studies used multiple environment types, and thus the sum of the numerators exceeds the denominator of 416. Photographs and/or sketches of intervention sites were included in 27.9% (n=115) of study reports.

Classification

For the purposes of this study, nomenclature was recorded as the identifier used by authors in the title and/or abstract. 155 unique NBI names were used (Figure 3). Many names contained overlapping similarities (e.g., horticultural therapy and horticultural activity), and some were commonly used interchangeably (e.g., forest bathing and shinrin yoku). Ninety names were used only once (58.1% of names). The most frequently recurring terms were wilderness therapy (7.5%, n=31), forest therapy (5.8%, n=24), walking in nature (5.5%, n=23), and green exercise (4.1%, n=17).

Interventions were categorized by dosage into (1) multi-day trips (29.8%, n=124), (2) single short sessions without an overnight component (29.3%, n=122) and (3) repeated sessions without an overnight component (40.9%, n=170). Between 1981 and

1997, only multi-day trips were reported. The first repeated session, non-overnight intervention was reported in 1997, with the first short single session intervention reported in 1998. Among multi-day trips, therapeutic trips (46.8%, n=58), challenge trips (37.9%, n=47), and retreat trips (15.4%, n=19) were reported. For single short session studies, the most common NBIs were nature-based exercise (52.5%, n=64), engaging/sitting/noticing nature (21.3%, n=26), and forest bathing (13.9%, n=17), with the following NBI representing less than 5% each: horticultural therapy, outdoor education/volunteerism, nature-based challenge, forest schools/outdoor classrooms, nature play, and ecotherapy. For repeated session studies, horticultural therapy (28.8%, n=49), nature-based exercise (22.9%, n=39), and engaging/sitting/noticing nature (18.8%, n=32) were most common, followed by other NBIs comprising less than 8% each: forest bathing, forest schools/outdoor classrooms, ecotherapy, outdoor education/volunteerism, nature-based challenge, and nature play.

Most studies employed some type of physical activity (74.5%, n=310). Sedentary components were prescribed for 38.9% of studies (n=162), while activity levels were unspecified in 16.3% of studies (n=68). Approximately two-thirds of studies (66.3%, n=276) employed human-guided NBI activity.

Methodology

Study Design

The majority of studies used a single group design (40.4%, n=168), followed by randomized (23.8%, n=99), quasi-experimental (19.5%, n=81), and crossover (16.3%, n=68) trials. Single group, randomized, and quasi-experimental designs were used from the early days of NBI research, with crossover design emerging in the early 2000s. Approximately one-fifth of studies were reported to be pilot or feasibility studies

(20.4%, n=85). Study protocols were reported to have been registered for 6.3% of studies (n=26) and published for 3.1% of studies (n=13). Quantitative-only studies were most frequently reported (70.3%, n=294), followed by mixed methods (17.7%, n=74) and qualitative-only (11.5%, n=48). Total sample sizes ranged from 1 to 3992, with a median of 47 and modes of 20, 30, and 60.

Theoretical frameworks were named in 53.4% (n=222) of all studies but were more common among theses and dissertations (86.3%, n=69) versus peer-reviewed articles (45.5%, n=153). Of the studies naming theoretical frameworks, 70.7% (n=157) reported theories relating to the impact of the natural environment; other theories included psychological, learning, and change theories.

Participant incentives were reported for all participants in 12.5% of studies (n=50) and some participants (e.g., lottery drawing) in 2.6% of studies (n=11). The majority of studies reported one (40.1%, n=167), two (43.3%, n=180), or three (11.1%, n=46) treatment arms, with 5.5% (n=23) reporting four or more treatment arms. Of studies with a quantitative component, power analyses or sample size rationales were provided for 20.9% of studies (n=77).

Nearly one-fifth of NBI studies (18.9%, n=79) reported off-limit activities. Dependent upon the aims of the study, some of these forbidden activities included the consumption of tobacco (n=35, 8.4%), alcohol (n=29, 7.0%), caffeine and other stimulants (n=29, 6.7%), and food (n=16, 3.8%); using a cell phone or listening to music (n=18, 4.3%); talking with others (n=29, 7.0%); vigorous physical activity (n=24, 5.8%); reading (n=4, 1.0%); and foraging (n=2, 0.5%).

NBI were reported among a wide cross-section of the human population, with the greatest numbers in populations without specified health concerns or characteristics:

college students (n=89, 21.4%), adults (n=79, 19.0%), and children and adolescents (n=57, 13.7%). Children and adolescents with mental health and behavioral problems were targeted in 11.8% of studies (n=49), while children with physical health concerns or developmental disorders (e.g., cancer, organ transplant, autism) lagging at 1.2% (n=5). In adults, NBI targeted mental health concerns (e.g., depression, avoidant personality disorder, binge eating disorder) (n=46, 11.1%), physical health concerns (e.g., cancer, pregnancy, diabetes, hypertension) (n=29, 7.0%), and cognitive concerns (e.g., dementia) (n=4, 1.0%). Special populations receiving NBI included employees (n=18, 4.3%), veterans (n=14, 3.4%), unhoused individuals (n=5, 1.2%), individuals incarcerated or otherwise involved with the legal system (n=6, 1.4%), and victims of intimate partner violence (n=3, 0.7%).

Measurement

Methods of quantitative outcome measurement varied. Self-report surveys and calculators were most frequently used (90.8%, n=334). This category included instruments completed by the participant, a caretaker, or the researcher, and physical activity (self-reported or measured by device). Measured tests, operationalized as physical or mental tasks conducted by the participant and assessed by the participant, the researcher, or a technological device, were reported in 26.1% of studies (n=96). These measured tests included Digit Span Backward, and the Necker Cube Pattern Control. Anthropometrics, or measurements of body functioning (excluding laboratory tests), were conducted in approximately one-quarter of studies (25.8%, n=95). Commonly used anthropometric measurements included blood pressure, heart rate, body composition, and brain activity via electroencephalogram. Lab tests were

conducted in 13.0% of studies (n=48), and included blood serum and salivary testing of such markers as cortisol, C-reactive protein, IL-6, and natural killer cells.

Qualitative data collection methods were also diverse. More than half of qualitative studies used individual interviews (58.2%, n=71), followed by researcher observation (31.1%, n=38), group interviews (27.9%, n=34), open-ended survey questions (24.6%, n=30), and participant diaries (21.3%, n=26). Photo elicitation and art submissions were reported less frequently.

Across the array of quantitative and qualitative modes of assessment, common outcomes explored included, but were not limited to: quality of life, mental well-being, anxiety, depression, psychological and physiological stress response, life satisfaction, self-esteem, locus of control, restoration, attention, mood, affect, sleep quality, perceived exertion, locus of control, hope, nature relatedness, body composition, cardiovascular health, and physical activity.

Discussion

Summary

This study explored the existing body of NBI literature, with particular focus to context, classification, and methodology. As expected, and as corroborated by previous literature, the findings have revealed heterogeneity in each of these features.

Context

Over recent decades, and particularly since the late-1990s, NBI studies have been on the rise around the globe. Pre-doctoral researchers (those writing theses and dissertations) were early pioneers in bringing NBI to the forefront of research. Multi-day trips, particularly those used in wilderness therapy, paved the way for the development of NBI with shorter bouts of nature exposure. Initially tested as high dose

treatments for clinical and behavioral concerns,[22] smaller dose NBI are emerging for such concerns as work-related fatigue.[25] As longer trips are often not feasible for groups such as working adults and individuals with physical limitations, these shorter-session NBI have recently been tested as more accessible NBIs for a wider spectrum of populations and sub-clinical health concerns (e.g., stress).

We found that urban green spaces, forests, and a variety of other natural settings hosted NBI; however, depth of setting detail varied greatly in the reports. Insufficient setting descriptions were previously identified by Wilkie and Davinson's scoping review of NBI for adult health behaviors and outcomes[26] and Gobster et al.'s scoping review of forest therapy reports.[27] The essence of the natural setting is a key component in NBI programming, and thus, reporting of foliage, terrain, weather, and other key environmental features provides vital information to the reader.

Classification

Of the 416 NBI assessed, 155 different names were used by the authors. While many similarities were identified (e.g., horticultural therapy and horticultural activity), inconsistent naming conventions limit the visibility of work in this field and the efforts to synthesize NBI findings across studies. Additionally, we found that the terms used to name the NBI did not consistently and accurately identify the actual activity conducted. For example, "forest bathing" could refer to sitting, walking, or conducting other activities in a forest or other green environment. This is corroborated by Kotera et al. (scoping review of forest bathing)[16] and Moeller et al.'s (NBI in institutional settings)[14] findings that studies using the same NBI name report an array of activities, levels of guiding, and intensity.

Methodology

As this study sought to scope the breadth of NBI design and reporting across the spectrum of health and wellbeing outcomes, we predictably identified a vast assortment of measurement approaches and tools. While the wide array of outcomes explored in the evidence base can be a strength, the diversity of measurement tools creates difficulty in exploring outcomes across studies, as identified by Christiana et al. (scoping review of nature-based physical activity)[3] and Fyfe-Johnson et al. (systematic review of nature and children's health).[17] This presents an opportunity for collaboration among researchers exploring similar outcomes in determining measurement tools for future studies.

As noted by Britton et al., the blue space interventions included in their systematic review "were not designed with the intention of conducting research" but purely for treatment, and recommended collaboration among researchers and practitioners to establish a proper evidence base.[9] We found this to be the case for many of the studies included in this paper, as reflected in the design of included studies. While practice-based evidence is vital in developing interventions and creating knowledge that is close to the source, practical, and relevant,[28] this approach can sometimes eschew traditionally accepted design features contributing to research rigor. Of the studies included in this scoping review, few protocols were prospectively registered or published, and 59.9% (n=249) of studies used single group or quasi-experimental design. Brito et al. (systematic review and meta-analysis exploring nature-based exercise)[29] and Antonelli et al. (systematic review and meta-analysis exploring forest bathing)[15] identified variable use of randomization and blinding, and inconsistent reporting on these study components.

Implications & Recommendations

NBI reporting varied widely in focus and depth of detail. Likely due to diversity in researcher discipline, intervention approach, outcome of interest, and venue of publication, report components were given varying levels of interest. For example, a forestry-oriented researcher may give significant attention to describing the flora of the experimental site, while a psychology-oriented researcher may focus more detail on the processes of administering the treatment and outcome measures. Acknowledging that NBI research is burgeoning across disciplinary boundaries, is conducted in diverse settings, and is targeted at an array of physiological, psychological, and quality of life outcomes spanning all cross-sections of global humanity, the development of a broadly-applicable reporting checklist in collaboration with other NBI researchers appears warranted. Preliminary recommendations for checklist items include detailed site descriptions, photographs, meteorological data, air and noise pollution, dose characteristics, and theoretical foundations. Researchers are also encouraged to develop theory-based logic models to explain each intervention to ensure the environmental exposure is theoretically linked to psychosocial predictors of behavior and outcome changes.

Of additional concern is the lack of consistent naming conventions, reducing NBI visibility and creating hardship for researchers and practitioners attempting to search the evidence base. The NBI community should collectively decide on a few broad key terms with which to label studies. While additional descriptors should still be used to thoroughly describe the specific intervention addressed in an article, the agreed-upon catch-all terms should be included in titles (where appropriate), abstracts, and key terms lists in order to improve visibility and ease of searching. Upon completion of this

review, the authors recommend “nature-based intervention” as a broad umbrella term, with [setting] + [activity] as a formula for sub-NBI nomenclature.

Understanding the extent of exposure (“dose”) is uniquely challenging for NBI. All nature is not the same, and different environments can have diverse effects. For instance, while trees emit volatile organic compounds that may support human health, different species emit different compounds, providing different effects.[30] While studies typically describe the duration and frequency of nature exposure in clear detail, description of the site is less consistently provided. Reports should give a thorough description of the site, including such features as foliage, terrain, weather, and noise pollution as appropriate. When permitted by publications, photographs should also be provided to convey key details about the site.

Strengths and Limitations

This study comprises the first scoping review to use the PRISMA-ScR framework to explore the vast diversity of nature-based interventions.[18] As this field of research is rapidly growing and expanding, understanding the previous and current naming conventions, contexts, and study methodologies of NBI provides key insights with which to guide the continuing development of a rigorous evidence base.

This paper demonstrated the wide array of nomenclature that is used to describe and report NBI. Because of this naming heterogeneity, our robust search strategy was likely incapable of capturing all articles meeting eligibility criteria. In addition, the decision to only include outdoor nature, and to exclude virtual nature and animal-based therapies, restricted the ever-expanding conceptualization of how humans connect with the natural environment and how those connections are being operationalized in research and practice.

Practical limitations also restricted the articles which we could include. We sought to be as inclusive as possible by including articles with English-language abstracts, but our translation capabilities were ultimately inadequate in translating all of the articles identified as otherwise eligible. Despite our multiple attempts to locate eligible articles, some articles were not retrieved and included in this analysis. Some relevant articles may have been published in journals that are not indexed in the databases we searched, and thus, may have been missed.

Additional limitations concern decisions that the research team made after publication of the protocol. For example, dual coding was initially intended to increase the accuracy of coded data; however, the number of included studies ultimately exceeded expectations and thus dual coding would have surpassed the time and resources available for this study. However, our approach does comply with current PRISMA 2020 Guidelines.[31] We also planned to review the reference lists of existing evidence synthesis articles to identify additional records for inclusion, but we ultimately did not conduct this extended search due to the same resource limitations discussed above. Further, the definitions of "nature" and "nature-based interventions" were refined post hoc, and thus, may have resulted in the exclusion of studies that were intended as nature-based interventions but not clearly reported in those terms.

Conclusions

The rapid expansion of NBI across natural environments, geographical settings, disciplinary sectors, and target populations is encouraging; however, further work should establish intervention and reporting structures to guide robust empirical work and broaden visibility of the field and its findings.

Funding

This research received no specific grant from any funding agency.

Table 1: Inclusion/Exclusion Criteria Using PICOS Framework

Category	Include	Exclude
Participants	Any human population	Non-human populations
Interventions	Nature-based	Non-nature-based interventions
Comparisons	Any nature-based comparison	No exclusions
Outcomes	Any health or quality-of-life outcomes	Non-health or quality-of-life outcomes, for example, cost-effectiveness
Study design/setting	Experimental or observational studies in any natural setting, including but not limited to parks, trails, forests, and beaches	Virtual reality, animal-based therapy (e.g., equine) studies

Table 2: Included Articles by Ascending Publication Year – Peer-Reviewed

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Berman & Anton[23]	Residential Treatment for Children & Youth	1988	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Davis-Berman & Berman[32]	Journal of Contemporary Psychotherapy	1989	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Gillett et al.[33]	Journal of Environmental Education	1991	Canada	Quantitative	Quasi-experimental	Nature Challenge Trip	Wilderness Experience
Bandoroff & Scherer[34]	Journal of Child and Family Studies	1994	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness Therapy
Ohtsuka et al.[35]	International Journal of Biometeorology	1998	Japan	Quantitative	Quasi-experimental	Forest Bathing	Shinrin Yoku
Stark[36]	Clinical Nursing Research	2003	USA	Quantitative	Quasi-experimental	Engage With/Sit/Notice Nature	Spending Time In Nature
Hartig et al.[37]	Journal of Environmental Psychology	2003	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Clark et al.[38]	Journal of Experiential Education	2004	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Stevens et al.[39]	Pediatric Blood & Cancer	2004	Canada	Qualitative	Single group	Nature Challenge Trip	Adventure Therapy
Romi & Kohan[40]	Child & Youth Care Forum	2005	Israel	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness Program
Wichrowski et al.[41]	Journal of Cardiopulmonary Rehabilitation & Prevention	2005	USA	Quantitative	Quasi-experimental	Horticultural Therapy	Horticultural Therapy
Yamaguchi et al.[42]	Journal of International Medical Research	2006	Japan	Quantitative	Crossover	Nature-Based Exercise	Walking In A Forest
Eikenaes et al.[43]	Nordic Journal of Psychiatry	2006	Norway	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness Therapy
Kerr et al.[44]	Psychology of Sport and Exercise	2006	Japan	Quantitative	Crossover	Nature-Based Exercise	Running In Nature
Morita et al.[45]	Public Health	2006	Japan	Quantitative	Crossover	Forest Bathing	Shinrin Yoku
Harper et al.[46]	Child & Youth Care Forum	2007	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Pretty et al.[47]	Journal of Environmental Planning and Management	2007	UK	Quantitative	Single group	Nature-Based Exercise	Green Exercise
Hayashi et al.[48]	Environmental Control in Biology	2008	Japan	Quantitative	Quasi-experimental	Horticultural Therapy	Horticultural Activity
			Japan	Quantitative	Single group	Horticultural Therapy	Horticultural Activity
			Japan	Quantitative	Single group	Horticultural Therapy	Horticultural Activity
Janelle et al.[49]	Australasian Psychiatry	2009	Canada	Both	Single group	Nature Therapy Trip	Wilderness Trip
Cha & Kim[50]	Journal of Korean Academy of Nursing	2009	South Korea	Qualitative	Single group	Nature Therapy Trip	Forest Experience
Lee et al.[51]	Scandinavian Journal of Forest Research	2009	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest
Park et al.[52]	Silva Fennica	2009	Japan	Quantitative	Crossover	Forest Bathing	Forest Recreation
Kam et al.[53]	Hong Kong Journal of Occupational Therapy	2010	Hong Kong	Both	Randomized controlled trial	Horticultural Therapy	Horticulture
Gonzalez et al.[54]	Journal of Advanced Nursing	2010	Norway	Quantitative	Single group	Horticultural Therapy	Therapeutic Horticulture
Kjellgren & Buhrkall[55]	Journal of Environmental Psychology	2010	Sweden	Both	Crossover	Engage With/Sit/Notice Nature	Spending Time In Nature
Mackay & Neill[56]	Psychology of Sport and Exercise	2010	Australia	Quantitative	Quasi-experimental	Nature-Based Exercise	Green Exercise
Johansson et al.[57]	Applied Psychology: Health and Well-Being	2011	Sweden	Quantitative	Crossover	Nature-Based Exercise	Walking Outdoors
Morita et al.[58]	Biopsychosocial Medicine	2011	Japan	Quantitative	Quasi-experimental	Nature-Based Exercise	Walking In A Forest
Kyriakopoulos[59]	Counselling & Psychotherapy Research	2011	UK	Qualitative	Single group	Nature-Based Challenge	Outdoor Experience
Gonzalez et al.[60]	International Journal of Mental Health Nursing	2011	Norway	Quantitative	Single group	Horticultural Therapy	Therapeutic Horticulture
Gonzalez et al.[61]	Issues in Mental Health Nursing	2011	Norway	Quantitative	Single group	Horticultural Therapy	Therapeutic Horticulture
Matsunaga et al.[62]	Japanese Journal of Hygiene	2011	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Relaxing In A Rooftop Forest

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Lee et al.[63]	Japanese Journal of Hygiene	2011	Japan	Quantitative	Quasi-experimental	Forest Bathing	Forest Therapy
Martens et al.[64]	Journal of Environmental Psychology	2011	Switzerland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Forest
Greffrath et al.[65]	Leisure Studies	2011	South Africa	Both	Crossover	Nature Challenge Trip	Wilderness Adventure
O'Brien et al.[66]	Perspectives in Public Health	2011	UK	Qualitative	Single group	Outdoor Education/Volunteerism	Environmental Volunteering
			UK	Qualitative	Single group	Outdoor Education/Volunteerism	Environmental Volunteering
Nisbet & Zelenski[67]	Psychological Science	2011	Canada	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
			Canada	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Lee et al.[68]	Public Health	2011	Japan	Quantitative	Crossover	Nature Retreat Trip	Forest Bathing
Mao et al.[69]	Biomedical and Environmental Sciences	2012	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Bathing
Barley et al.[70]	British Journal of General Practice	2012	UK	Qualitative	Single group	Horticultural Therapy	Social And Therapeutic Horticulture
Sung et al.[71]	Clinical and Experimental Hypertension	2012	South Korea	Quantitative	Quasi-experimental	Forest Bathing	Forest Therapy
Mao et al.[72]	Journal of Cardiology	2012	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Bathing
Bettmann et al.[73]	Journal of Child and Family Studies	2012	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Sellers et al.[74]	Preventive Medicine	2012	UK	Quantitative	Crossover	Nature-Based Exercise	Walking In A Park
Adevi et al.[75]	Urban Forestry & Urban Greening	2012	Sweden	Qualitative	Single group	Horticultural Therapy	Garden Therapy
Blair et al.[76]	Acta Oncologica	2013	USA	Quantitative	Single group	Horticultural Therapy	Gardening
Hewitt et al.[77]	British Journal of Occupational Therapy	2013	UK	Both	Single group	Horticultural Therapy	Therapeutic Gardening

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Goto et al.[78]	Health Environments Research & Design Journal	2013	USA	Quantitative	Crossover	Engage With/Sit/Notice Nature	Garden Visits
Beil & Hanes[79]	International Journal of Environmental Research and Public Health	2013	USA	Quantitative	Crossover	Engage With/Sit/Notice Nature	Sitting In Nature
Crust et al.[80]	International Journal of Sport Psychology	2013	UK	Quantitative	Quasi-experimental	Nature-Based Exercise	Green Exercise
Grabbe et al.[81]	Journal of Holistic Nursing	2013	USA	Qualitative	Single group	Horticultural Therapy	Gardening
Song et al.[82]	Journal of Physiological Anthropology	2013	Japan	Quantitative	Crossover	Nature-Based Exercise	Walking In A Park
Song et al.[83]	Journal of Physiological Anthropology	2013	Japan	Quantitative	Crossover	Forest Bathing	Forest Therapy
Vella et al.[84]	Military Medicine	2013	US	Quantitative	Single group	Nature Challenge Trip	Outdoor Recreation
Reed et al.[85]	PloS One	2013	UK	Quantitative	Crossover	Nature-Based Exercise	Green Exercise
Hoag et al.[86]	Residential Treatment for Children & Youth	2013	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Rogers et al.[87]	American Journal of Occupational Therapy	2014	USA	Quantitative	Single group	Nature-Based Challenge	Ocean Therapy
Sempik et al.[88]	British Journal of Occupational Therapy	2014	UK	Quantitative	Single group	Horticultural Therapy	Social And Therapeutic Horticulture
Passmore & Howell[89]	Ecopsychology	2014	Canada	Both	Randomized controlled trial	Engage With/Sit/Notice Nature	Nature Activities
Lee & Lee[90]	European Journal of Integrative Medicine	2014	South Korea	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Forest
Lee et al.[91]	Evidence-based Complementary and Alternative Medicine	2014	Japan	Quantitative	Crossover	Forest Bathing	Forest Therapy
Sahlin et al.[92]	International Journal of Environmental Research and Public Health	2014	Sweden	Both	Single group	Horticultural Therapy	Nature-Based Stress Management
Dolgin[93]	Journal of Creativity in Mental Health	2014	USA	Qualitative	Single group	Nature Challenge Trip	Wilderness Intervention
Weng & Chiang[94]	Journal of Leisure Research	2014	Taiwan	Quantitative	Quasi-experimental	Engage With/Sit/Notice Nature	Outdoor Leisure Activities
Song et al.[95]	Journal of Physiological Anthropology	2014	Japan	Quantitative	Crossover	Nature-Based Exercise	Walking In A Park

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Währborg et al.[96]	Journal of Rehabilitation Medicine	2014	Sweden	Quantitative	Quasi-experimental	Horticultural Therapy	Gardening
Ritchie et al.[97]	Rural and Remote Health	2014	Canada	Both	Quasi-experimental	Nature Challenge Trip	Outdoor Adventure Leadership Experience
Pálsdóttir et al.[98]	Scandinavian Journal of Occupational Therapy	2014	Sweden	Both	Single group	Horticultural Therapy	Nature-Based Rehabilitation
Brown et al.[99]	Scandinavian Journal of Work, Environment & Health	2014	UK	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Detweiler et al.[100]	Alternative Therapies in Health and Medicine	2015	USA	Quantitative	Randomized controlled trial	Horticultural Therapy	Horticultural Therapy
Spees et al.[101]	American Journal of Health Behavior	2015	USA	Qualitative	Single group	Horticultural Therapy	Urban Gardening
Grazuleviciene et al.[102]	Biomed Research International	2015	Lithuania	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Park
Tucker et al.[103]	Child & Youth Care Forum	2015	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness Therapy
Richardson et al.[104]	Environmental Values	2015	Multiple	Qualitative	Single group	Engage With/Sit/Notice Nature	Noticing Nature
Kim et al.[105]	European Journal of Integrative Medicine	2015	South Korea	Quantitative	Single group	Nature Retreat Trip	Forest Therapy
López-Pousa et al.[106]	Evidence-Based Complementary and Alternative Medicine	2015	Spain	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Forest
Barton et al.[107]	International Journal of Environmental Health Research	2015	UK	Quantitative	Single group	Nature Play	Nature Play
Sahlin et al.[108]	International Journal of Environmental Research and Public Health	2015	Sweden	Quantitative	Quasi-experimental	Horticultural Therapy	Nature-Based Rehabilitation
Ritchie et al.[109]	Journal of Adventure Education and Outdoor Learning	2015	Canada	Qualitative	Single group	Nature Challenge Trip	Outdoor Adventure Leadership Experience
Gidlow et al.[110]	Journal of Environmental Psychology	2015	UK	Quantitative	Crossover	Nature-Based Exercise	Walking In Nature
Bratman et al.[111]	Proceedings of the National Academy of Sciences	2015	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Nature Experience

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Caddick et al.[112]	Qualitative Health Research	2015	UK	Qualitative	Single group	Nature Therapy Trip	Surfing
Sonntag-Ostrom et al.[113]	Scandinavian Journal of Forest Research	2015	Sweden	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Forest Rehabilitation
Sonntag-Ostrom et al.[114]	Urban Forestry & Urban Greening	2015	Sweden	Qualitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Forest Rehabilitation
Combs et al.[115]	Child & Youth Care Forum	2016	USA	Quantitative	Single group	Nature Therapy Trip	Outdoor Behavioral Healthcare
Korpela et al.[116]	Ecopsychology	2016	Finland	Quantitative	Crossover	Nature-Based Exercise	Walking In Nature
Bowen et al.[117]	Evaluation and Program Planning	2016	Australia	Quantitative	Single group	Nature Therapy Trip	Wilderness Adventure Therapy
Yu et al.[118]	Forest Science and Technology	2016	South Korea	Quantitative	Single group	Nature Retreat Trip	Forest Therapy
Brown et al.[119]	HortTechnology	2016	USA	Quantitative	Single group	Horticultural Therapy	Gardening
Gladwell et al.[120]	International Journal of Environmental Research and Public Health	2016	UK	Quantitative	Crossover	Nature-Based Exercise	Walking In Nature
Rogerson et al.[121]	International Journal of Environmental Research and Public Health	2016	UK	Quantitative	Crossover	Nature-Based Exercise	Green Exercise
Han et al.[122]	International Journal of Environmental Research and Public Health	2016	South Korea	Quantitative	Quasi-experimental	Nature Retreat Trip	Forest Therapy
Lacharite-Lemieux & Dionne[123]	Journal of Aging and Physical Activity	2016	Canada	Quantitative	Randomized controlled trial	Nature-Based Exercise	Outdoor Physical Activity
Combs et al.[124]	Journal of Child and Family Studies	2016	USA	Quantitative	Single group	Nature Therapy Trip	Outdoor Behavioral Healthcare
Barton et al.[125]	Journal of Experiential Education	2016	Multiple	Quantitative	Single group	Nature Challenge Trip	Wilderness Expedition
Tucker et al.[126]	Journal of Experiential Education	2016	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
McCaffrey & Liehr[127]	Journal of Holistic Nursing	2016	USA	Quantitative	Single group	Nature-Based Exercise	Reflective Walking In A Garden
Howarth et al.[128]	Journal of Public Mental Health	2016	UK	Qualitative	Single group	Horticultural Therapy	Therapeutic Horticulture

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Jakubec et al.[129]	Landscape Research	2016	Canada	Both	Single group	Nature Challenge Trip	Adaptive Nature Trip
Fruhauf et al.[130]	Mental Health and Physical Activity	2016	Austria	Quantitative	Crossover	Nature-Based Exercise	Outdoor Physical Activity
Rogerson et al.[131]	Perspectives in Public Health	2016	UK	Quantitative	Quasi-experimental	Nature-Based Exercise	Green Exercise
Liden et al.[132]	Scandinavian Journal of Caring Sciences	2016	Sweden	Quantitative	Single group	Horticultural Therapy	Garden Therapy
Calogiuri et al.[133]	Work	2016	Norway	Quantitative	Randomized controlled trial	Nature-Based Exercise	Green Exercise
Vujcic et al.[134]	Environmental Research	2017	Serbia	Quantitative	Randomized controlled trial	Horticultural Therapy	Nature-Based Therapy
Turner & Stevinson[135]	International Journal of Environmental Health Research	2017	UK	Quantitative	Crossover	Nature-Based Exercise	Green Exercise
Grahn et al.[136]	International Journal of Environmental Research and Public Health	2017	Sweden	Quantitative	Quasi-experimental	Horticultural Therapy	Nature-Based Rehabilitation
Yu et al.[137]	International Journal of Environmental Research and Public Health	2017	Taiwan	Quantitative	Single group	Forest Bathing	Forest Bathing
Bang et al.[138]	International Journal of Environmental Research and Public Health	2017	South Korea	Quantitative	Quasi-experimental	Nature-Based Exercise	Walking In A Forest
Bettmann et al.[139]	Journal of Child and Family Studies	2017	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Strout et al.[140]	Journal of Community Health Nursing	2017	USA	Both	Single group	Horticultural Therapy	Gardening
Roberts et al.[141]	Journal of Counseling and Development	2017	USA	Quantitative	Single group	Nature Therapy Trip	Outdoor Behavioral Healthcare
de Bloom et al.[142]	Journal of Environmental Psychology	2017	Finland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Park
Passmore & Holder[143]	Journal of Positive Psychology	2017	Canada	Both	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature
Largo-Wight et al.[144]	Journal of Workplace Behavioral Health	2017	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Outdoor Breaks
Smidl et al.[145]	Occupational Therapy in Mental Health	2017	USA	Both	Single group	Horticultural Therapy	Therapeutic Gardening

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Triguero-Mas et al.[146]	PLoS One	2017	Spain	Quantitative	Crossover	Engage With/Sit/Notice Nature	Nature Exposure
Niedermeier et al.[147]	PLoS One	2017	Austria	Quantitative	Crossover	Nature-Based Challenge	Mountain Hiking
Takayama et al.[148]	Progress in Earth and Planetary Science	2017	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest
Richardson & Sheffield[149]	Psyecology	2017	UK	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature
Woodford et al.[150]	Therapeutic Recreation Journal	2017	Canada	Both	Single group	Nature Therapy Trip	Wilderness Therapy
Soeda et al.[151]	Transplantation Proceedings	2017	Japan	Both	Single group	Nature Challenge Trip	Outdoor Nature Challenge
Dolling et al.[152]	Urban Forestry & Urban Greening	2017	Sweden	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Visiting A Forest
Han[153]	Urban Forestry & Urban Greening	2017	Taiwan	Quantitative	Randomized controlled trial	Nature-Based Exercise	Green Exercise
Chiumento et al.[154]	BMC Public Health	2018	UK	Both	Single group	Horticultural Therapy	Therapeutic Horticulture
Stigsdotter et al.[155]	British Journal of Psychiatry	2018	Denmark	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Nature-Based Therapy
Trapasso et al.[156]	Children	2018	UK	Both	Crossover	Forest Bathing	Forest School
DeMille et al.[157]	Children and Youth Services Review	2018	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Outdoor Behavioral Healthcare
Marchand et al.[158]	Complementary Therapies in Medicine	2018	USA	Quantitative	Quasi-experimental	Nature-Based Challenge	Sailing Adventure Therapy
Han et al.[159]	Complementary Therapies in Medicine	2018	South Korea	Quantitative	Randomized controlled trial	Horticultural Therapy	Horticultural Therapy
Oh et al.[160]	Complementary Therapies in Medicine	2018	South Korea	Quantitative	Quasi-experimental	Horticultural Therapy	Horticultural Therapy
McCree et al.[161]	Early Child Development and Care	2018	UK	Both	Quasi-experimental	Forest Bathing	Forest School
Fuegen & Breitenbecher[162]	Ecopsychology	2018	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Schweighardt et al.[163]	Ecopsychology	2018	USA	Quantitative	Single group	Nature Challenge Trip	Nature-Based Physical Activity Training
Silva et al.[164]	Ecopsychology	2018	Portugal	Both	Single group	Ecotherapy	Nature-Based Development Program
Hassan et al.[165]	Evidence-Based Complementary and Alternative Medicine	2018	China	Quantitative	Crossover	Nature-Based Exercise	Walking In A Forest
Chen et al.[166]	Forests	2018	Taiwan	Quantitative	Single group	Nature Retreat Trip	Forest Bathing
Calogiuri et al.[167]	Frontiers in Psychology	2018	Norway	Both	Crossover	Nature-Based Exercise	Walking In Nature
Pasanen et al.[168]	Frontiers in Psychology	2018	Finland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
			Finland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Largo-Wight et al.[169]	International Journal of Environmental Health Research	2018	USA	Quantitative	Crossover	Forest Bathing	Outdoor Classroom
Corazon et al.[170]	International Journal of Environmental Research and Public Health	2018	Denmark	Both	Quasi-experimental	Ecotherapy	Nature-Based Therapy
Mygind et al.[171]	International Journal of Environmental Research and Public Health	2018	Denmark	Quantitative	Crossover	Forest Schools/ Outdoor Classrooms	Outdoor Education
Wallner et al.[172]	International Journal of Environmental Research and Public Health	2018	Austria	Quantitative	Crossover	Engage With/Sit/Notice Nature	Outdoor Breaks
Corazon et al.[173]	International Journal of Environmental Research and Public Health	2018	Denmark	Quantitative	Randomized controlled trial	Ecotherapy	Nature-Based Therapy
Ng et al.[174]	International Journal of Environmental Research and Public Health	2018	Singapore	Quantitative	Randomized controlled trial	Horticultural Therapy	Horticultural Therapy
Tesler et al.[175]	International Journal of Environmental Research and Public Health	2018	Israel	Quantitative	Quasi-experimental	Nature-Based Exercise	Physical Activity In A Forest
Bang et al.[176]	International Journal of Environmental Research and Public Health	2018	South Korea	Quantitative	Quasi-experimental	Forest Schools/ Outdoor Classrooms	Health Promotion Program In A Forest

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Kwon et al.[177]	International Journal of Sport Psychology	2018	South Korea	Both	Crossover	Nature-Based Exercise	Green Exercise
Conlon et al.[178]	Journal of Adventure Education and Outdoor Learning	2018	UK	Qualitative	Single group	Nature Therapy Trip	Wilderness Therapy
Hignett et al.[179]	Journal of Adventure Education and Outdoor Learning	2018	UK	Both	Single group	Nature-Based Challenge	Surfing
McIver et al.[180]	Journal of Creativity in Mental Health	2018	Australia	Qualitative	Single group	Nature Therapy Trip	Wilderness Therapy
Sianoja et al.[181]	Journal of Occupational Health Psychology	2018	Finland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Park
Williams et al.[182]	Journal of Outdoor and Environmental Education	2018	Australia	Quantitative	Crossover	Nature Challenge Trip	Outdoor Adventure
Tsao et al.[183]	Oncotarget	2018	Taiwan	Quantitative	Single group	Nature Retreat Trip	Visiting A Forest
Mokhtar et al.[184]	Pertanika Journal of Social Science and Humanities	2018	Malaysia	Quantitative	Crossover	Nature-Based Exercise	Walking In Green Space
Razani et al.[12]	PLoS One	2018	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Park Prescription
Tucker et al.[185]	Research on Social Work Practice	2018	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Bielinis et al.[186]	Urban Forestry & Urban Greening	2018	Poland	Quantitative	Randomized controlled trial	Forest Bathing	Forest Bathing
Bailey et al.[187]	World Leisure Journal	2018	USA	Quantitative	Crossover	Nature-Based Exercise	Walking In Nature
Morris & Scott[188]	Advances in Mental Health	2019	UK	Qualitative	Single group	Nature-Based Exercise	Running In A Park
Harper et al.[189]	Children and Youth Services Review	2019	Canada	Qualitative	Single group	Nature Therapy Trip	Wilderness Therapy
Zhou et al.[190]	Chinese Geographical Science	2019	China	Quantitative	Crossover	Forest Bathing	Forest Bathing
Ward et al.[191]	Early Child Development and Care	2019	Australia	Qualitative	Single group	Nature Play	Nature Play
Furuyashiki et al.[192]	Environmental Health and Preventive Medicine	2019	Japan	Quantitative	Single group	Forest Bathing	Forest Bathing
Song et al.[193]	Forests	2019	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Bielinis et al.[10]	Forests	2019	Poland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Forest Recreation
Hunter et al.[194]	Frontiers in Psychology	2019	USA	Quantitative	Single group	Engage With/Sit/Notice Nature	Nature Experience
Ojalaa et al.[195]	Health & Place	2019	Finland	Quantitative	Crossover	Nature-Based Exercise	Viewing And Walking In Nature
Gabrielsen et al.[196]	International Journal of Adolescence and Youth	2019	Norway	Both	Single group	Nature Therapy Trip	Wilderness Therapy
Maund et al.[197]	International Journal of Environmental Research and Public Health	2019	UK	Both	Single group	Outdoor Education/Volunteerism	Wetland Nature-Based Intervention
Koselka et al.[198]	International Journal of Environmental Research and Public Health	2019	USA	Quantitative	Crossover	Nature-Based Exercise	Nature Prescription
Yi et al.[199]	International Journal of Environmental Research and Public Health	2019	South Korea	Quantitative	Quasi-experimental	Forest Bathing	Forest Therapy
McEwan et al.[200]	International Journal of Environmental Research and Public Health	2019	UK	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature
Takayama et al.[201]	International Journal of Environmental Research and Public Health	2019	Japan	Quantitative	Crossover	Nature-Based Exercise	Sitting And Walking In The Forest
Coventry et al.[202]	International Journal of Environmental Research and Public Health	2019	UK	Both	Quasi-experimental	Outdoor Education/Volunteerism	Activities In Green Space
Fraser et al.[203]	International Journal of Environmental Research and Public Health	2019	UK	Both	Quasi-experimental	Nature-Based Exercise	Green Exercise
O'Brien[204]	International Journal of Environmental Research and Public Health	2019	UK	Qualitative	Single group	Nature-Based Exercise	Physical Activity In A Forest
Lyu et al.[205]	International Journal of Environmental Research and Public Health	2019	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Therapy
Pratiwi et al.[206]	International Journal of Environmental Research and Public Health	2019	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing Urban Parks
Song et al.[207]	International Journal of Environmental Research and Public Health	2019	Japan	Quantitative	Crossover	Nature-Based Exercise	Walking In A Forest

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Mutz et al.[208]	Journal of Adventure Education and Outdoor Learning	2019	France	Quantitative	Single group	Nature Challenge Trip	Outdoor Adventure
Dopko et al.[209]	Journal of Environmental Psychology	2019	Canada	Quantitative	Crossover	Engage With/Sit/Notice Nature	Nature Experience
An et al.[210]	Journal of Forest Research	2019	China	Quantitative	Crossover	Nature-Based Exercise	Walking In A Forest
Lyu et al.[211]	Journal of Forest Research	2019	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Therapy
Usuba et al.[212]	Journal of Outdoor and Environmental Education	2019	Canada	Quantitative	Single group	Nature Challenge Trip	Outdoor Adventure Leadership Experience
Lucke et al.[213]	Mental Illness	2019	Germany	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Mindfulness In Nature
Hitter et al.[214]	Notulae Botanicae Horti Agrobotanici Cluj-Napoca	2019	Romania	Quantitative	Single group	Horticultural Therapy	Therapeutic Horticulture
Bettmann et al.[215]	Psychological Services	2019	USA	Quantitative	Single group	Nature Therapy Trip	Therapeutic Adventure Program
Rodríguez-Montero et al.[216]	Revista de Educacion Fisica	2019	Costa Rica	Quantitative	Single group	Forest Bathing	Being Outdoors
Glover & Polley[217]	Sports	2019	Australia	Quantitative	Single group	Nature-Based Exercise	Green Exercise
Ekenga et al.[218]	Sustainability	2019	USA	Quantitative	Single group	Forest Schools/ Outdoor Classrooms	Nature Contact
Lee et al.[219]	Urban Forestry & Urban Greening	2019	South Korea	Qualitative	Single group	Forest Bathing	Forest Therapy
Forsyth et al.[220]	Ecopsychology	2020	Canada	Both	Single group	Nature Challenge Trip	Wilderness Adventure
Cooley et al.[221]	Ecopsychology	2020	UK	Qualitative	Single group	Nature-Based Exercise	Walking In Green Space
Markwell & Gladwin[222]	Ecopsychology	2020	UK	Both	Quasi-experimental	Forest Bathing	Shinrin Yoku
Heras et al.[223]	Education 3-13	2020	Spain	Qualitative	Single group	Forest Schools/ Outdoor Classrooms	Nature Field Trips

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Olafsdottir et al.[224]	Environment and Behavior	2020	Iceland	Both	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Saadi et al.[225]	Environmental Research	2020	Israel	Quantitative	Crossover	Engage With/Sit/Notice Nature	Visiting Urban Parks
Janeczko et al.[226]	Forests	2020	Poland	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In A Forest
Browning et al.[227]	Frontiers in Psychology	2020	USA	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Nature Exposure
Sprague et al.[228]	Health Equity	2020	USA	Both	Single group	Forest Schools/ Outdoor Classrooms	Nature-Based Environmental Education
Brown et al.[229]	Health Promotion Practice	2020	USA	Quantitative	Randomized controlled trial	Horticultural Therapy	Gardening
Kim et al.[230]	International Journal of Environmental Research and Public Health	2020	South Korea	Quantitative	Randomized controlled trial	Forest Bathing	Forest Therapy
Cervinka et al.[231]	International Journal of Environmental Research and Public Health	2020	Austria	Quantitative	Single group	Nature-Based Exercise	Forest Tour
Lim et al.[232]	International Journal of Environmental Research and Public Health	2020	Singapore	Both	Quasi-experimental	Engage With/Sit/Notice Nature	Nature Immersion
Irvine et al.[233]	International Journal of Environmental Research and Public Health	2020	UK	Both	Single group	Nature-Based Exercise	Walking In Nature
Zeng et al.[234]	International Journal of Environmental Research and Public Health	2020	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Therapy
Song et al.[235]	International Journal of Environmental Research and Public Health	2020	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest
Rogerson et al.[236]	International Journal of Environmental Research and Public Health	2020	UK	Quantitative	Crossover	Nature-Based Exercise	Green Exercise
Peters et al.[237]	International Journal of Environmental Research and Public Health	2020	Netherlands	Quantitative	Crossover	Engage With/Sit/Notice Nature	Nature Experience
Park et al.[238]	International Journal of Environmental Research and Public Health	2020	South Korea	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Therapy

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Kim et al.[239]	International Journal of Environmental Research and Public Health	2020	South Korea	Quantitative	Single group	Nature Retreat Trip	Forest Therapy
Wu et al.[240]	International Journal of Gerontology	2020	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Bathing
Makizako et al.[241]	Journal of Clinical Medicine	2020	Japan	Quantitative	Randomized controlled trial	Horticultural Therapy	Horticultural Activity
Assem et al.[242]	Journal of Engineering and Applied Science	2020	Egypt	Quantitative	Single group	Nature-Based Exercise	Walking In Nature
Payne et al.[243]	Journal of Environmental and Public Health	2020	Australia	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Spending Time In Nature
Norton et al.[244]	Journal of Outdoor Recreation, Education, and Leadership	2020	USA	Quantitative	Quasi-experimental	Ecotherapy	Outdoor Adventure Therapy
Kim et al.[245]	Journal of People, Plants, and Environment	2020	South Korea	Quantitative	Single group	Nature Therapy Trip	Forest Therapy
Song et al.[246]	Journal of Psychosocial Nursing and Mental Health Services	2020	South Korea	Both	Single group	Forest Schools/ Outdoor Classrooms	Health Promotion Program In A Forest
Palsdottir et al.[247]	Journal of Rehabilitation Medicine	2020	Sweden	Quantitative	Randomized controlled trial	Horticultural Therapy	Nature-Based Rehabilitation
McEwan et al.[248]	Landscape and Urban Planning	2020	UK	Qualitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature
Choe et al.[249]	Landscape and Urban Planning	2020	UK	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Mindfulness In Nature
Wheeler et al.[250]	PLoS One	2020	UK	Quantitative	Randomized controlled trial	Nature-Based Exercise	Outdoor Recreation
			UK	Quantitative	Randomized controlled trial	Nature-Based Exercise	Outdoor Recreation
Triguero-Mas et al.[251]	Preventing Chronic Disease	2020	Spain	Both	Quasi-experimental	Horticultural Therapy	Rooftop Gardening
Johnson et al.[252]	Psychological Trauma-Theory Research Practice and Policy	2020	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Sia et al.[253]	Scientific Reports	2020	Singapore	Quantitative	Single group	Horticultural Therapy	Therapeutic Horticulture

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Sobko et al.[254]	Scientific Reports	2020	Hong Kong	Quantitative	Randomized controlled trial	Nature Play	Nature-Related Activities
Battaglia et al.[255]	Sustainability	2020	Italy	Quantitative	Quasi-experimental	Nature-Based Exercise	Walking In Nature
Song et al.[256]	Sustainability	2020	Japan	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest
Simkin et al.[257]	Urban Forestry & Urban Greening	2020	Finland	Quantitative	Crossover	Nature-Based Exercise	Viewing And Walking In A Forest
Rajoo et al.[258]	Urban Forestry & Urban Greening	2020	Malaysia	Quantitative	Single group	Forest Bathing	Forest Therapy
Deng et al.[259]	Urban Forestry & Urban Greening	2020	China	Quantitative	Crossover	Nature-Based Exercise	Sitting And Walking In Nature
Yu & Hsieh[260]	Urban Forestry & Urban Greening	2020	Taiwan	Quantitative	Single group	Forest Bathing	Forest Therapy
Bourdon & Belmin[261]	Alzheimers Research & Therapy	2021	France	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Garden Visits
Izenstark et al.[262]	Applied Psychology: Health and Well-Being	2021	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Samsudin et al.[263]	Asian Journal of University Education	2021	Malaysia	Quantitative	Single group	Nature Challenge Trip	Outdoor Education
Missen et al.[264]	Australian Journal of Primary Health	2021	Australia	Both	Single group	Horticultural Therapy	Therapeutic Gardening
Petrunoff et al.[265]	BMC Public Health	2021	Singapore	Both	Randomized controlled trial	Nature-Based Exercise	Park Prescription
Littman et al.[266]	BMJ Open	2021	USA	Both	Randomized controlled trial	Nature-Based Exercise	Nature Hiking
Suto et al.[267]	Canadian Journal of Occupational Therapy	2021	Canada	Qualitative	Single group	Horticultural Therapy	Community Gardening
Meore et al.[268]	Complementary Therapies in Medicine	2021	USA	Quantitative	Single group	Horticultural Therapy	Horticultural Therapy
Lassell et al.[269]	Complementary Therapies in Medicine	2021	USA	Quantitative	Quasi-experimental	Horticultural Therapy	Adaptive Gardening
Shehade & Kyriakopolous[270]	Counselling & Psychotherapy Research	2021	UK	Qualitative	Single group	Nature Challenge Trip	Adventure Therapy

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Liu et al.[271]	Forests	2021	China	Quantitative	Crossover	Nature-Based Exercise	Nature Experience
Korcz et al.[272]	Forests	2021	Poland	Quantitative	Randomized controlled trial	Outdoor Education/Volunteerism	Education In A Forest
Janeczko et al.[273]	Forests	2021	Poland	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest
Pollin & Retzlaff-Furst[274]	Frontiers in Psychology	2021	Germany	Both	Crossover	Horticultural Therapy	Gardening
Wang et al.[275]	Frontiers in Psychology	2021	China	Quantitative	Randomized controlled trial	Nature-Based Exercise	Physical Activity In A Park
Pirchio et al.[276]	Frontiers in Psychology	2021	Italy	Quantitative	Quasi-experimental	Outdoor Education/Volunteerism	Outdoor Environmental Education
			Italy	Quantitative	Quasi-experimental	Outdoor Education/Volunteerism	Outdoor Environmental Education
Schoenberg et al.[277]	German Journal of Sports Medicine	2021	Germany	Quantitative	Single group	Nature Challenge Trip	Ocean Sailing
Djernis et al.[278]	Healthcare	2021	Denmark	Quantitative	Randomized controlled trial	Nature Retreat Trip	Mindfulness In Nature
Prentice & Waliczek[279]	HortTechnology	2021	USA	Quantitative	Quasi-experimental	Forest Schools/ Outdoor Classrooms	Taking Tests In A Natural Environment
Zhoua et al.[280]	Industrial Crops & Products	2021	China	Quantitative	Randomized controlled trial	Nature Retreat Trip	Forest Bathing
Lee et al.[281]	Integrative Medicine Research	2021	South Korea	Both	Single group	Horticultural Therapy	Horticultural Therapy
Høegmark et al.[282]	International Journal of Environmental Research and Public Health	2021	Denmark	Quantitative	Quasi-experimental	Nature-Based Exercise	Nature-Based Rehabilitation
Meneguzzo et al.[283]	International Journal of Environmental Research and Public Health	2021	Italy	Quantitative	Quasi-experimental	Forest Bathing	Forest Therapy
Yu et al.[284]	International Journal of Environmental Research and Public Health	2021	Taiwan	Quantitative	Randomized controlled trial	Forest Bathing	Forest Therapy
Liu et al.[285]	International Journal of Environmental Research and Public Health	2021	China	Quantitative	Crossover	Nature-Based Exercise	Sitting And Walking In The Forest

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Yi et al.[286]	International Journal of Environmental Research and Public Health	2021	South Korea	Quantitative	Randomized controlled trial	Nature-Based Exercise	Qigong And Walking In A Forest
Park et al.[287]	International Journal of Environmental Research and Public Health	2021	South Korea	Quantitative	Single group	Nature Therapy Trip	Forest Healing
Jeon et al.[288]	International Journal of Environmental Research and Public Health	2021	South Korea	Quantitative	Quasi-experimental	Nature Therapy Trip	Forest Therapy
Simkin et al.[289]	International Journal of Environmental Research and Public Health	2021	Finland	Quantitative	Crossover	Nature-Based Exercise	Viewing And Walking In A Forest
Anabitarte et al.[290]	International Journal of Environmental Research and Public Health	2021	Spain	Quantitative	Crossover	Nature Play	Green Space Exposure
Kim et al.[291]	International Journal of Environmental Research and Public Health	2021	South Korea	Quantitative	Randomized controlled trial	Nature-Based Exercise	Forest Activities
Petersen et al.[292]	International Journal of Environmental Research and Public Health	2021	Multiple	Qualitative	Single group	Nature Challenge Trip	Solo Experiences In Nature
Kim & Shin[293]	International Journal of Environmental Research and Public Health	2021	South Korea	Both	Randomized controlled trial	Forest Bathing	Forest Therapy
Barrable et al.[294]	International Journal of Environmental Research and Public Health	2021	UK	Quantitative	Single group	Engage With/Sit/Notice Nature	Mindfulness In Nature
Kang et al.[295]	International Journal of Environmental Research and Public Health	2021	South Korea	Quantitative	Randomized controlled trial	Ecotherapy	Nature-Based Art Therapy
Andkjaer et al.[296]	International Journal of Environmental Research and Public Health	2021	Denmark	Qualitative	Single group	Nature-Based Exercise	Friluftsliv
Morris et al.[297]	International Journal of Exercise Science	2021	Canada	Both	Quasi-experimental	Engage With/Sit/Notice Nature	Nature Experience
Kotera & Fido[298]	International Journal of Mental Health and Addiction	2021	Japan	Quantitative	Single group	Nature Retreat Trip	Shinrin Yoku
Albers et al.[299]	Journal of Adolescent and Young Adult Oncology	2021	Italy	Both	Single group	Nature Challenge Trip	Positive Psychology Group Intervention In Nature
Blaine & Akhurst[300]	Journal of Adventure Education and Outdoor Learning	2021	South Africa	Both	Quasi-experimental	Nature Challenge Trip	Outdoor Adventure Education

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Fernee et al.[301]	Journal of Adventure Education and Outdoor Learning	2021	Norway	Qualitative	Single group	Nature Therapy Trip	Wilderness Therapy
Kiers et al.[302]	Journal of American College Health	2021	USA	Both	Quasi-experimental	Forest Schools/ Outdoor Classrooms	Nature-Based Instruction
Bettmann et al.[303]	Journal of Clinical Psychology	2021	USA	Quantitative	Single group	Nature-Based Challenge	Spending Time Outdoors
van den Berg et al.[304]	Journal of Environmental Psychology	2021	Netherlands	Both	Quasi-experimental	Ecotherapy	Walk And Talk Coaching In Nature
Stevenson et al.[305]	Journal of Environmental Psychology	2021	New Zealand	Quantitative	Crossover	Nature-Based Exercise	Walking In Nature
Sneed et al.[306]	Journal of Experiential Education	2021	USA	Quantitative	Randomized controlled trial	Nature-Based Challenge	Nature Hiking
Bettmann et al.[307]	Journal of Experiential Education	2021	USA	Quantitative	Single group	Nature Therapy Trip	Therapeutic Adventure Program
Ekstam et al.[308]	Journal of Occupational Science	2021	Sweden	Qualitative	Single group	Horticultural Therapy	Nature-Based Rehabilitation
Park et al.[309]	Journal of People, Plants, and Environment	2021	South Korea	Quantitative	Single group	Nature Retreat Trip	Forest Therapy
Sprague & Ekenga[310]	Journal of Public Health	2021	USA	Quantitative	Quasi-experimental	Forest Schools/ Outdoor Classrooms	Nature-Based Education
Keenan et al.[311]	Journal of Public Mental Health	2021	UK	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature
South et al.[312]	Journal of Urban Health	2021	USA	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Spending Time In Green Space
Parry et al.[313]	Journal of Youth Development	2021	UK	Qualitative	Single group	Nature Challenge Trip	Outdoor Adventure
Chalmin-Pui et al.[314]	Landscape and Urban Planning	2021	UK	Both	Quasi-experimental	Horticultural Therapy	Horticulture
Souter-Brown et al.[315]	Landscape and Urban Planning	2021	New Zealand	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Spending Time In A Garden
Talhouk et al.[316]	Local Environment	2021	Lebanon	Both	Single group	Horticultural Therapy	Vertical Gardening
Blair et al.[317]	Nutrients	2021	USA	Quantitative	Single group	Horticultural Therapy	Gardening

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Lacoste et al.[318]	Physical Activity and Health	2021	Canada	Quantitative	Quasi-experimental	Outdoor Education/Volunteerism	Outdoor Learning
Bielinis et al.[319]	PLoS One	2021	Finland	Quantitative	Crossover	Engage With/Sit/Notice Nature	Viewing A Forest
Ng et al.[320]	Social Science & Medicine	2021	Singapore	Quantitative	Randomized controlled trial	Horticultural Therapy	Horticultural Therapy
Lee et al.[321]	Social Science Journal	2021	USA	Quantitative	Crossover	Nature-Based Exercise	Running In Nature
Hung et al.[322]	Sustainability	2021	Taiwan	Quantitative	Randomized controlled trial	Nature-Based Exercise	Qigong In Green Spaces
McEwan et al.[323]	Sustainability	2021	UK	Quantitative	Quasi-experimental	Forest Bathing	Forest Bathing
Herman et al.[324]	Sustainability	2021	Poland	Quantitative	Crossover	Engage With/Sit/Notice Nature	Visiting Informal Green Spaces
Han[325]	Sustainability	2021	Taiwan	Quantitative	Randomized controlled trial	Nature-Based Exercise	Green Exercise
Raman et al.[326]	Sustainability	2021	Malaysia	Quantitative	Crossover	Nature-Based Exercise	Walking In Nature
Lee et al.[327]	Sustainability	2021	South Korea	Quantitative	Single group	Horticultural Therapy	Horticultural Activity
Norman-Burgdolf & Rieske[328]	Urban Forestry & Urban Greening	2021	USA	Quantitative	Single group	Outdoor Education/Volunteerism	Citizen Science
Nghiem et al.[329]	Urban Forestry & Urban Greening	2021	Singapore	Quantitative	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Hong et al.[330]	Urban Forestry & Urban Greening	2021	South Korea	Quantitative	Single group	Nature Therapy Trip	Forest Healing
Mourão et al.[331]	British Journal of Occupational Therapy	2022	Portugal	Quantitative	Quasi-experimental	Horticultural Therapy	Therapeutic Horticulture
Høegmark et al.[332]	Complementary Therapies in Clinical Practice	2022	Denmark	Quantitative	Quasi-experimental	Engage With/Sit/Notice Nature	Nature-Based Intervention
Olszewska-Guizzo et al.[333]	Frontiers in Psychiatry	2022	Singapore	Quantitative	Crossover	Engage With/Sit/Notice Nature	Exposure To A Therapeutic Garden
Passmore et al.[334]	Frontiers in Psychology	2022	Canada (and elsewhere - not	Both	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
			limited to location)				
Tesler et al.[335]	Health Promotion International	2022	Israel	Quantitative	Quasi-experimental	Nature-Based Exercise	Physical Activity In A Forest
Lee et al.[336]	Healthcare	2022	South Korea	Quantitative	Randomized controlled trial	Nature-Based Exercise	Physical Activity In Nature
Ho et al.[337]	International Journal of Environmental Research and Public Health	2022	China	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Nature-Based Intervention
Irvine et al.[338]	International Journal of Environmental Research and Public Health	2022	UK	Qualitative	Single group	Nature-Based Exercise	Walking In Nature
Tsao et al.[339]	International Journal of Environmental Research and Public Health	2022	Taiwan	Quantitative	Quasi-experimental	Nature Retreat Trip	Forest Bathing
Wu et al.[340]	International Journal of Environmental Research and Public Health	2022	China	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Viewing A Forest
Toselli et al.[341]	International Journal of Environmental Research and Public Health	2022	Italy	Quantitative	Single group	Nature-Based Exercise	Park Based Intervention
Toselli et al.[342]	International Journal of Environmental Research and Public Health	2022	Italy	Quantitative	Single group	Nature-Based Exercise	Physical Activity In A Park
Fu et al.[343]	International Journal of Environmental Research and Public Health	2022	Canada	Quantitative	Single group	Nature-Based Exercise	Nature Break
Daniels et al.[344]	International Journal of Hygiene and Environmental Health	2022	Belgium	Quantitative	Randomized controlled trial	Ecotherapy	Nature-Based Activities
Reese et al.[345]	Journal for Specialists in Group Work	2022	USA	Qualitative	Single group	Nature-Based Challenge	Fishing
Stalsberg et al.[346]	Journal of Clinical Medicine	2022	Norway	Quantitative	Randomized controlled trial	Nature-Based Exercise	Outdoor Physical Activity
Song et al.[25]	Journal of Environmental and Occupational Medicine	2022	China	Quantitative	Randomized controlled trial	Forest Bathing	Forest Therapy
Muro et al.[347]	Journal of Forest Research	2022	Spain	Quantitative	Single group	Forest Bathing	Forest Bathing
Passmore et al.[348]	Journal of Happiness Studies	2022	China	Both	Randomized controlled trial	Engage With/Sit/Notice Nature	Noticing Nature

Authors	Journal	Pub. Year	Location	Approach	Design	Intervention Type	Intervention Name
Lipponen et al.[349]	Journal of Multidisciplinary Healthcare	2022	Finland	Quantitative	Single group	Engage With/Sit/Notice Nature	Mindfulness And Physical Exercise In Nature
Johnsen et al.[350]	Landscape Research	2022	Norway	Quantitative	Crossover	Nature-Based Exercise	Walking Outdoors
Blaine & Akhurst[351]	South African Journal of Psychology	2022	South Africa	Quantitative	Single group	Nature Challenge Trip	Outdoor Adventure Education
Noushad et al.[352]	Stress and Health	2022	Pakistan	Quantitative	Randomized controlled trial	Nature-Based Exercise	Physical Activity In Nature
Flowers et al.[353]	Urban Forestry & Urban Greening	2022	Australia	Quantitative	Crossover	Nature-Based Exercise	Green Exercise
Stepansky et al.[354]	Urban Forestry & Urban Greening	2022	USA	Both	Single group	Engage With/Sit/Notice Nature	Garden Visits
Reese et al.[355]	Virtual Reality	2022	Germany	Quantitative	Randomized controlled trial	Forest Bathing	Shinrin Yoku
Jauk-Ajamie & Blackwood[356]	Women & Criminal Justice	2022	USA	Qualitative	Single group	Horticultural Therapy	Gardening

Table 3: Included Articles by Ascending Publication Year– Dissertations and Theses

Authors	Pub. Year	Country	Approach	Study Design	Intervention Type	Intervention Name
Doyle[20]	1981	USA	Both	Quasi-experimental	Nature Challenge Trip	Outdoor Challenge Experience
Plouffe[21]	1981	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness School
Gibson[22]	1981	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Kraus[357]	1982	USA	Quantitative	Randomized controlled trial	Nature Therapy Trip	Wilderness Therapy
Nunley[358]	1983	USA	Quantitative	Randomized controlled trial	Nature Therapy Trip	Therapeutic Outdoor Program
Pompa[359]	1983	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Wilderness Experience
Nurenberg[360]	1985	USA	Both	Single group	Nature Therapy Trip	Wilderness Therapy
Steiger[361]	1986	USA	Both	Randomized controlled trial	Nature Challenge Trip	Wilderness Adventure
Pfirman[362]	1988	USA	Quantitative	Single group	Nature Challenge Trip	Wilderness Challenge
Bateman[363]	1990	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapeutic Camp
Allen[364]	1991	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness Therapy
Hanna[365]	1996	USA	Qualitative	Single group	Nature Therapy Trip	Wilderness Therapy
Bradley[366]	1997	USA	Qualitative	Single group	Ecotherapy	Nature-Based Psychotherapy
Larson[367]	1998	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Adventure Camp
Gin[368]	1998	USA	Both	Single group	Nature Challenge Trip	Wilderness Program
Warpeha[369]	1998	USA	Quantitative	Randomized controlled trial	Outdoor Education/Volunteerism	Outdoor Forestry Program
Shetler[370]	1998	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Adventure Recreation
Edgmon[371]	2001	USA	Qualitative	Quasi-experimental	Nature Therapy Trip	Wilderness Therapy
O'Connell[372]	2001	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Outdoor Adventure Education
Newman[373]	2001	USA	Quantitative	Single group	Nature Challenge Trip	Wilderness Adventure

Authors	Pub. Year	Country	Approach	Study Design	Intervention Type	Intervention Name
Kafsky[374]	2001	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Adventure Orientation
McNamara[375]	2001	USA	Both	Single group	Nature Therapy Trip	Adventure-Based Programming
Martinez[376]	2002	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Hagan[377]	2002	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Orren[378]	2003	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Wilderness Program
Irvine[379]	2004	USA	Both	Randomized controlled trial	Engage With/Sit/Notice Nature	Outdoor Breaks
Vissell[380]	2004	USA	Both	Quasi-experimental	Nature Therapy Trip	Wilderness Therapy
Riley[381]	2004	Canada	Qualitative	Single group	Nature Challenge Trip	Wilderness Trip
Lowe[382]	2005	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Treatment
Marti[383]	2007	USA	Qualitative	Single group	Nature Therapy Trip	Wilderness Therapy
Norton[384]	2007	USA	Both	Single group	Nature Therapy Trip	Wilderness Therapy
Malcarne[385]	2007	USA	Qualitative	Single group	Outdoor Education/Volunteerism	Wilderness Skills Intervention
O'Shea[386]	2008	USA	Quantitative	Single group	Nature Challenge Trip	Outdoor Adventure
Christensen[387]	2008	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Therapy
Lewis[388]	2009	USA	Both	Quasi-experimental	Nature Play	Nature Play
Walsh[389]	2009	USA	Quantitative	Quasi-experimental	Nature Therapy Trip	Wilderness Adventure
Frank[390]	2009	USA	Both	Quasi-experimental	Nature Therapy Trip	Outdoor Experiential Education
Shellman[391]	2009	USA	Both	Quasi-experimental	Nature Challenge Trip	Adventure Education
Rader[392]	2009	USA	Quantitative	Single group	Engage With/Sit/Notice Nature	Spending Time In A Park
Sweeney[393]	2010	USA	Quantitative	Single group	Nature Therapy Trip	Outdoor Behavioral Healthcare
Libby[394]	2010	USA	Qualitative	Single group	Nature Challenge Trip	Wilderness Canoe Trip
Perrin[395]	2010	Canada	Qualitative	Single group	Nature Challenge Trip	Outdoor Education
Belknap[396]	2011	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Outdoor Orientation Program

Authors	Pub. Year	Country	Approach	Study Design	Intervention Type	Intervention Name
Uvanile[397]	2012	Canada	Qualitative	Single group	Horticultural Therapy	Therapeutic Horticulture
Freeman[398]	2013	UK	Both	Quasi-experimental	Nature Challenge Trip	Walking And Solo Experience
Chambliss[399]	2013	USA	Both	Quasi-experimental	Nature Challenge Trip	Practicing Contemplation Outdoors
Chambliss[399]	2013	USA	Both	Randomized controlled trial	Engage With/Sit/Notice Nature	Practicing Contemplation Outdoors
Viti[400]	2014	USA	Quantitative	Quasi-experimental	Nature Challenge Trip	Wilderness Program
Thompson[401]	2014	UK	Quantitative	Single group	Nature-Based Exercise	Green Exercise
Roche[402]	2014	USA	Quantitative	Single group	Nature Therapy Trip	Wilderness Program
Schlenker[403]	2014	USA	Quantitative	Quasi-experimental	Forest Schools/ Outdoor Classrooms	Nature Education
DeMille[404]	2015	USA	Quantitative	Single group	Nature Therapy Trip	Outdoor Behavioral Healthcare
Bratman[405]	2016	USA	Quantitative	Randomized controlled trial	Nature-Based Exercise	Nature Experience
Lloyd[406]	2016	Australia	Both	Single group	Forest Schools/ Outdoor Classrooms	Place-Based Outdoor Learning
Amrhein[407]	2016	USA	Quantitative	Single group	Nature-Based Challenge	Ocean Surfing Course
Vincent[408]	2017	Canada	Qualitative	Single group	Nature-Based Exercise	Walking In Nature
Roberts[409]	2017	UK	Both	Single group	Forest Bathing	Forest School
Vice-Reshel[410]	2017	USA	Both	Single group	Ecotherapy	Nature Therapy
Lewis[411]	2018	USA	Quantitative	Quasi-experimental	Nature-Based Exercise	Walking In A Park
Johnson[412]	2018	UK	Qualitative	Single group	Engage With/Sit/Notice Nature	Mindfulness In Nature
Hughes[413]	2018	USA	Both	Single group	Nature-Based Exercise	Outdoor After-School Program
Tejpar[414]	2018	Canada	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Gratitude In Nature
		Canada	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Gratitude In Nature
Luvaas[415]	2019	USA	Quantitative	Quasi-experimental	Engage With/Sit/Notice Nature	Nature Engagement

Authors	Pub. Year	Country	Approach	Study Design	Intervention Type	Intervention Name
Rían[416]	2019	USA	Quantitative	Randomized controlled trial	Forest Schools/ Outdoor Classrooms	Nature-Based Guidance Lessons
Seymour[417]	2019	UK	Qualitative	Single group	Horticultural Therapy	Horticulture
Hopman[418]	2019	USA	Quantitative	Single group	Nature Challenge Trip	Spending Time In Nature
		USA	Quantitative	Crossover	Nature Challenge Trip	Spending Time In Nature
Lachance[419]	2020	Canada	Quantitative	Quasi-experimental	Nature-Based Exercise	Walking In Green Space
Radford[420]	2020	UK	Qualitative	Single group	Nature Therapy Trip	Adventure Therapy
Fleming[421]	2020	USA	Quantitative	Single group	Nature Challenge Trip	Outdoor Recreation
Ascencio[422]	2020	USA	Both	Single group	Horticultural Therapy	Horticultural Therapy
Austin[423]	2020	UK	Both	Single group	Nature-Based Exercise	Outdoor Physical Activity
Fraser[424]	2021	UK	Quantitative	Single group	Nature-Based Exercise	Green Exercise
Perrins[425]	2021	USA	Quantitative	Randomized controlled trial	Engage With/Sit/Notice Nature	Nature Contact
de la Vega[426]	2021	USA	Both	Quasi-experimental	Ecotherapy	Nature-Based Art Therapy
Azra-Lewis[427]	2021	USA	Both	Randomized controlled trial	Nature-Based Exercise	Walking In Nature
Brown[428]	2021	USA	Quantitative	Randomized controlled trial	Nature-Based Challenge	Mountain Biking
Kane[429]	2022	USA	Quantitative	Single group	Nature Challenge Trip	Outdoor Adventure
Sassaman[430]	2022	USA	Both	Single group	Nature Challenge Trip	Outdoor Experiential Education

Figure 1: Nature-Based Interventions Reported By Year

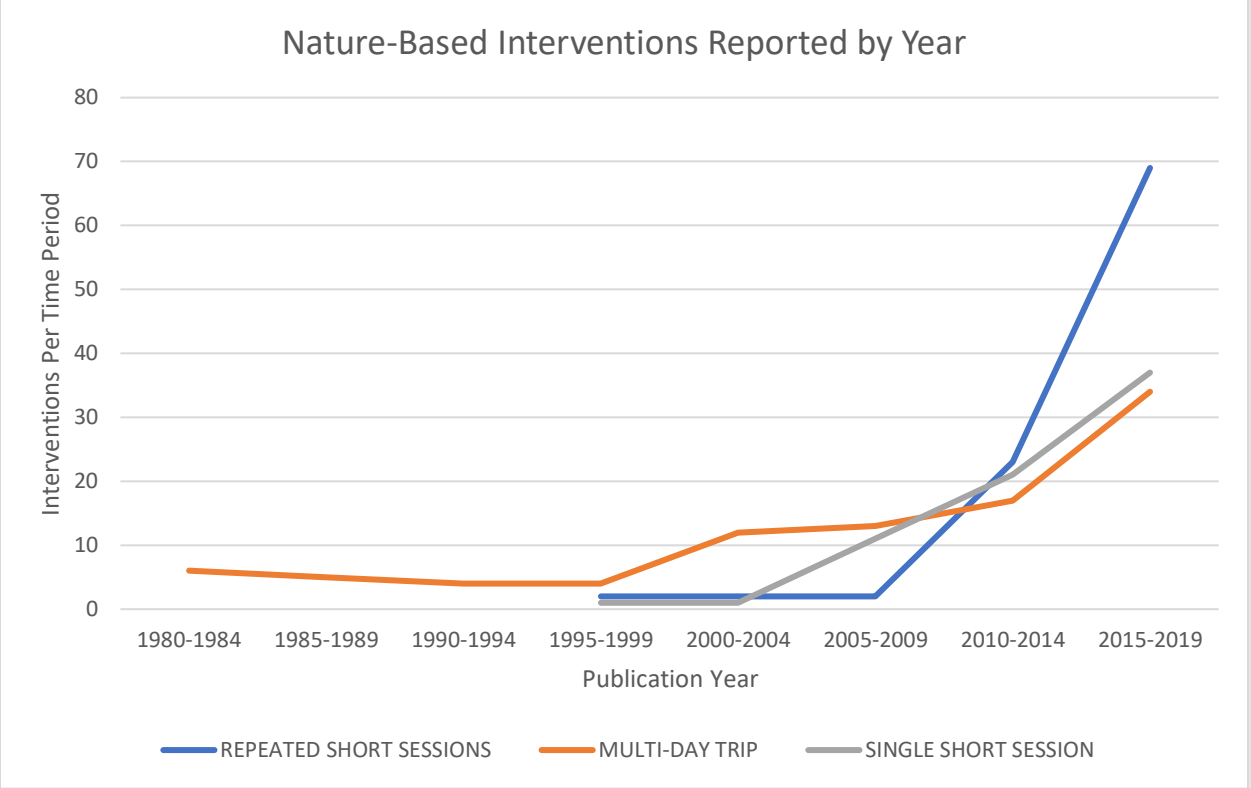

Figure 2: Study Environment Types

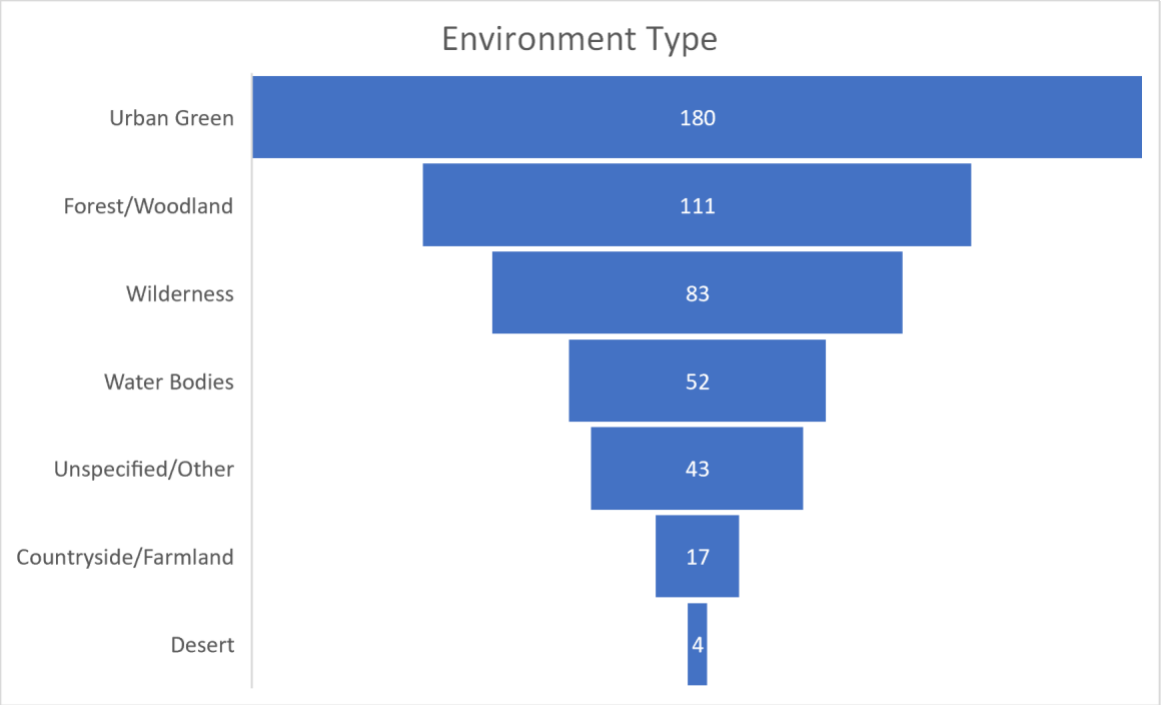

Figure 3: Nomenclature Word Cloud

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Chapter 3. The Feasibility of Implementing a Pilot Forest Bathing Intervention for Stress Management Among Clinical Health Professions Students

Abstract

Background

Health professions program (HPP) students' reported stress exceeds reported stress levels of their same-age peers. Time in nature has been shown to reduce stress, but nature-based interventions have not been reported among HPP students.

Methods

We conducted a single-arm feasibility trial of forest bathing, a type of nature-based intervention. The six-week pilot intervention enrolled HPP students from a public university in the United States, and explored psychological outcomes and feasibility indicators. Eligible participants were age 18 or older, enrolled in a clinical HPP program at the university, and without any health conditions making it unsafe to walk in the forest alone. Once per week for six weeks, participants engaged in 40-minute self-guided forest bathing sessions at a public arboretum. Quantitative and qualitative data were gathered through online surveys and a follow-up focus group. The protocol was registered prior to recruitment (https://osf.io/wr69n).

Results

Advertisements were done via emails, learning management system postings, and digital campus infostation ads to a campus with nearly 4000 students enrolled in clinical and allied research degree programs. Additionally, live recruitment

presentations reached 413 students directly. Thirteen students enrolled. Seven individuals participated in at least one session; of those attending at least once, five (71.4%) attended at least five of the six sessions. Measures and data collection methods were well-received and reliably reported. Participants reliably self-monitored for time, but engaged in other behaviors discouraged by program instructions (e.g., listening to podcasts, talking with others, running). Interpersonal commitment was a primary facilitator to participation, and time constraints were a key barrier.

Conclusions

This feasibility study illuminated key challenges for stress management programming in the HPP population. Recommendations for future research are discussed.

Keywords

nature-based interventions, forest bathing, clinical students, health professions, stress

Introduction

Stress is prevalent among health professions program (HPP) students,[1,2] and it carries significant risk to health and academic performance.[3,4] HPP disciplines include, but are not limited, to medicine, nursing, pharmacy, dentistry, physical therapy, and occupational therapy. In medical programs in the United States alone, 95,475 students are currently enrolled.[5] Broadening the definition of HPP students to include disciplines such as nursing, dentistry, and physical therapy, the issue of HPP-related stress impacts hundreds of thousands of students at any point in time. While experiences vary between HPP disciplines and throughout the course of a degree program,[6,7] commonly reported stressors include rigorous academic course loads, routine exposure to human suffering in the clinical setting, and financial strain.[4,8] Unmanaged stress can result in adverse outcomes such as the development of chronic disease, mental health disorders, professional burnout, and suicidality.[3,4,9] In addition to the time limitations and financial constraints that may provide barriers to treatment, stigma can inhibit HPP students from seeking mental health support when needed.[10] While this population reports higher degrees of coping capabilities than their same-age peers, they nonetheless report higher levels of stress;[11] therefore, additional coping supports tailored to the unique needs, barriers, and preferences of HPP students should be developed and disseminated.

Coping Strategies and Interventions

Coping strategies include a variety of behavioral, social, and cognitive methods to mitigate the impacts of forces causing stress and other discomforts. A wide array of coping strategies have been reported among HPP students, including, but not limited to: 1) strategies to transfer stress energy into productive activity, such as exercise; 2)

strategies to distract from stress energy, such as playing video games; and 3) strategies to make sense of the stress, such as talking to a friend.[1,12] Research suggests that knowledge alone is not sufficient to prompt adoption of positive and effective coping strategies. For example, while vigorous-intensity physical activity has been empirically linked to reductions in stress, medical students engage in less vigorous-intensity physical activity than their same-age peers.[6] While medical students report greater resilience and coping skills than their peers, stress levels in this population nonetheless exceed their peers, thus indicating the need for additional support.[11]

Lifestyle interventions have shown promise in reducing HPP student stress, though several methodological challenges exist. For example, while mindfulness, yoga, and journaling interventions have been rated highly by participants and generally resulted in improvements to perceived stress, attrition and program adherence have proven problematic.[13-16] In addition, small sample sizes and heterogeneous study designs further challenge generalizability and the establishment of conclusive support for such interventions. Furthermore, while curriculum-embedded and other institutional interventions are likely potent in impacting HPP student stress, activities outside of the academic environment may more strongly impact well-being.[17]

Forest Bathing for Stress Management

The forest environment's numerous health benefits have been measured across the body's various physiological and psychological systems.[18-26] For example, research has identified multiple mechanisms related to nature's healing properties, implicating such factors as the volatile organic compounds emitted from plant life, the clean air resulting from pollution mitigation processes, and the evolutionary necessity for humans to interact with the natural environment.[27-29] Nature further provides a venue

for health-promoting physical activity,[30] and such activities may reduce stress-inducing rumination.[31] Consistent with *vis medicatrix naturae*, or the human body's propensity for healing itself within the context of the natural environment,[32,33] research suggests that forest exposure contributes to a recalibration of physiological and psychological systems toward ideal levels.[21]

Nature-based interventions have shown benefit for the treatment of existing ailments and the prevention of potential health problems.[23,32] Forest bathing, a type of nature-based intervention, will be explored in this study. Also called Shinrin-yoku, forest bathing involves spending time in a forested setting while engaging the five senses.[21,34,35] It is this combination of nature exposure with mindfulness practices that uniquely situates forest bathing to attenuate stress.[36] Some forest bathing programs are self-guided and solitary, while others involve the guidance of a trained interventionist. Forest bathing interventions have been linked to improvements in stress and affect in as little as 15 minutes,[37] and have been shown to be effective for both prevention and treatment of physical and mental health issues.[23,38]

As no known trials of forest bathing among the HPP student population have been reported in the peer-reviewed literature, and in consideration that individual factors such as present psychological health and perceived quality of life may influence receptivity to the natural environment,[39] a feasibility study was indicated. Therefore, the purpose of this study was to assess the feasibility of implementing a pilot forest bathing intervention for stress management among clinical HPP students.

Methods

Given variation in the literature regarding the definition of and distinction between feasibility and pilot studies and the confusion that can create, we drew

primarily from Eldridge et al.'s delineation of terms.[40] Under this conceptualization, both feasibility studies and pilot studies seek to answer 1) if an endeavor can be performed, 2) if it should be performed, and 3) how it should be performed.[40] The focus of this study was on answering the first and third questions (i.e, if an endeavor can be performed and how it should be performed) using multiple methods of data. Thus, we conducted a single-arm pilot study of a 6-week forest bathing intervention, exploring program implementation feasibility.

As recommended by Lancaster et al.[41] for rigorous reporting of non-randomized trials, we adapted the Consolidated Standards of Reporting Trials (CONSORT) 2010 Statement Extension to Randomized Pilot and Feasibility Trials checklist (Appendix A).[41,42] This statement encourages the presentation of the methods developed a priori and the description of any adjustments made during implementation. The checklist is included as Appendix L.

Theoretical Framework

This intervention draws primary theoretical guidance from Ulrich's Stress Reduction Theory, which posits that experiences of stress are improved by interactions with the natural environment.[43] Attention Restoration Theory is a key secondary theory, as it suggests that interactions with the natural environment may improve experiences of mental fatigue.[43] Social Cognitive Theory (SCT) guides the study's behavioral change processes, as the intervention included strategies intended to 1) increase knowledge, 2) set a goal for weekly nature access, 3) practice skills (navigation of an outdoor recreation site, engaging the senses in the natural environment), 4) induce positive reinforcement (post-session stress relief) that may help establish new habits, and 5) address barriers and facilitators involved in spending time outdoors in nature.[44]

Protocol

The protocol was registered in Open Science Framework prior to recruitment (https://osf.io/wr69n). A two-arm randomized controlled trial of a 6-week forest bathing program was planned in a population of HPP students. As a result of low enrollment, we deviated from the registered protocol in several regards (Table 1).

Participants

Eligibility

Eligible students were enrolled in a HPP degree program at a public university's health science campus during the September and October of 2022. While certain disciplines received targeted recruitment (Occupational Therapy, Nursing, Communication Sciences and Disorders, Dentistry, Exercise Physiology, Physician Assistant Studies, and Physical Therapy), students from other programs were eligible if they self-identified as a clinical HPP student. Participants were required to be at least 18 years of age, have access to a smartphone, and be willing to use their university email address for survey authentication and study communications. Those disclosing a health condition that would make it unsafe for them to walk in the forest alone were excluded.

Recruitment

Prospective participants were invited to participate through a variety of methods. Throughout late July and early August, advertisements were sent through department email lists, posted to the learning management system, and posted on digital campus infostations. These advertisements linked to an online tool where interested students could sign up to be notified of enrollment. These notification emails were sent on the first day of formal enrollment (August 22) linking prospective participants to the informed consent form and the completion of baseline information.

A second wave of advertisements were distributed through email, the learning management system, and digital campus infostations in late August. Additionally, the first author gave live recruitment presentations at the beginning of eight class sessions across six disciplines, directly reaching 413 students. Virtual advertisements and flyers distributed in class directed prospective participants to the survey platform, Qualtrics, to review the informed consent and complete baseline information. Enrollment closed on September 2.

Sample Size

The primary goals of this study were to assess the feasibility of implementing the intervention, assess acceptability, and establish preliminary outcome estimates to guide the development of an appropriately powered trial.[45] The primary outcome for which we sought to explore preliminary efficacy was perceived stress as measured with the Perceived Stress Scale 10, analyzed as a continuous variable.[46,47] Initially planning a two-arm design, conservatively assuming a small effect size, employing a continuous primary outcome variable, and in preparation for a 90% powered main trial, Whitehead et al. recommended 25 participants per treatment arm as a rule of thumb.[48] As this was the first known nature-based intervention of any variety seeking to improve experiences of stress in this population, we referenced a yoga intervention with otherwise similar study design in planning for attrition. Mathad et al.[49] reported on an 8-week, once weekly in-person yoga intervention for psychological well-being in nursing students, which found a 20% attrition rate in both the active intervention and control arms. Thus, a sample size of 60 allowed for the random assignment of 30 participants to both treatment arms, resulting in 25 participants per arm after 20% attrition.

Ultimately, recruitment did not yield the anticipated sample size; thus, design and analysis adjustments were made, and we proceeded with a single-arm study (Table 1).

Study Design

The single-arm, 6-week forest bathing intervention was held at a public arboretum on the university's campus. In the week prior to the first session, participants received a forest bathing informational handout via email (Appendix K), intervention instructions (Appendix J), and a facility map. Participants were instructed to attend one proctored session per week for six weeks, spending 40 minutes in the forested environment per week.

Intervention and Setting

Intervention

Participants were instructed to travel to the arboretum site once per week for six weeks to participate in a 40-minute proctored, but unguided, forest bathing session. Initially, three, one-hour-long late afternoon time slots (Wednesday 4-5PM, Wednesday 5-6PM, and Thursday 4-5 PM) were offered per week, and participants were directed to arrive on the hour. No sign-ups were required for time slots, and participants were permitted to choose the same or different time slots each week. Upon soliciting participant feedback at the end of the first week, a fourth hour was added, and participants were allowed more flexibility in arriving at any time during the designated, proctored times (Wednesday 4-6 PM and Thursday 4-6 PM).

At the beginning of each week, the research team sent reminder emails, including information such as the session schedule, projected weather, and any extenuating circumstances that may require additional planning on the part of participants.

During check-in, participants reported to the project welcome station set up at the facility entrance. Study personnel directed participants to complete the check-in survey via QR code, then to spend approximately 40 minutes in the forested area of the arboretum. Participants were instructed to 1) avoid using electronic devices, 2) limit interactions with other people, 3) avoid high intensity activity in favor of walking or resting, 4) engage their senses as appropriate and try to remain in the present moment, and 5) return to the welcome table to sign out. After 40 minutes, participants returned to the project welcome station and completed the check-out survey via QR code before departing.

Setting

The West Virginia University Core Arboretum (Figure 1) is managed by the university's Department of Biology and located less than two miles from the health sciences campus. Access to the site is available free of charge. The arboretum is adjacent to well-known campus landmarks, and free parking is available on-site. University and community bus lines serve the vicinity, and a rapid transit station is located approximately one-third of a mile from the arboretum entrance. Portable toilets are available at the main entrance.

The Core Arboretum is situated on a mountainous 91-acre tract and is home to more than 150 species of trees and shrubs.[50] Its forest boasts a generally closed canopy, with many mature deciduous trees exceeding 20 meters in height, creating a shady environment during growing season, and spectacular color change in the autumn before leaves fall. Small seasonal streams are abundant on the steep slopes, and wildlife species (squirrels, deer, birds) are readily spotted. Developed gravel trails wind throughout the site and link to the Caperton Rail-Trail, a paved trail following the Monongahela River.

The lawn near the main entrance is gently sloped, leading to steeply sloped forested areas. Benches are available throughout the trail system, and some trees bear informational markings listing common names, scientific names, and native range. In the immediate vicinity of the check-in station are Douglas Fir, Western Red Cedar, and Pin Oak trees.

The program was conducted during fall semester 2022, spanning early September through mid-October. Weather patterns were typical for fall in West Virginia, with an average temperature of 68.8 degrees Fahrenheit (SD=7.4, range 57-82) and light precipitation reported during only two of the 21 recorded time points. From the check-in station, study personnel noted multiple sources of sound and/or noise: traffic, marching band practice, and nature sounds (birds and insects).

Outcome Measures

Surveys and a focus group were used for data collection from participants. Two series of survey data were collected via an online platform (Qualtrics): (1) program surveys collected at baseline, midpoint (3 weeks), endpoint (6 weeks), and follow-up (9 weeks), and (2) session surveys collected at the beginning and end of each session. Data from all survey responses were explored to assess attendance, survey burden, and any patterns of missing survey responses.

In addition to participant data collection, study personnel 1) recorded recruitment metrics, including but not limited to the count of students exposed to recruitment presentations; 2) completed a report on Qualtrics at the bottom of the hour of each session, recording such information as weather, traffic, and adverse events; and 3) maintained a log of session field notes.

Program Surveys

The program survey included items to gather demographic and academic data (baseline only) and effectiveness measures explored in Aim 3.

Session Surveys

Check-in and check-out surveys explored preliminary effectiveness measures, which will be further discussed in Aim 3.

Check-out session surveys also included measures of participant adherence to protocols via physical activity and social setting. Physical activity was assessed with the question: "Of the time that you spent in the forested environment, approximately what percentage of the time did you spend doing the following activities?" Three categories were provided: sitting/still, low/moderate intensity (i.e., walking), and high intensity (i.e., running). Participants were asked to enter percentages into text boxes, with survey validation requiring a total of 100%. Social setting was assessed with the question: "Of the time that you spent, approximately what percentage of the time did you spend alone versus with another person(s)? Two categories were provided: alone and with someone else. Participants were asked to enter percentages into text boxes, with survey validation requiring a total of 100%.

Focus Group

A focus group was conducted after the conclusion of the full intervention period. Participants attending at least half of the sessions (n=6) were invited via email. The focus group was held in a private library study room on the university's health sciences campus where the students attend class, limited to one hour in duration, and snacks were provided. Informed by Orsmond et al.'s framework of feasibility assessment,[51] a semi-structured interview guide provided a framework for participants to share about their enrollment motivations; experiences participating in the study, personal nature

relatedness, barriers and facilitators encountered, resulting behavior changes, adherence to protocols, perceived benefits and harms, and recommendations for future programming (Appendix I). The session was audio recorded and a transcript developed by the first author.

Incentives

Participants that completed the 3-week (midpoint), 6-week (final), and 9-week (follow-up) program surveys were entered into a drawing for a $50 gift card. Each focus group participant received a $15 gift card.

Ethics Review and Informed Consent

The WVU Institutional Review Board acknowledged protocols for the intervention (2205578004) and follow-up focus group (2210658337). Informed consent was obtained from intervention enrollees digitally via Qualtrics, and from focus group participants verbally at the beginning of the session. Digital and paper copies of informed consent cover letters were provided.

Analysis

Feasibility studies are used to assess questions relating to five broad categories: 1) recruitment and sample (i.e., whether the study can recruit a sample of sufficient size and composition); 2) data collection procedures and outcome measures (i.e., whether the data collection measures are appropriate for the population and accurately reported the constructs measured); 3) acceptability and suitability (i.e., whether members of the target population find the program appealing and are able to successfully engage in program activities); 4) resources and capabilities (i.e., whether the organizers have sufficient capacity to offer the program with fidelity); and 5) participant response (i.e., measured or self-reported change in health, behavior, or other outcomes of interest).[51]

This paper addresses the first four feasibility categories using quantitative and qualitative inquiry; participant response is explored in Aim 3.

Quantitative analyses were conducted in Microsoft Excel;[52] qualitative analyses were conducted in Microsoft Excel and NVivo. Focus group transcripts were analyzed by the first author using directed coding of pre-defined classifications informed by the five categories of feasibility.[53]

Results

Quantitative and qualitative data are presented jointly throughout this section using data from the baseline program surveys (n=13), the program surveys completed by participants at the follow-up time points (n=7), the session surveys completed by participants at the beginning and end of each session (n=7), the focus group (n=3), and recordings of researcher observation. Illustrative quotes are ascribed to focus group participants as P1, P2, and P3.

Recruitment and Sample Characteristics

Enrollees ranged in age from 19-29, with an average age of 22.7 (SD=2.6). Most identified as female (n=9, 69.2%) and reported spending time in nature multiple times per week during childhood (n=12, 92.3%). Seven disciplines were represented (Communication Sciences and Disorders, Dentistry, Medicine, Occupational Therapy, Physical Therapy, Pathology, and Biomedical Research), with 76.9% reporting graduate student status (n=10). Of the 13 enrollees, 7 individuals participated in program activities (53.8%).

Interest

As the program was advertised using a variety of approaches, the degree of interest and subsequent enrollment were difficult to quantify. Of the 13 enrollees, 8

reported academic majors in which the research team conducted in-person advertising. Thus, of the 413 students exposed to an in-class recruitment presentation, 1.9% (n=8) enrolled. The remaining 5 enrollees were likely recruited through advertisements sent via mass email, posted to the learning management system, or posted on digital campus infostations.

Enrollment Motivations – focus group

Motivations for participating were varied. Study participation provided an opportunity for some to complete required community service hours; students reported that other community service opportunities often necessitate that students spend money to complete service activities. The gift card drawings provided additional financial appeal; notably, focus group participants stated that the planned randomization did not factor into enrollment decision-making, perhaps because the control group would have also been eligible for gift card drawings. Participants also cited potential benefits as motivators, as the study provided a "good opportunity to just go and walk" (P1), and might provide improvements for depression.

Data Collection Procedures and Outcome Measures

Survey completion – program and session surveys

Of those enrolled (n=13), 7 completed the 3-week survey (53.8%), 6 completed the 6-week survey (46.2%), and 5 completed the 9-week survey (38.5%). Of those participating in at least one session (n=7), completion rates were 100% at the 3-week survey, 85.7% at the 6-week survey, and 71.4% at the 9-week survey.

Response missingness – program and session surveys

Participants provided thorough survey responses. On the baseline survey, one participant skipped the gender identity question, despite multiple available options. No

items had missing responses on the 3 week, 6 week, and 9 week survey, nor on the pre-session and post-session surveys.

Survey Burden – program and session surveys

Session check-in and check-out survey self-administration time averaged 0.7 minutes and 1.2 minutes, respectively. Two outliers of greater than 18 minutes were removed from the check-out survey data analysis. Baseline surveys averaged 9.8 minutes (range 5.8-17.6), 3-week surveys averaged 4.2 minutes (range 2.4-5.4), 6-week surveys averaged 8.8 minutes (range 7.8-11.5), and 9-week surveys averaged 3.7 minutes (range 2.8-4.3).

Acceptability and Suitability

Attendance and Retention – program and session surveys

Of the 13 enrollees, 7 participated in at least 1 session. Five of these individuals (71.4%) participated at least 5 of the 6 weeks. One participant attended only the first week, then reported scheduling conflicts that would preclude further participation. Two participants missed the final session. Otherwise, no patterns of absence were noted.

Attitudes toward spending time in nature – focus group

Post-intervention focus group participants described differences in personal preference and past exposure to nature. One participant identified as an “inside person” who wouldn’t go to the forest on their own accord but grew up near the coast. Since coming to the university, they missed the ability to visit the beach, “smell the salt of the water, hear the waves” (P3).

Others shared their affinity for the outdoors. For one participant, the setting sparked memories of running through wooded trails on their middle school cross country team: “it's been a while since I've been in an area where like you just follow the

trail because otherwise I have no other way to get out" (P1). Participants reported camping, hiking, walking, and running outdoors, often with friends, family, and pets. Outdoor activities were discussed as being particularly enjoyable during the COVID-19 pandemic.

Reported enjoyment of time spent in nature seemingly corresponded with the types of activities conducted outdoors. During the focus group, participants P1 and P2 primarily reported outdoor leisure activities and stated their enjoyment of time spent outdoors. On the other hand, time spent outdoors for P3 was predominantly functional, namely as a means of transportation. "I walk a lot… if it's functional, I'll be outside" (P3). This outdoor transportation activity was reported to not be particularly enjoyable.

Adverse Events – session surveys and researcher field notes

Of the 33 distinct participant sessions, no adverse events were reported during 87.8% of sessions (n=29). Reported adverse events included insect bite (n=3), sunburn (n=1), and a near-fall related to the participant's dog pulling (n=1). Study personnel recorded zero instances of adverse events.

Barriers to participation – focus group

As expected among this population, time was the central barrier to participation as reported by focus group participants. Coursework, clinical work, graduate assistantships, and activities of daily living vied for participants' limited time. As the program instructed unplugging from technology, one participant lamented that forest bathing sessions constituted "another time where I can't use my phone" (P3). Weather provided an additional complication for some who reported swapping day and time slots in response to the weather forecast.

The available session times were inconvenient for some. Indeed, the late afternoon sessions aligned with heavy traffic volume. Academic and clinical schedules varied between programs and among individuals. Some participants reported rushing from class, changing in campus bathrooms, battling traffic, and finding creative parking solutions. After the first week, in an attempt to address this barrier, study personnel added an additional hour of weekly availability and encouraged participants to complete their 40-minute sessions anytime during the two, two-hour blocks per week, not necessarily at the top of the hour as initially planned.

Steep terrain was problematic for some, reporting that "it's very difficult to get lost in nature when you're not trying to fall down" (P3). Due to the layout of the program site, the check-in/check-out station was located uphill from most of the site; thus, some participants reported exhaustion on check-out, particularly in consideration of the session time limit. Some participants wished they had more time available to spend in the natural environment.

Facilitators to participation – focus group

Focus group participants reported that commitment was a central facilitator – commitment to self, to friends, and to the researcher. Sessions were found to be "something to look forward to… as long as it was going to be nice" (P2). Some participants reported that the decision to enroll was made collaboratively among several members of their cohort, and that they attended sessions together. Others were prompted by the commitment they made to the researcher upon enrollment. Session proctoring was reported to be helpful in providing accountability, and the opportunity to choose between two different days per week afforded flexibility. One participant lauded the site's close proximity to public transportation.

Positive experiences at the site, even those unrelated to this program, encouraged continued visits. At the end of one early session, a participant stayed for a tasting event of locally foraged fruit. This participant spoke enthusiastically of this event as "something novel, you get to see little kids running around and acting all goofy, we all get to partake in this joyous experience…that incentivized me to be outside, not so much being outside itself, unfortunately" (P3).

Perceived benefits – focus group

Some participants found forest bathing to be a rejuvenating activity that helped them transition from day to evening. P1 found it "refreshing to go, clear your mind for a little bit, and then obviously get some exercise," sharing that "if I had gone home, I probably wouldn't have studied right after school because the semester has been draining." P2 added that the nature break "prompted actually going home and getting dinner, and then being able to sit down and start on work…rather than coming home and sitting on your bed on TikTok for two hours."

Another participant reported deriving the most benefit while experiencing nature with others, sharing that they "needed that sense of being with somebody else to say it was beneficial" (P3). The participant spoke warmly of discovering an inchworm during a session, sharing another session with their partner, and encountering a community tasting event for locally foraged fruit.

Perceived harms – focus group

Few perceived harms were reported. Focus group participants reported occasionally feeling that they were wasting valuable time by participating in the forest bathing program, particularly during exam weeks. For one participant, the forest

bathing activity did not distract them from anxieties, but rather provided opportunity for further rumination.

Behavior change – focus group

Participants did not report significant behavior change as a result of the study, but participation largely reinforced existing behavior patterns. P1 reported pre-existing habits of spending time outdoors with the anticipation that those habits would continue. Noting the shift to winter weather at the time of the focus group, P2 reported that when the weather improves, they "might be more willing to go out for a walk." Echoing concerns for weather, P3 indicated that they might go out hiking with their partner when weather improves but noted the hilly terrain and lack of pedestrian infrastructure. "I don't want to go out and walk here because there are barely any sidewalks. It feels like a workout every time you want to go outside" (P3).

Participant adherence to protocols – session surveys and researcher field notes

Participants generally adhered to the guidance to spend 40 minutes in the natural environment. On one occasion, a participant spent 70 minutes in the environment due to phone timer malfunction. With this one outlier removed from analysis, sessions averaged 40.6 minutes (SD=2.9, range 33-47).

According to study personnel fieldnotes and focus group responses, intervention guidelines were frequently discarded, or when followed, prompted frustration. One participant reported working diligently to unplug from technology as instructed, but wished to take photos as a means of nature engagement. Several others routinely wore earbuds, and one participant reported listening to a podcast during the session. While participants were instructed to spend the time alone and in quiet, two participants spent all of their sessions together and talked with each other. On isolated occasions, one

participant brought a non-participant friend, another brought a dog. Most participants adhered to the guidance to avoid high intensity activity, although one participant occasionally jogged.

Resources and Capabilities

Staff adherence to protocols – session surveys and researcher field notes

A number of modifications were made to session scheduling. After the first week, study personnel asked for participant feedback on session times. In response to feedback, staff added an extra hour of availability and allowed participants to attend any 40-minute slot during the available hours. Initially, sessions were scheduled for 4 PM and 5 PM on Wednesdays and 4 PM on Thursdays; participants were instructed to start at the top of the hour. After the first week, participants were encouraged to attend any 40-minute slot between 4 PM and 6 PM on Wednesdays or Thursdays. During the final week, a large collegiate sporting event eliminated nearby parking, significantly increased traffic, and ultimately precluded Thursday session feasibility; thus, the Wednesday slot was extended by one hour, 3:30 PM to 6:30 PM.

Paper surveys were always available but never needed, as participants reliably brought their phones to sessions and on-site cell data coverage was acceptable. Sunscreen, insect repellant, and bottled water were always available and occasionally used. Staff occasionally adjusted the welcome table signage and contents due to wind and precipitation; however, the station location did not change. Per protocol, study personnel reliably completed the online session report at the bottom of each hour.

Participant Recommendations – focus group

Focus group participants provided recommendations for improving future iterations of the program. More direct guidance and programmatic diversity was

suggested. Participants wanted an activity to do, such as a scavenger hunt, that would give them something else to think about and disrupt rumination about school. Ideally, participants would like to do "something different each week" (P1), and visit different settings, such as botanic gardens. Acknowledging that it was difficult to become fully immersed in nature during the 40 minute limit, participants suggested increasing the duration of exposure. Participants noted that, due to heavy schedules, weekends may provide better opportunity for directed nature programming.

Discussion

Overall Findings

Recruitment challenges in this population have been noted in reports of other stress management programming.[15] Of those interested (i.e., enrolled) and without scheduling conflicts, participants were able to commit to a 6 week program. One participant attended the first session before reporting scheduling conflicts and dropped out. The remaining six participants attended at least half of the six weeks.

These findings bear similarities to the Terp et al.'s[54] feasibility trial of a cognitive behavioral stress management program for nursing students. While this 12-week program saw an enrollment rate of 29% (higher than this study's 1.9%), and 36.8% of enrollees completed all sessions or missed only one session (similar to this study's 38.5%). Terp et al. noted that participants frequently ignored intervention guidelines regarding cognitive behavioral homework assignments; however, qualitative findings indicated that the intervention ultimately aided participants in learning new stress management techniques.

Participant outcome measures and measurement approaches were appropriate. No problems were reported with the email delivery of longitudinal surveys and QR

access to session surveys. Back-up paper copies of session surveys were available on-site but were not needed. When participants started a survey entry, the response was thoroughly completed. No significant missingness was observed among survey items.

Most participants rated sessions positively and reported affective benefits. Perceived harms included losing productive time available for schoolwork and the self-guided programming allowing time for further rumination. Preliminary data suggests that enjoyment and perceived benefit of time spent outdoors may be associated with personal preferences (e.g., time spent alone or with others, type of nature encountered) and type of activity (e.g. leisure, transportation); other nature-based intervention studies have corroborated this finding.[55,56]

Adverse events were minor and addressed by safety protocols instructing participants to use insect repellant and sunscreen, wear appropriate footwear, and carry a phone in case of emergency. Survey burden was minimal and appropriate. Participant adherence to instructions was variable. Individuals reliably self-monitored their time and spent approximately 40 minutes in the natural environment per session. Program guidance requested that participants unplug from technology, spend time alone, and avoid high intensity activity. Over the six weeks, some participants were observed to use earbuds; spend time with other participants, pets, and non-participant friends; and run. On the other hand, staff adherence to prescribed procedure was consistent. Welcome station set-up and maintenance, data collection, and communication instructions were well-delineated and reproducible.

Significant behavior change was not noted in the data; rather, existing behavior patterns were generally reinforced. Focus group participants stated openness to spending time outdoors in nature once the weather improves.

Interpersonal commitments served as key facilitators in attending on a regular basis. While sessions were intended to be individualized, some participants were motivated by the opportunity to do something with their classmates. Session proctoring provided programmatic support and accountability for others. As anticipated, time was the key barrier to participation. The available session times often conflicted with academic and clinical responsibilities; some participants wished they had more than 40 minutes to connect with nature; and while others were able to attend during the available sessions, they reported that they might be more mentally present at a different time, such as the weekend.

Strengths and Potential Limitations

To the authors' knowledge, this study comprises the first published endeavor to implement forest bathing or other nature-based interventions targeting a HPP population. The study's feasibility findings will be beneficial in informing the development of future HPP wellness programming.

The primary limitation was the low sample size among enrollees (n=13), intervention participants (n=7), and focus group participants (n=3). Low enrollment also necessitated that changes be made to key design characteristics during implementation, hindering our ability to test the protocol as designed. Modifications should be made to future iterations to increase enrollment; our findings suggest that weekend availability, programmatic diversity, and increased academic and financial incentives may improve participation rates. Scheduling changes were made after the first week in response to participant feedback, and during the final week due to a large event occurring in the vicinity. While these scheduling changes were in service of

improving participant experiences, they ultimately constituted inconsistency between weeks over the course of the study.

The program was held at a public facility; thus, other uses and users were not controlled. While generally light, visitor density varied. Over the course of the study, personnel noted recurring uses such as cross-country team practices and volunteer maintenance gatherings with activities ranging from mulching to mowing. A small, foraged fruit tasting event was held. Individuals, small groups, and pets engaged in walking, running, biking, and sitting. Participant experience may have been impacted, positively or negatively, by these other uses.

We utilized a proctored, self-guided approach to forest bathing. Partially due to this approach, participant deviations from the protocol were commonly observed. Study personnel did not redirect participants engaging in these deviations, but recorded observed events as these may inform future iterations of the protocol. In alignment with participant recommendations, future iterations of nature-based interventions in this population may benefit from more guided activities.

Implications for Future Research

Feasibility work is crucial in the development of effective interventions. Further nature-based intervention trials should endeavor to address the unique needs and preferences of HPP students as identified in this paper, namely 1) time limitations and 2) the desire for directed activity to move the mind beyond academic rumination. Two promising options include 1) a self-guided noticing nature program,[57,58] wherein participants receive daily prompts to pause and observe something positive in the natural environment; and 2) a recurring guided program featuring diverse natural environments and interactive activities on weekends.

Conclusion

Time spent in the natural environment has the potential to positively impact the stress experiences of clinical HPP students; however, this study found program recruitment and adherence to a self-guided protocol to be challenging. These feasibility findings provide guidance in developing successful nature-based programs in clinical HPP students.

Funding

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Table 1: Changes from Protocol

Feature	Protocol	Actual Practice
Sample	60 participants total; 30 per arm	13 enrollees
Design	Two-arm RCT	Single-arm trial
Population	Students enrolled in specific clinical HPP programs	Students in self-identified HPP programs (including research)
Session Scheduling	Start on the hour during the three one-hour sessions	Start at any time during the allotted four hours
Weekly Reminders	No reminders	Email reminders sent at the beginning of each week

Figure 1: Site Photos

Check-in station as viewed from main entrance. Photo taken during week 1.

Developed trail with bridge over stream. Photo taken during week 5.

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Chapter 4. Preliminary Effectiveness of a Forest Bathing Intervention for Stress Management Among Clinical Health Professions Students

Abstract

Background: Stress is a prevalent health concern. Nature-based interventions, including, but not limited to, forest bathing, have been shown to improve experiences of stress. A vast diversity of research has been conducted, but to our knowledge, no nature-based interventions have been conducted with clinical health professions students, a population that experiences high amounts of stress.

Methods: This pilot study assessed the preliminary effectiveness of a one-arm trial of a six-week forest bathing intervention for health professions students at a public university in the United States, exploring such outcomes as perceived stress, attitudes toward spending time in nature (TSN), self-efficacy TSN, intentions TSN, mood states, and present stress. Participants were instructed to attend one 40-minute proctored but self-guided forest bathing session per week at a public arboretum on the university campus. Participants were at least 18 years of age, enrolled in a clinical health professions program at the university's main campus, and without health conditions making it unsafe to walk alone outdoors. Survey measures were taken at baseline, 3 weeks, 6 weeks, 9 weeks (follow-up), and at the beginning and end of each session. The protocol was registered prior to recruitment and modified as outlined in a companion article. Exploratory analyses included linear mixed modeling, matched pairs t-tests, and independent samples t-tests.

Results: Thirteen students enrolled, and 7 (53.8%) participated in at least one session. Participants reported positive affective impacts during 63.6% (n=21) of sessions, and present stress declined an average of 1.9 points on an 0-10 scale per session (p=0.0007). Over the course of the study and into follow-up, stress decreased by half of a point on the Perceived Stress-10 scale per week (p=0.0308). Participating enrollees and non-participating enrollees may have differed on baseline perceived stress, baseline positive attitudes TSN, and time spent in nature in the week prior to enrollment.

Conclusions: Forest bathing may provide stress-relieving benefits for clinical health professions students. Recommendations for further research are discussed.

Keywords: Nature-based interventions, forest bathing, clinical student, health profession, stress

Introduction

Stress is a global health concern. In the immediate aftermath of the SARS-CoV-2 pandemic, it was estimated that 36.5% of the worldwide population experienced stress and 50.0% experienced distress (i.e., extreme stress).[1] Unmanaged stress may prompt systemic chronic inflammation, ultimately contributing to the development of chronic disease.[2,3] The potential individual and societal consequences of allowing widespread chronic stress to persist are pervasive.

Clinical health professions students (e.g., medicine, dentistry, physical therapy) are particularly susceptible to stress due in part to rigorous course loads and challenging clinical experiences.[4,5] These students report high stress levels in excess of their peers in other degree programs.[6-9] Left untreated, stress in this population can contribute to poor mental and physical health, substance misuse, and professional burnout.[4,10] Previous studies have highlighted an array of positive and negative coping strategies in this population; however, spending time in nature is frequently unreported as a coping mechanism.[6,11]

Nature-based interventions, including forest bathing, therapeutic horticulture, environmental volunteerism, nature play, nature-based art therapy, and exercising in the natural environment, (Aim 1) are increasingly used to improve mental health, physical health, social connection, and general wellness.[12-16] These interventions are diverse in dose, design, environmental setting, outcome of interest, and target population (Aim 1). The practice of forest bathing, also known as Shinrin Yoku, asks the individual to engage the five senses while immersed in a forested environment, combining nature exposure with mindfulness-type practices.[16-18] Forest bathing has previously been employed as a stress intervention for general university students,

women experiencing fatigue, and middle-aged service industry workers, among other populations.[19-21]

To the authors' knowledge, no nature-based interventions for clinical students, forest bathing or otherwise, have been reported in the academic literature. Thus, the purpose of this study was to assess the preliminary effectiveness of a pilot forest bathing intervention for stress management among clinical health professions students.

Methods

A two-arm randomized trial of a six-week forest bathing program was planned and the protocol prospectively registered with Open Science Framework (https://osf.io/wr69n). Due to low enrollment, a one-arm trial was implemented; deviations from the protocol were described in a companion article focused on implementation feasibility (Aim 2). Reporting of this study follows the Consolidated Standards of Reporting Trials (CONSORT) 2010 Statement Extension to Randomized Pilot and Feasibility Trials,[22] modified for single-arm trial where appropriate.[23] The checklist is reported as Appendix M. In accordance with the CONSORT guidance to report protocol deviations in intervention reports, such programmatic changes will be discussed in this report, but have been addressed in greater detail in Aim 2.

Eligibility and Recruitment

Eligibility

Eligible individuals were at least 18 years old and enrolled in a health sciences degree program at a public university in the United States. While certain disciplines received targeted recruitment (Occupational Therapy, Nursing, Communication Sciences and Disorders, Dentistry, Exercise Physiology, Physician Assistant Studies, and Physical Therapy), students from other programs were eligible if they self-identified as a

clinical health professions student. Participants were required to have access to a smartphone and be willing to use their university email address throughout the study. Individuals reporting health conditions making it unsafe to walk alone outdoors were excluded.

Recruitment

Prospective participants were recruited through in-class presentations, digital bulletin board announcements, learning management system advertisements, and emails sent to academic department listservs. Prior to the enrollment period (August 22-September 2), all advertisements directed interested individuals to join an email notification list via URL and QR code links to a Qualtrics instrument; upon the opening of enrollment (August 22), an automated email was sent to this notification list, providing a hyperlink to the informed consent and baseline program survey. After the beginning of the two-week enrollment period, all advertisements directed interested individuals to the informed consent and baseline program survey via URL and QR code.

Sample Size

As this was a pilot study, the sampling strategy was driven by feasibility. Planning a two-arm trial, assuming a small effect size, aiming for a 90% powered future definitive trial, and using a continuous primary outcome variable (Perceived Stress Scale 10), Whitehead et al. recommended 25 participants per arm.[24] Allowing for the 20% attrition reported by a repeated session intervention for stress among nursing students,[25] we sought to enroll a total of 60 students. The recruitment goal was not met; thus, a single-arm trial was implemented, and all enrollees were assigned to the forest bathing program.

Intervention Design

A six-week forest bathing program was planned for clinical health professions students at a public university. Participants were to complete one 40-minute forest bathing session per week during designated, proctored timeframes in late afternoon on weekdays. Participants were not required to pre-register for session times but were invited to choose among designated timeslots as their schedules permitted.

Initially, three total hours spanning two different weekdays were available (Wednesday 4-6PM and Thursday 4-5PM). In response to participant feedback after the first week, an additional hour of availability was added (Wednesday 4-6PM and Thursday 4-6PM). During the final week, only three hours were available on one weekday due to a large athletic event in the vicinity significantly impacting traffic volume and parking availability (Wednesday 3:30-6:30PM).

Prior to the first session, participants received via email (1) program instructions outlining check-in procedures and safety recommendations (Appendix J), (2) forest bathing instructions (Appendix K), and (3) a facility map. Participants were instructed to spend time alone in low-intensity physical and mental states, avoid the use of technology, and focus on breathing and the senses. Safety recommendations included carrying a phone for emergency use only, wearing appropriate clothing and footwear for the weather and terrain, and using sunscreen and insect repellant.

Email reminders about weekly sessions were sent on Tuesdays. Upon arrival, a study team member (SIM) greeted participants at a welcome table located near the arboretum entrance. Facility maps, insect repellant, sunscreen, and bottled water were available. Participants were instructed to scan a QR code and take a check-in session survey, spend 40 minutes in the natural environment, then return to the welcome station to complete a check-out session survey via a second QR code-linked survey.

Theoretical Framework

The intervention was designed based on the evidence that supports using nature contact for improvements in stress, attention, and overall wellbeing (Biophilia hypothesis, attention restoration theory, and stress reduction theory) [26,27] and providing opportunities for learning and practicing new skills (social cognitive theory).[28] Biophilia hypothesis, attention restoration theory, and stress reduction theory are the predominant guiding theories in the nature-based intervention literature, (Aim 1) as they elucidate pathways in which exposure to the natural environment connects humanity with its evolutionary roots, allows the brain to recalibrate its attention functions, and facilitates the easing of psychological and physiological stress. While the nature-based intervention literature focuses primarily on nature-based theories, other psychological theories prove beneficial in informing intervention design decisions. Social cognitive theory guided this intervention, in providing opportunities for gaining new information (learning about forest bathing practices and becoming acquainted with a local arboretum), practicing a new skill (engaging in up to six sessions of forest bathing), and reflecting on the experience (completing post-session surveys), with goals to increase self-efficacy (becoming confident to forest bathe without guidance or prompting) and change future behavior (continuing to spend time in nature).[28]

Setting

The intervention took place at the Core Arboretum on the West Virginia University Campus in Morgantown, West Virginia (Figure 1). This 91-acre green space is home to more than 150 species of trees and shrubs, including but not limited to, a variety of oak, pine, and rhododendron species.[29] A three-mile trail system winds throughout the site and connects to the Caperton Rail trail along the Monongahela

River. Admission is free of charge. Parking, public transit, and toilet facilities are available nearby. During the program's autumn sessions, temperature averaged a moderate 68.8 degrees Fahrenheit (SD=7.4, range 57-82), and light precipitation only occurred on two occasions.

Outcome Measures

Preliminary effectiveness was assessed using program surveys and session surveys conducted online. All surveys and email communications were conducted within a HIPAA-compliant Qualtrics account.

Program Surveys

The program survey included items to gather demographic data (baseline only); self-reported time spent outdoors in nature; perceived stress; and attitudes, intentions and self-efficacy to spend time in nature (TSN). Program surveys were sent via email at baseline (August 22-September 2), at the end of week 3 (midpoint), week 6 (final), and week 9 (follow-up).

Self-reported time spent outdoors in nature. Self-reported time spent outdoors in nature was assessed with a question asking: "During the previous week, how many days did you spend at least 10 minutes outdoors in nature?" with responses recorded as discrete numbers ranging from 1 to 7. This item was developed for this study and has not been validated.

Perceived stress. Perceived stress was measured using the Perceived Stress Scale 10 (PSS-10),[30,31] a validated instrument consisting of ten items. Responses are recorded on a 5-point Likert-type scale and coded according to instrument guidelines. Generally, "Never" is coded as 0, "Almost Never" is coded as 1, "Sometimes" is coded as 2, "Often" is coded as 3, and "Very Often" is coded as 4. Responses to questions 4, 5, 7, and 8 are

scored in reverse. Total responses were calculated for each survey with a simple sum formula. Per the instrument, interpretation of total scores is as follows: 0-13 indicates low stress, 14-26 indicates moderate stress, and 27-40 indicates high stress.

Attitudes toward spending time in nature (TSN). Attitudes TSN were measured using the scale developed and validated by Maddock et al.[32] This scale includes 18 items and is comprised of three sub-scales: positive attitudes (Attitudes TSN-Positive), negative attitudes (Attitudes TSN-Negative), and concerns about nature (Attitudes TSN-Concerns). Each item is reported on a Likert-type scale from 1 (strongly disagree) to 5 (strongly agree). Results are reported as means tabulated for each of the three sub-scales, with higher scores indicating greater degrees of the construct being examined (e.g., a high score on the positive attitudes sub-scale indicates a greater degree of positive attitudes TSN).

Intentions TSN. Intentions TSN were measured using the 8-item scale developed and validated by Maddock et al.[33] This scale includes 8 items reported on a Likert-type scale with responses ranging from 1 (strongly disagree) to 5 (strongly agree). Results were reported as a mean score ranging 1 to 5, with a higher score indicating greater intentions TSN.

Self-efficacy TSN. Self-efficacy TSN was measured using the 14-item scale developed and validated by Maddock et al.[33] Responses were recorded on a Likert-type scale ranging from 1 (not at all confident) to 5 (extremely confident). Results were reported as a mean score ranging 1 to 5 with a higher score indicating a greater degree of self-efficacy to spend time in nature.

Session Surveys

At check-in and check-out of each session, each participant was asked to rate their mood state and present stress.

Mood state. Self-appraisal of mood state was assessed with a free text question asking participants: "In a sentence or less, briefly describe how you are feeling at the present moment." This item was developed for this study and has not been validated.

Present stress. Present stress was measured with a scaled question asking participants to indicate "In the present moment, how stressed do you feel?" on a scale of 0 to 10, with 0 indicating "not at all stressed" and 10 indicating "as stressed as possible." This item was developed for this study and has not been validated.

Incentives

Intervention participants were not guaranteed compensation, but drawings for $50 gift cards were conducted at each program survey period beyond baseline (i.e., weeks 3, 6, and 9).

Ethics Review and Informed Consent

The WVU Institutional Review Board acknowledged the protocol for the intervention (2205578004). Participants consented digitally via Qualtrics and were provided with a digital copy of the informed consent cover letter.

Analysis

Data cleaning was conducted in Microsoft Excel. Descriptive statistics included means and standard deviations for continuous data, and frequencies and valid percentages for categorical data; these analyses were conducted in Microsoft Excel. Inferential statistics conducted in JMP 17.0 Pro included independent samples t-test, matched pairs t-test, and linear mixed modeling.

Within instruments, no missing data was identified; that is, when a participant started an instrument, they completed all items and did not skip questions. Over the course of the study, however, fewer survey responses were provided. Of the 13 baseline completers, 7 completed the 3 week survey (53.8%), 6 completed the 6 week survey (46.2%), and 5 completed the 9 week survey (38.5%). The drop-off from baseline to 3 weeks corresponds directly with program participation; although all enrollees were prompted to complete subsequent surveys regardless of participation status, only individuals participating in a session completed a subsequent program survey.

Baseline differences between participants and non-participants

Baseline scores of participants (n=7) versus non-participants (n=6) were explored using independent samples pooled t-test for the following constructs: PSS-10, Attitudes TSN-Positive, Attitudes TSN-Negative, Attitudes TSN-Concerns, and Intentions TSN. Data consisted of independent samples, with no overlap between participants and non-participants. While data violated the random sampling assumption held by the independent samples t-test, due to small sample size, exploratory analyses were conducted. Homogeneity of variances was met for all constructs except Self-Efficacy TSN; thus, Self-Efficacy TSN was analyzed using an unequal variances t-test.

Per-session present stress

Using pre-post session data measuring present stress at the level of individual forest bathing sessions (n=33), pre-session and post-session means were calculated for each participant (n=7). For each participant, data from all attended sessions were used to calculate a mean pre-session score and a mean post-session score for the individual. These seven pairs of pre-post means were analyzed using a matched pairs t-test. As data

data violated assumptions of random sampling and homogeneity of variance, analyses were exploratory in nature.

Per-session mood state

Free text assessments of mood state (n=33) were assessed in Microsoft Excel. Responses primarily consisted of one- or two-word phrases. The first author open-coded responses, recognizing three emerging themes: positive affective impacts, negative affective impacts, and physiological responses.

Program effects over time

Perceived stress, Attitudes TSN-Positive, Attitudes TSN-Negative, Attitudes TSN-Concerns, Intentions TSN, and Self-efficacy TSN were each explored over the 4 time periods (baseline, 3W, 6W, 9W) using linear mixed models. This approach was chosen due to its robustness in analyzing datasets with small sample sizes and missing data.[34] All complete baseline responses (n=13) and subsequent survey responses were included in the analysis, regardless of completion of subsequent surveys or participation in study activities; analysis included 31 data points. Time period was set as a fixed effect, with the participant identifier set as the random effect. Likely due in part to small sample size, assumptions were violated (equal variance and normal distribution of residuals); however, exploratory linear mixed models were conducted and interpreted cautiously.

Results

Thirteen students enrolled in the study (Appendix F). The majority identified as female (n=9, 69.2%), as graduate students (n=10, 76.9%), and having spent time in nature as children at least several times per week (n=12, 92.3%). Participants averaged 22.7 years of age (SD=2.7, range=19-29). Of the thirteen enrollees, 7 participated in at least one program session (53.8%), and 5 participated in at least three sessions (38.5%).

Baseline differences between participants and non-participants – program surveys

Baseline data of participants and non-participants are presented in Table 1, as are comparisons of participants and non-participants. Analyses revealed differences on PSS-10 and Attitudes TSN-Positive of marginal statistical significance. While the p-values exceed the 0.05 benchmark, they are submitted here for consideration. The results for all baseline comparisons of participants and non-participants can be found in Table 1.

Perceived stress

At baseline, participants reported an average PSS-10 score of 25.9 (SD=4.3), while non-participants reported a mean of 20.5 (SD=5.3). Notably, the participant mean is near the lower bound (27) of the high stress category. The difference was 5.4 (SE=2.7, p=0.07). These findings suggest that those enrollees who ultimately participated in forest bathing sessions were experiencing higher degrees of stress than the enrollees who did not participate.

Attitudes TSN-Positive

At baseline, participants reported an average of 3.7 (SD=0.6) on the Attitude TSN-Positive scale, while non-participants reported a mean of 4.3 (SD=0.5). The mean difference was 0.6 (SE=0.3, p=0.10). Interpreted conservatively, this test may indicate that non-participants had greater positive attitudes toward spending time in nature than participants at baseline.

Time spent in nature

At baseline, non-participants reported spending time outdoors in nature on more days during the previous week (M = 4.0, SD=1.9) than did participants (M = 2.0, SD=2.9).

Per-session present stress – session surveys

In the 33 distinct participant sessions, Likert scale reports on check-in and check-out session surveys indicated decreased stress after 90.1% of sessions (n=30). On two occasions, a single participant reported an increase in stress. On a separate occasion, a different participant indicated no change in stress. Comparing pre- and post-session present stress scores via matched-pairs t-test, we found a statistically significant difference (p=0.0007) over the course of a 40-minute forest bathing session (Table 2). Mean pre-session and post-session scores were 6.1 (SD=0.6) and 4.1 (SD=1.2), respectively. The mean pre-post session difference was 1.9 (SE=0.3) and we have 95% confidence that the true mean difference is between 1.2 and 2.7. On average, participants reported a per-session decrease in present stress of 1.9 points on an 0-10 scale.

Per-session mood state– session surveys

Among free-text check-out responses (n=33), participants reported positive affective impacts (e.g., calmness, relaxation, fulfillment, happiness) in 63.6% of reports (n=21), negative affective impacts (e.g., anxiety, stress, boredom) in 12.1% (n=4) of reports, and physiological responses (e.g., tiredness, hunger) in 39.4% (n=13) of reports.

Program effects over time – program surveys

Means at each time point are presented in Table 3, with linear mixed models analyses for all dependent variables presented in Table 4.

Perceived stress

The linear mixed model exploring PSS-10 scores was statistically significant (p=0.0308). This model posits a mean baseline score of 24.1 (SE=1.6; 95% CI 20.64, 27.64), with a decrease of 0.5 PSS-10 units (SE=0.2, 95% CI 0.05, 0.95) for each week of study involvement. Per the model, over the course of the study and into follow-up, participants experienced an average decrease in perceived stress by half of an increment on the PSS-10 scale per week.

Attitude TSN, Intentions TSN, and Self-Efficacy TSN

Models for multiple dependent variables (Attitude TSN-Positive, Attitude TSN-Negative, Attitude TSN-Concerns, Intentions TSN, and Self-Efficacy TSN) were not statistically significant.

Discussion

While small sample size limited the generalizability of quantitative analyses, baseline attitudes toward spending time in nature scores generally indicated high positive attitudes and low negative attitudes toward spending time in nature among enrollees. This suggests that time spent outdoors may be generally acceptable to clinical students; however, we only have baseline data for 13 individuals who chose to enroll in the program. Thus, those enrolling in the program may have held positive pre-existing attitudes toward spending time in nature which influenced the decision to enroll.

Notably, at baseline, enrollees attending no sessions reported less perceived stress, greater positive attitudes TSN, and more days spent in nature in the previous week than those attending at least one session. Plausibly, these highly nature-positive enrollees who did not ultimately participate in study activities may have engaged in self-directed nature-based activities on their own time. If further study supports the theory that a sub-population of clinical students are nature-positive and already engage in

nature-based activity, future NBI trials should seek to engage these students as NBI peer interventionists.

Over the study period and into follow-up, participants reported statistically significant reductions in perceived stress. Across the six-week intervention and three-week follow-up, we found a reduction in 0.5 PSS-10 units per week. Terp et al.'s[35] cognitive behavioral program for nursing students found a reduction of 4.6 PSS-10 units over the ten-week intervention (0.5 units per week), albeit not statistically significant. Moore et al.'s[36] mindfulness training for medical students found a reduction of 1.8 PSS-10 units over the eight-week intervention (0.2 units per week), again not statistically significant. While these comparisons should be assessed cautiously in consideration of differences in intervention type, intervention duration, measurement intervals, and analysis approaches, these findings combined suggest that targeting programming, NBI and otherwise, may effectively reduce stress in this population.

Mean scores of participants also indicated decreases in negative attitudes TSN, decreases in concerns TSN, increases in positive attitudes TSN, and increases in self-efficacy TSN, albeit without statistical significance. While underpowered for statistical significance, these findings suggest the presence of preliminary effects warranting further study.

Acute per-session impacts may have constituted the strongest findings from this study. Post-session reports of positive affective outcomes vastly outnumbered reports of negative affective outcomes, and participants reported statistically significant improvements in present stress over the course of the session. While stress-relieving benefits were identified over the course of the study, the acute benefits were perhaps most potent.

Implications and Future Directions

Despite low enrollment and the substantial proportion of enrollees not attending any sessions, those attending at least one session reported benefitting from forest bathing sessions. Future studies should endeavor to overcome recruitment challenges and test efficacy in a larger sample size. Involving members of the target population in early stages of intervention planning, such as through surveys or focus groups, may aid in developing a nature-based intervention capable of attracting and enrolling more students. Additionally, as baseline data suggested that non-attending enrollees may engage in self-directed nature exposure, inquiry into the pre-existing nature-based habits of clinical students is warranted.

Strengths and Limitations

To the authors' knowledge, this study reports on the first feasibility trial of a repeated-session forest bathing program for clinical health profession students. A subset of these students was agreeable to spending time outdoors in nature, and some may already be spending time in nature apart from the intervention. While recruitment goals were not met, retention of students attending at least one session was high. Participants generally reported benefits to mood and present stress.

A two-arm randomized study was initially planned, but low enrollment necessitated a modification to a single-arm design. The small sample size and single-arm design was underpowered, and these preliminary findings may not be generalizable. Additionally, while we requested follow-up survey participation from enrollees who did not participate in sessions, no follow-up data were received from these non-participants.

Modifications were made to the protocol after registration. Central to the participant experience was a change in session availability and related guidance. Initially, three proctored hours over two days were available per week, and participants were instructed to begin on-the-hour. After the first week, proctored sessions were increased to four hours over two days, and participants were permitted to attend during any 40-minute segment of the proctored sessions. During the final week, session availability was again changed due to a high-traffic collegiate athletic event in the vicinity; three hours were available on one day. While the first set of changes were made in response to participant feedback, and the second set of changes were due to unavoidable traffic and parking conflict, the inconsistency may have impacted participation and outcomes.

Conclusion

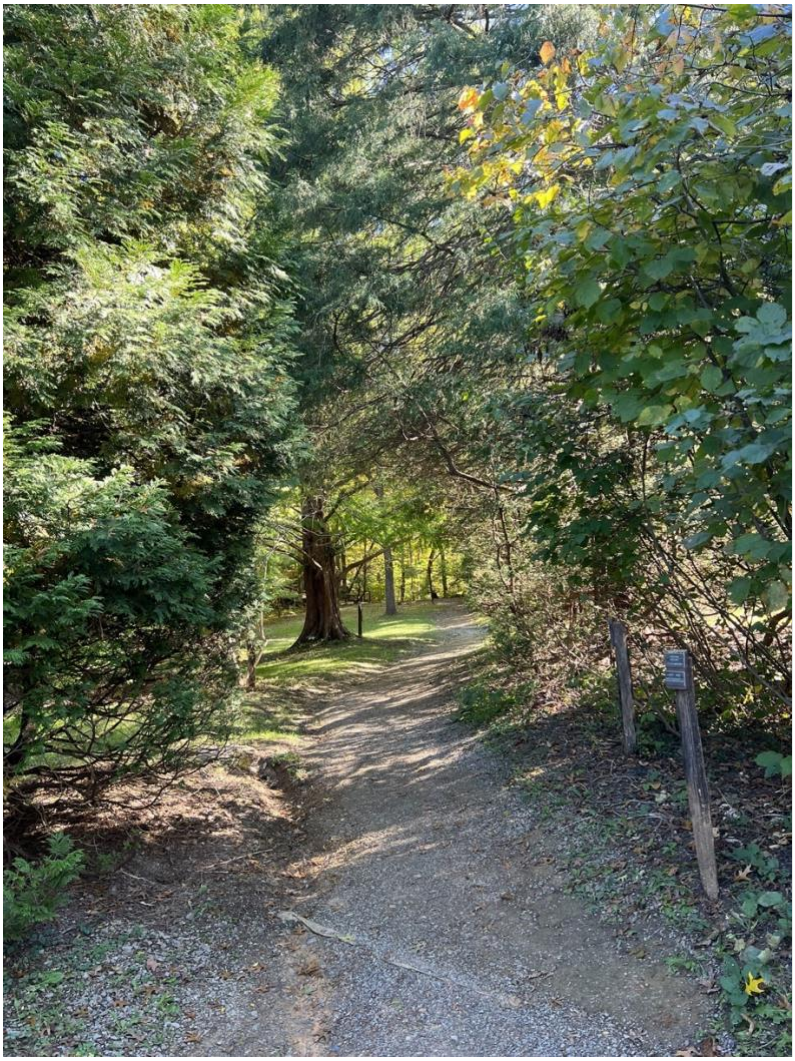
Forest bathing may provide acute stress-relieving benefits to clinical health professions students. More feasibility work is indicated to determine a study design capable of attracting a sufficient sample size.

Funding

This research received no specific grant from any funding agency.

Figure 1: Site Photos

Arboretum lawn observed during week 1.



Trail observed during week 5. Note informational signage

Table 2: Baseline Scores by Participation Status

	Participants n=7		*Non-Participants n=6*		*All n=13*		*Difference*		
	Mean (SD)	*95% CI*	*Mean (SD)*	*95% CI*	*Mean (SD)*	*95% CI*	*Diff (Std Error)*	*95% CI*	*p*
PSS-10[a]	25.86 (4.34)	21.85, 29.87	20.50 (5.32)	14.92, 26.08	23.38 (5.38)	20.13-26.63	5.36 (2.7)	-0.53, 11.25	0.0705
Attitude TSN-Pos[a]	3.74 (0.58)	3.21, 4.28	4.32 (0.58)	3.71, 4.92	4.01 (0.63)	3.63-4.39	-0.57 (0.32)	-1.28, 0.14	0.1024
Attitude TSN-Neg[a]	2.34 (0.78)	1.62, 3.06	1.90 (0.73)	1.13, 2.67	2.14 (0.76)	1.68-2.60	0.44 (0.42)	-0.49, 1.37	0.3175
Attitude TSN-Con[a]	3.26 (0.81)	2.50, 4.01	3.07 (0.50)	2.54, 3.59	3.17 (0.67)	2.77-3.57	0.19 (0.38)	-0.65, 1.03	0.6293
Intentions TSN[a]	3.43 (1.14)	2.38, 4.48	3.98 (0.78)	3.16, 4.81	3.68 (0.99)	3.08-4.28	-0.55 (0.55)	-1.77, 0.66	0.3368
Self-Efficacy TSN[b]	2.60 (1.03)	1.64, 3.56	2.63 (0.85)	1.84, 3.42	2.68 (0.63)	2.30-3.06	-0.12 (0.34)	-0.92, 0.67	0.7303

Participant set as referent group versus non-participant for difference comparisons.

[a]*PSS-10, Attitude TSN-Positive, Attitude TSN-Negative, Attitude TSN-Concerns, and Intentions TSN used pooled t-tests*

[b]*Self-Efficacy TSN used an unequal variances t-test*

Abbreviations: PSS-10 – Perceived Stress Scale 10; Attitude TSN-Pos – Positive Attitudes Toward Spending Time in Nature; Attitude TSN-Neg – Negative Attitudes Toward Spending Time in Nature; Attitude TSN-Con – Concerns about Spending Time in Nature Self-Efficacy TSN – Self-Efficacy Toward Spending Time in Nature; Intentions TSN – Intentions to Spend Time in Nature

Table 2: Mean Difference in Pre-Session and Post-Session Present Stress

(n=7)

	Pre-Session		Post-Session					
	Mean	*SD*	*Mean*	*SD*	*Mean difference*	*Std Error*	*95% CI*	*p*
Present Stress	6.1	0.6	4.1	1.2	1.9	0.3	1.2–2.7	0.0007

Table 3: Mean Instrument Scores by Program Survey Interval

	Baseline (0W) n=13		Midpoint (3W) n=7		Final (6W) n=6		Follow-Up (9W) n=5	
	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
PSS-10	23.38 (5.38)	20.13-26.63	26.71 (5.65)	21.49-31.94	23.83 (5.91)	17.63-30.04	20.40 (6.35)	12.52-28.28
Attitude TSN-Pos	4.01 (0.63)	3.63-4.39	3.7 (0.91)	2.93-4.61	3.65 (1.05)	2.55-4.75	3.94 (1.15)	2.52-5.36
Attitude TSN-Neg	2.14 (0.76)	1.68-2.60	2.26 (1.02)	1.32-3.20	2.57 (1.07)	1.44-3.69	2.08 (1.10)	0.71-3.45
Attitude TSN-Con	3.17 (0.67)	2.77-3.57	2.57 (1.06)	1.59-3.55	3.17 (1.35)	1.75-4.58	2.6 (1.14)	1.18-4.02
Intentions TSN	3.68 (0.99)	3.08-4.28	3.69 (1.02)	2.74-4.63	3.83 (1.06)	2.72-4.94	3.48 (1.51)	1.60-5.36
Self-Efficacy TSN	2.68 (0.63)	2.30-3.06	2.60 (1.03)	1.64-3.56	2.67 (1.25)	1.35-3.98	3.06 (0.97)	1.85-4.27

Table 4: Linear Mixed Model of Instrument Scores Over All Time Intervals (0W, 3W, 6W, 9W)

Measure	*Feature*	*Estimate*	*Standard Error*	*p value*	*Lower 95% CI*	*Upper 95% CI*
PSS-10	Intercept	24.1412	1.6314	<0.0001	20.6397	27.6426
	Week	-0.5025	0.2159	0.0308	-0.9534	-0.0515
Attitude TSN-Pos	Intercept	3.985	0.2218	<0.0001	3.5088	4.4621
	Week	0.0125	0.0224	0.5824	-0.0343	0.0594
Attitude TSN-Neg	Intercept	2.1495	0.2432	<0.0001	1.6287	2.6703
	Week	-0.0026	0.0276	0.9271	-0.0602	0.0551
Attitude TSN-Con	Intercept	3.0630	0.2480	<0.0001	2.5340	3.5920
	Week	-0.0344	0.0277	0.2291	-0.0922	0.0234
Intentions TSN	Intercept	3.7492	0.2742	<0.0001	3.1688	4.3295
	Week	-0.0051	0.0384	0.0847	-0.0848	0.0745
Self-Efficacy TSN	Intercept	2.6598	0.2112	<0.0001	2.2067	3.1127
	Week	0.0161	0.0186	0.3984	-0.0229	0.0550

Abbreviations: PSS-10 – Perceived Stress Scale 10; Attitude TSN-Pos – Positive Attitudes Toward Spending Time in Nature; Attitude TSN-Neg – Negative Attitudes Toward Spending Time in Nature; Attitude TSN-Con – Concerns about Spending Time in Nature Self-Efficacy TSN – Self-Efficacy Toward Spending Time in Nature; Intentions TSN – Intentions to Spend Time in Nature

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Chapter 5. Summary

Results Summary

In this dissertation I explored the existing landscape of nature-based interventions for health and wellbeing, and conducted a feasibility trial of forest bathing among clinical students, a population previously unreached by nature-based interventions. The three aims are summarized below.

Aim 1 employed a scoping review protocol to examine the current evidence base for nature-based interventions in dissertations, theses, and peer-reviewed literature. Findings showed that reported nature-based interventions were diverse in naming convention, design, setting, and target outcome. These findings support future endeavors to (1) develop a reporting checklist to increase rigor and consistency in publication and (2) build consensus around consistent naming conventions.

Aim 2 examined the feasibility of implementing a six-week forest bathing intervention for stress among a clinical health student population. Findings showed that that recruitment among this population was challenging due in part to the program's weekday scheduling, but individuals choosing to participate attended regularly. Additionally, participants eschewed forest bathing instructions and spent the allotted time in nature according to their own activity and social preferences, but wanted additional guidance to aid in distracting their minds from school-related concerns. These findings suggest that guided, interactive weekend activities provided in a variety of natural environments may be of interest to this population.

Aim 3 examined the acceptability and preliminary effectiveness of a six-week forest bathing intervention for stress among a clinical health student population.

Findings showed that participants, on average, reported improved stress and affect at each forest bathing sessions and over the full intervention period, and few perceived harms or adverse events were reported. These findings suggest that a NBI is acceptable among a subset of clinical students and such programming may provide stress-relieving benefits.

Strengths and Limitations

This dissertation filled two gaps in the NBI literature: (1) assessing existing NBI practices regarding intervention classification, study context, and methodology across the diversity of NBI sub-types; and (2) assessing the feasibility and effectiveness of NBI programming for clinical students. Additionally, each chapter was written in accordance with methodologically-appropriate reporting guidelines and checklists to ensure rigor: Aim 1 followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR),[1] while Aims 2 and 3 modified the Consolidated Standards of Reporting Trials (CONSORT) 2010 Statement Extension to Randomized Pilot and Feasibility Trials checklist to fit a single-arm design.[2]

Due to financial and other resource constraints, Aim 1 did not utilize dual-coding, which could have increased the reliability of the data. Likewise, Aims 2 and 3 did not provide financial incentives to all participants, rather relying on a drawing for a limited number of gift cards; guaranteed incentives could have improved recruitment outcomes and addressed the limitation in statistical power due to low participation which necessitated using a single arm trial. Aims 2 and 3 could have been strengthened by the addition of biomarker measurements, such as cortisol and C-reactive protein.

Implications and Future Directions

Nature-based interventions have the potential to support positive health and wellbeing, but further work is needed to (1) enhance the consistency and rigor of reporting and (2) successfully recruit and meaningfully engage unreached populations. Aim 1 provided an analysis of past and present practices in NBI research. Moving forward from this scoping review, researchers and practitioners in the field should collaborate on the development of (1) consistent naming conventions and (2) NBI-specific reporting guidelines and checklist.

Aims 2 and 3 piloted a type of NBI, forest bathing, among clinical students at a public university in the United States. While recruitment failed to attract the intended sample size, the positive experiences of participants warrants further feasibility work in this population. In accordance with participants' stated needs and preferences, future NBI trials for clinical students should focus programming on weekends, provide guided activities, and engage a variety of natural settings as feasible. Due to the unique nature of the clinical student experience, future interventions should be designed prospectively in collaboration with the intended participants.

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Appendices – Aim 1

Appendix A: PRISMA-ScR Reporting Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	14
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	14-15
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	16
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	16-17
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	17
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	17, 33
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	17-18
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	176-177
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	18-19
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	20
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	180-203

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	20
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	179
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	34-58
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	21-26
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	21-26
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	26-28
Limitations	20	Discuss the limitations of the scoping review process.	30-31
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	31
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	32

Appendix B: Search Strategy

PubMed

((nature[Title]) OR (natural[Title]) OR (outdoor*[Title]) OR (park[Title]) OR (forest[Title]) OR (alpine[Title]) OR (blue space*[Title]) or (green space*[Title]) OR (blue exercise[Title]) OR (green exercise[Title]) OR (ocean[Title]) OR (trail[Title]) OR (Shinrin Yoku[Title]) OR (garden*[Title]) OR (horticult*[Title]) OR (ecotherapy*[Title]) OR (adventure[Title]) OR (wilderness[Title]))

AND ((therap*[Title/Abstract]) OR (intervention[Title/Abstract]) OR (experiment*[Title/Abstract]) OR (trial[Title/Abstract]) OR (prescription[Title/Abstract]) OR (rx[Title/Abstract]) OR (treatment[Title/Abstract]) OR (bath*[Title/Abstract]) OR (comparison[Title/Abstract]) OR (observation*[Title/Abstract]))

AND ((health[Title/Abstract]) OR (wellbeing[Title/Abstract]) OR (well-being[Title/Abstract]) OR (wellness[Title/Abstract]) OR (outcome[Title/Abstract]) OR (change[Title/Abstract]))

AND ((human*[Title/Abstract]) OR (adult*[Title/Abstract]) OR (wom?n[Title/Abstract]) OR (m?n[Title/Abstract]) OR (child*[Title/Abstract]) OR (adolesc*[Title/Abstract]) OR (participant*[Title/Abstract]) OR (female*[Title/Abstract]) OR (male*[Title/Abstract]) OR (student*[Title/Abstract]))

Filter: Human Subjects

Web of Science

(TI=(nature) OR TI=(natural) OR TI=(outdoor*) OR TI=(park) OR TI=(forest) OR TI=(alpine) OR TI=(blue space*) OR TI=(blue exercise) OR TI=(green space*) OR TI=(green exercise) OR TI=(ocean) OR TI=(trail) OR TI=(Shinrin Yoku) OR TI= garden* OR TI=(horticult*) OR TI=(ecotherapy*) OR TI=(adventure) OR TI=(wilderness))

AND (TI=(therap*) OR TI=(intervention) OR TI=(experiment*) OR TI=(trial) OR TI=(prescription) OR TI=(rx) OR TI=(treatment) OR TI=(bath*) OR TI=(comparison) OR TI=(observation*) OR AB=(therap*) OR AB=(intervention) OR AB=(exercise) OR AB=(experiment*) OR AB=(trial) OR AB=(prescription) OR AB=(rx) OR AB=(treatment) OR AB=(bath*) OR AB=(comparison) OR AB=(observation*))

AND (TI=(health) OR TI=(wellbeing) OR TI=(well-being) OR TI=(wellness) OR TI=(outcome) OR TI=(change) OR AB=(health) OR AB=(wellbeing) OR AB=(well-being) OR AB=(wellness) OR AB=(outcome) OR AB=(change))

AND (TI=(adult*) OR TI=(child*) OR TI=(adolesc*) OR TI=(student*) OR TI=(human*) OR TI=(m?n) OR TI=(wom?n) OR TI=(participant*) OR TI=(male*) OR TI=(female*) OR AB=(adult*) OR AB=(child*) OR AB=(adolesc*) OR AB=(student*) OR AB=(human*) OR AB=(m?n) OR AB=(wom?n) OR AB=(participant*) OR AB=(male*) OR AB=(female*))

Document Type Filter: Articles

Scopus

(TITLE(nature) OR TITLE(natural) OR TITLE(outdoor*) OR TITLE(park) OR TITLE(forest) OR TITLE(alpine) OR TITLE("blue space*") OR TITLE("blue exercise") OR TITLE("green space*") OR TITLE("green exercise") OR TITLE(ocean) OR TITLE(trail) OR TITLE(Shinrin Yoku) OR TITLE(horticult*) OR TITLE(ecotherapy) OR TITLE(adventure) OR TITLE(wilderness))

AND (TITLE-ABS(therap*) OR TITLE-ABS(intervention) OR TITLE-ABS(experiment*) OR TITLE-ABS(trial) OR TITLE-ABS(prescription) OR TITLE-ABS(rx) OR TITLE-ABS(treatment) OR TITLE-ABS(bath*) OR TITLE-ABS(comparison) OR TITLE-ABS(observation*))

AND (TITLE-ABS(health) OR TITLE-ABS(wellbeing) OR TITLE-ABS(well-being) OR TITLE-ABS(wellness) OR TITLE-ABS(outcome) OR TITLE-ABS(change))

AND (TITLE-ABS(adult*) OR TITLE-ABS(child*) OR TITLE-ABS(adolesc*) OR TITLE-ABS(student*) OR TITLE-ABS(human*) OR TITLE-ABS(m?n) OR TITLE-ABS(wom?n) OR TITLE-ABS(participant*) OR TITLE-ABS(male*) OR TITLE-ABS(female*))

Document Type Filter: Article
Source Type Filter: Journal

ProQuest Dissertations and Theses Global

ti(nature OR natural OR park OR outdoor* OR forest OR alpine OR "blue space* OR "blue exercise" OR "green space* OR "green exercise" OR ocean OR trail OR "Shinrin Yoku" or Shinrin-Yoku or horticult* OR ecotherapy OR adventure OR wilderness)

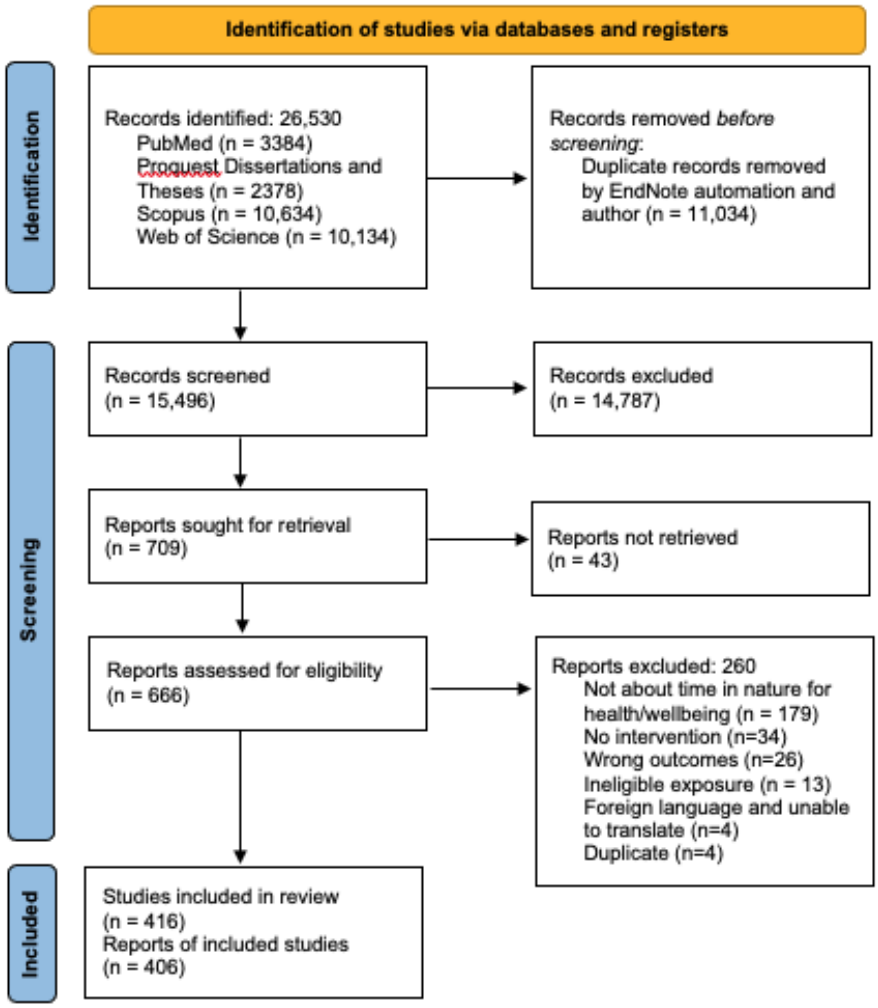
AND ab(therap* OR intervention OR experiment* OR trial OR prescription OR rx OR treatment OR bath* OR comparison OR observation*)

AND ab(health OR wellbeing OR well-being OR wellness OR outcome OR change)

AND ab(adult* OR child* OR adolesc* OR student* OR human* OR m?n OR wom?n OR participant* OR male* OR female*)

Appendix C: PRISMA 2020 Flow Diagram

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Appendix D: Excluded Articles

This appendix is uploaded to the WVU Electronic Theses and Dissertations record as a supplemental file.

Appendix E: Code Book

Start of Block: Administrative Details

Q2 Article Title

_____

Q3 Authors

_____

Q5 Journal

_____

Q6 Year published

_____

Q88 Publication Type

- ○ Peer-reviewed article (1)
- ○ Thesis/Dissertation (2)
- ○ Other (3) _____

Q1 Record number

_____

Q4 Affiliations

_____

Q12 Location of intervention/observation

- ○ City (4) _____
- ○ State/Region (5) _____
- ○ Country (6) _____

Q13 Month(s) of intervention/observation

- [ ] January (1)
- [ ] February (2)
- [ ] March (3)
- [ ] April (4)
- [ ] May (5)
- [ ] June (6)
- [ ] July (7)
- [ ] August (8)
- [ ] September (9)
- [ ] October (10)
- [ ] November (11)
- [ ] December (12)

Q14 Year(s) of intervention/observation

_____

End of Block: Administrative Details

Start of Block: Study Design

Q84 Is this a pilot or feasibility study?

- ○ Yes, a pilot or feasibility study (1)
- ○ No (2)

Q87 Was the protocol registered and/or published?

- [ ] Registered (1)
- [ ] Published (2)
- [x] Neither registered nor published (3)

Q83 Approach used (choose all that apply)

- [ ] Quantitative (1)
- [ ] Qualitative (2)

Q7 Study design

- [ ] Randomized controlled trial (1)
- [ ] Quasi-experimental (2)
- [ ] Crossover (4)
- [ ] Single group (6)
- [ ] Other (3) _____

Q9 Behavioral model or theoretical framework used?

- ○ Yes (1)
- ○ No (2)

Q10 Name of models or theories used

_____

Q11 Change mechanisms identified, if any

_____

Page Break

Q78 Intervention nomenclature

What do they call it? Ex: nature rx, forest walking

_____

Q26 Brief intervention description

_____

Q27 Inclusion criteria

_____

Q28 Exclusion criteria

_____

Q29 *Are people instructed to be active or sedentary? Select all that apply.*

- ☐ Active (4)
- ☐ Sedentary (sitting) (5)
- ☐ Unspecified (7)

Q85 Are incentives provided to participants?

- ○ Yes, all participants (1)
- ○ Yes, some participants (e.g., drawing) (2)
- ○ No incentives at all (3)

Display This Question:
If Are incentives provided to participants? = Yes, all participants
Or Are incentives provided to participants? = Yes, some participants (e.g., drawing)

Q86 Incentive types

- [ ] Cash/gift cards (1)
- [ ] Academic credit (4)
- [ ] Vouchers (2)
- [ ] Other (3) _____

Q35 Forbidden activities

- [ ] Caffeine (4)
- [ ] Alcohol (13)
- [ ] Eating food (11)
- [ ] Tobacco (10)
- [ ] Vigorous exercise (5)
- [ ] Listening to music (6)
- [ ] Talking with others (7)
- [ ] Using cell phone (8)
- [ ] Sitting down (12)
- [ ] Other (9) _____

Page Break

Q30 Environment Type

- ☐ Urban Green (1)
- ☐ Water Bodies (2)
- ☐ Forest/Woodland (3)
- ☐ Countryside/Farmland (4)
- ☐ Wilderness (5)
- ☐ Desert (7)
- ☐ Unspecified (8)
- ☐ Other (6) _____

Q31 Dose duration

Ex: 1 hour sessions

_____

Q32 Dose frequency

Ex: 2 sessions per week

_____

Q34 Length of intervention period

Ex: 6 weeks

_____

Q33 Dose intensity

Please provide the authors' description of the site

_____

Q84 Are photos/sketches of the intervention sites included in the paper?

- ○ Yes (1)
- ○ No (2)

Page Break

Q8 Number of treatment arms

If no comparators, choose "1"

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)
- ○ 6 (6)
- ○ 7 or more (7) _____

End of Block: Study Design

Start of Block: Total Sample

Q18 Total sample size

_____

Q19 Total sample - age

- ○ Mean (4) _____
- ○ Standard deviation of mean (5) _____
- ○ Minimum (6) _____
- ○ Maximum (7) _____

Q25 Total sample - percent female

_____

Q24 Total sample - race ethnicity

_____

Q23 Total sample - special population features

(ex: undergraduate students, breast cancer survivors)

_____

End of Block: Total Sample

Start of Block: Treatment Arm 1

Q15 Treatment arm 1 type

- ○ Intervention (1)
- ○ Control (2)
- ○ Observation (3)

Q16 Treatment arm 1 activity description - distinguish from other arms

(ex: "guided forest walking," or "no activity control")

_____

Q88 Treatment arm 1 activity - guided or unguided activity

- ○ Guided (1)
- ○ Unguided (2)
- ○ Other (3) _____

Q36 Treatment arm 1 - sample size

_____

Q38 Treatment arm 1 age

- ○ Mean (4) _____
- ○ Standard deviation of mean (5) _____
- ○ Minimum (6) _____
- ○ Maximum (7) _____

Q42 Treatment arm 1 - percent female

_____

Q37 Treatment arm 1 - race ethnicity

_____

End of Block: Treatment Arm 1

Start of Block: Treatment Arm 2

Q43 Treatment arm 2 type

- ○ Intervention (1)
- ○ Control (2)
- ○ Observation (3)

Q44 Treatment arm 2 activity description - distinguish from other arms

(ex: "guided forest walking," or "no activity control")

_____

Q89 Treatment arm 2 activity - guided or unguided

- ○ Guided (1)
- ○ Unguided (2)
- ○ Other (3) _____

Q45 Treatment arm 2 - sample size

_____

Q46 Treatment arm 2 - age

- Mean (4) _____
- SD of mean (5) _____
- Min (6) _____
- Max (7) _____

Q50 Treatment arm 2 - percent female

_____

Q51 Treatment arm 2 - race ethnicity

_____

End of Block: Treatment Arm 2

Start of Block: Treatment Arm 3

Q52 Treatment arm 3 type

- Intervention (1)
- Control (2)
- Observation (3)

Q53 Treatment arm 3 activity description - distinguish from other arms

(ex: "guided forest walking," or "no activity control")

_____

Q90 Treatment arm 3 activity - guided or unguided

- ○ Guided (1)
- ○ Unguided (2)
- ○ Other (3) _____

Q54 Treatment arm 3 - sample size

_____

Q55 Treatment arm 3 - age

- ○ Mean (4) _____
- ○ SD of mean (5) _____
- ○ Min (6) _____
- ○ Max (7) _____

Q59 Treatment arm 3 - percent female

_____

Q60 Treatment arm 3 - race ethnicity

_____

End of Block: Treatment Arm 3

Start of Block: Treatment Arm 4

Q61 Treatment arm 4 type

- ○ Intervention (1)
- ○ Control (2)
- ○ Observation (3)

Q62 Treatment arm 4 activity description - distinguish from other arms

(ex: "guided forest walking," or "no activity control")

_____

Q91 Treatment arm 4 activity - guided or unguided

- ○ Guided (1)
- ○ Unguided (2)
- ○ Other (3) _____

Q63 Treatment arm 4 - sample size

_____

Q64 Treatment arm 4 - age

- ○ Mean (4) _____
- ○ SD of mean (5) _____
- ○ Min (6) _____
- ○ Max (7) _____

Q68 Treatment arm 4 - percent female

_____

Q69 Treatment arm 4 - race ethnicity

_____

End of Block: Treatment Arm 4

Start of Block: Treatment Arm 5

Q111 Treatment arm 5 type

- ○ Intervention (1)
- ○ Control (2)
- ○ Observation (3)

Q112 Treatment arm 5 activity description - distinguish from other arms

(ex: "guided forest walking," or "no activity control")

_____

Q113 Treatment arm 5 activity - guided or unguided

- ○ Guided (1)
- ○ Unguided (2)
- ○ Other (3) _____

Q114 Treatment arm 5 - sample size

_____

Q115 Treatment arm 5 - age

- ○ Mean (4) _____
- ○ SD of mean (5) _____
- ○ Min (6) _____
- ○ Max (7) _____

Q116 Treatment arm 5 - percent female

_____

Q117 Treatment arm 5 - race ethnicity

_____

End of Block: Treatment Arm 5

Start of Block: Treatment Arm 6

Q118 Treatment arm 6 type

- ○ Intervention (1)
- ○ Control (2)
- ○ Observation (3)

Q119 Treatment arm 6 activity description - distinguish from other arms

(ex: "guided forest walking," or "no activity control")

_____

Q120 Treatment arm 6 activity - guided or unguided

- ○ Guided (1)
- ○ Unguided (2)
- ○ Other (3) _____

Q121 Treatment arm 6 - sample size

_____

Q122 Treatment arm 6 - age

- ○ Mean (4) _____
- ○ SD of mean (5) _____
- ○ Min (6) _____
- ○ Max (7) _____

Q123 Treatment arm 6 - percent female

_____

Q124 Treatment arm 6 - race ethnicity

_____

End of Block: Treatment Arm 6

Start of Block: Quantitative Analysis

Q77 Was a sample size/power rationale provided?

- Yes (1)
- No (2)

Q75 Is an effect size reported?

- Yes (1)
- No (2)

Display This Question:
If Is an effect size reported? = Yes

Q76 Which effect sizes were reported?

- [ ] Cohen's d (4)
- [ ] Cohen's U3 (7)
- [ ] Gamma (10)
- [ ] Hedge's g (5)
- [ ] Eta squared (9)
- [ ] Partial eta squared (8)
- [ ] Pearson's r (11)
- [ ] Other (6) _____

Page Break

Q80 Surveys/Calculators

- [ ] Activation- Deactivation Adjective Checklist (AD-ACL) (1)
- [ ] Attentional Function Index (AFI) (58)
- [ ] Beck Anxiety Inventory (28)
- [ ] Beck Depression Inventory-II (29)
- [ ] Behavioral symptom inventory (2)
- [ ] Brief Symptom Inventory (BSI) (30)
- [ ] Brooding Scale (subscale of Ruminative Response Scale) (59)
- [ ] Brunel Mood Scale (BRUMS - abbreviated POMS) (31)
- [ ] Checklist Individual Strength Questionnaire (60)
- [ ] Chinese Affect Scale (CAS-PA) (61)
- [ ] Connectedness to Nature (32)
- [ ] Coopersmith Self Esteem Inventory (33)
- [ ] CORE Family Functioning Questionnaire (34)
- [ ] Developed item: cheerfulness, relaxed, and natural feeling (56)
- [ ] Developed item: discomfort (57)
- [ ] Developed item: environment preference (62)
- [ ] Developed item: food knowledge and preferences (63)
- [ ] Developed item: restorative experience (64)
- [ ] Eating at America's Table (EATS) (65)
- [ ] Eating Disorder Examination (EDE) (53)
- [ ] Endorsed & Anticipated Stigma Inventory (EASI) (35)
- [ ] Engagement with Natural Beauty Scale (83)

- [ ] Family Assessment Measure III (FAM III) (36)
- [ ] Family Wheel Evaluation (37)
- [ ] Feeling Scale (3)
- [ ] Felt Activation Scale of the Telic State Measure (4)
- [ ] Flow State Scale (FSS) (66)
- [ ] General CVD risk calculator (5)
- [ ] Generalized Anxiety Disorder-7 (GAD-7) (6)
- [ ] General Health Questionnaire (GHQ) (55)
- [ ] Hope Scale (38)
- [ ] Individual treatment plan (39)
- [ ] Inclusion of Nature with Self (INS) (82)
- [ ] Internal-External Locus of Control Scale (7)
- [ ] Leisure Time Physical Activity Questionnaire (Godin) (67)
- [ ] Life Attitudes Schedule - Short Form (40)
- [ ] Maslach Burnout Inventory - General Survey (MBI-GS) (68)
- [ ] Nature Relatedness Scale (NR-6) (41)
- [ ] Outcome Rating Scale (42)
- [ ] Patient Health Questionnaire-2 (PHQ-2) (8)
- [ ] Patient Health Questionnaire-9 (PHQ-9) (9)
- [ ] Patient-Reported Outcomes Measurement Information System (PROMIS) (69)
- [ ] Pediatric Quality of Life Inventory (10)
- [ ] Perceived Exertion Scale (11)

- [ ] Perceived forest attractiveness (43)
- [ ] Perceived Restorativeness Scale (PRS) (12)
- [ ] Perceived Stress Questionnaire (PSQ) (70)
- [ ] Perceived Stress Scale (PSS) (13)
- [ ] Piers-Harris self-esteem inventory (14)
- [ ] Pittsburgh Sleep Quality Index (15)
- [ ] Positive and Negative Affect Schedule (PANAS) (16)
- [ ] Profile of Mood States (POMS) (17)
- [ ] Psychological General Well-Being Index (PGWB) (44)
- [ ] Qi Experience(QE) Questionnaire (71)
- [ ] Recovering Quality of Life (ReQoL (80)
- [ ] Relationship Change Scale (18)
- [ ] Resilience Questionnaire (45)
- [ ] Restoration Outcome Scale (19)
- [ ] Revised Behavior Problem Checklist (RBPC) (46)
- [ ] Rosenberg Self-Esteem Scale (47)
- [ ] Ryff's Scales of Psychological Well-being (RPWB) (72)
- [ ] Satisfaction with Life Scale (SWLS) (73)
- [ ] Scales of Mental State (Abele-Brehm) (48)
- [ ] Self Concept Questionnaire (74)
- [ ] Self Description Questionnaire III (SDQ III) (49)
- [ ] Self-Reported Delinquency Checklist (SRDC) (50)

- [ ] Shirom-Melamed Burnout Questionnaire (SMBQ) (51)
- [ ] SF-8 health questionnaire (20)
- [ ] SF-36 (Short Form Health Survey 36) (75)
- [ ] Sherer self-efficacy inventory (21)
- [ ] Social Provisions Scale (76)
- [ ] St Mary's Hospital Sleep Questionnaire (22)
- [ ] State-Trait Anxiety Inventory (STAI) (23)
- [ ] Subjective Vitality Scale (24)
- [ ] Traditional Environmental Qi (TEQ) (77)
- [ ] Types of Positive Affect Scale (TPAS) (81)
- [ ] Utrecht Work Engagement Scale (UWES) (78)
- [ ] Warwick Edinburgh Mental Well-being Scale (WEMWBS) (54)
- [ ] WHO-Five Well-Being Index (WHO-5) (79)
- [ ] WHO Quality of Life – Brief (WHOQOL-BREF) (25)
- [ ] Wilderness Therapy Checklist (26)
- [ ] Youth Self-Report (52)
- [ ] Other (27) _____

Q82 Anthropometrics

- [ ] Bioimpedance (9)
- [ ] Body composition (height, weight, BMI) (1)
- [ ] Blood pressure (2)
- [ ] EEG (8)
- [ ] fNIRS (11)
- [ ] Heart rate (3)
- [ ] Heart rate variability (4)
- [ ] Natural log of high frequency (lnHF) (5)
- [ ] Pulse (7)
- [ ] Vagal tone (10)
- [ ] Other (6) _____

Q83 Lab tests

- [ ] Alpha-amylase (salivary) (7)
- [ ] Cholesterol (10)
- [ ] Complete blood chemistry (CBC) (1)
- [ ] Cortisol (blood draw) (2)
- [ ] Cortisol (hair) (8)
- [ ] Cortisol (salivary) (3)
- [ ] C reactive protein (4)
- [ ] IL-6 (9)
- [ ] Natural killer cells (5)
- [ ] Triglycerides (11)
- [ ] Other (6) _____

Q84 Measured tests

- [ ] 2 minute step test (13)
- [ ] 30 s arm curl test (14)
- [ ] 30 s sit to stand test (15)
- [ ] 6 Minute Walk Test (1)
- [ ] 8 ft timed up and go test (16)
- [ ] Adverse events reporting (9)
- [ ] Digit Span Backward (2)
- [ ] d2 Test of Attention (17)
- [ ] Flexibility - back scratch, chair sit, reach (18)
- [ ] Health care utilization (11)
- [ ] Linguistic Inquiry and Word Count (12)
- [ ] Running speed (4)
- [ ] Senior fitness test (SFT) (21)
- [ ] Sick leave (10)
- [ ] Sleep (measured) (3)
- [ ] Sleep (self-reported) (19)
- [ ] Stabilometric test (20)
- [ ] Physical activity (accelerometer) (22)
- [ ] Physical activity (pedometer) (5)
- [ ] Physical activity (self-reported) (23)
- [ ] Symbol Digit Modalities Test (6)
- [ ] Time spent in nature (self-reported) (8)

☐ Other (7) _____

Page Break

Q80 Follow-up outcome measure(s). Name the instrument used.

_____

Q87 Follow-up time intervals

_____

Q83 Follow-up compliance

_____

Page Break

Q82 Drop-outs - provide any drop-out stats and rationales given

_____

Page Break

Q84 Results summary

_____

End of Block: Quantitative Analysis

Start of Block: Qualitative Analysis

Q73 Approach

- ☐ Narrative (1)
- ☐ Case Study (2)
- ☐ Grounded Theory (3)
- ☐ Phenomenological (4)
- ☐ Ethnography (7)
- ☐ Unspecified (9)
- ☐ Other (8) _____

Q83 Data collection

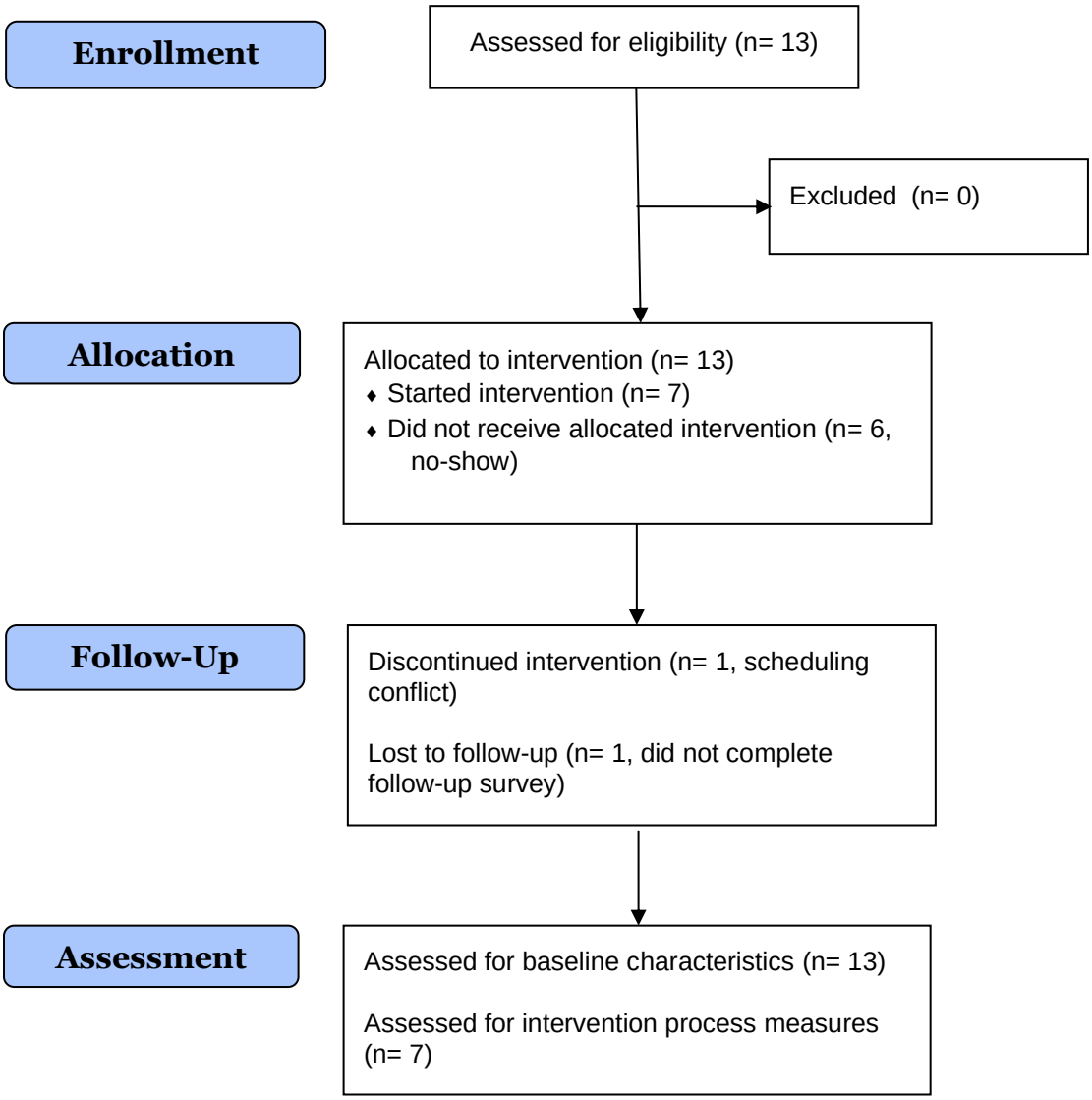
- ☐ Individual interviews (1)
- ☐ Group interviews (2)
- ☐ Open-ended survey question (7)
- ☐ Participant diary (6)
- ☐ Photo elicitation (3)
- ☐ Researcher observation (4)
- ☐ Other (5) _____

Q74 Themes explored

_____

Appendices – Aims 2 & 3

Appendix F: Modified CONSORT Participant Flow Diagram



Appendix G: Program Survey

A. Informed Consent [BASELINE ONLY]

0	[Insert script as required by IRB]		
1**	Are you 18 or older?	Yes; No	If no, conclude survey
2**	Do you have any physical or mental health condition that would make it unsafe for you to walk in the forest alone?	Yes; No	If yes, conclude survey
3**	I consent to participate, and I agree to random assignment to either active treatment or control.	Yes; No	If no, conclude survey
4**	Enter your full WVU email address. This will be used to sign in to future surveys.	Text entry with email address format required	

B. Academic Status [BASELINE ONLY]

1**	Select the discipline in which you are currently pursuing a clinical degree.	Athletic Training Communication Sciences and Disorders Exercise Physiology Medicine Nursing Occupational Therapy Pharmacy Physical Therapy Physician Assistant Studies None of the above	If "none of the above," end survey
2**	Which clinical degree are you currently pursuing?	Different version for each discipline with display logic.	
3**	As of the Fall 2022 semester, which year of the program are you entering?	Junior; Senior, Graduate Year 1; Graduate Year 2; Graduate Year 3; Graduate Year 4; Other (please describe)	

C. Stress [ALL SURVEYS]

N/A	Perceived Stress Scale		[No Header]

			[Note reversed coding for 4, 5, 7, 8]
1	In the last month, how often have you been upset because of something that happened unexpectedly?	Never [0]; Almost Never [1]; Sometimes [2]; Fairly Often [3]; Very Often [4]	
2	In the last month, how often have you felt that you were unable to control the important things in your life?	Never [0]; Almost Never [1]; Sometimes [2]; Fairly Often [3]; Very Often [4]	
3	In the last month, how often have you felt nervous and stressed?	Never [0]; Almost Never [1]; Sometimes [2]; Fairly Often [3]; Very Often [4]	
4	In the last month, how often have you felt confident about your ability to handle your personal problems?	Never [4]; Almost Never [3]; Sometimes [2]; Fairly Often [1]; Very Often [0]	
5	In the last month, how often have you felt that things were going your way?	Never [4]; Almost Never [3]; Sometimes [2]; Fairly Often [1]; Very Often [0]	
6	In the last month, how often have you found that you could not cope with all the things that you had to do.	Never [0]; Almost Never [1]; Sometimes [2]; Fairly Often [3]; Very Often [4]	
7	In the last month, how often have you been able to control irritations in your life?	Never [4]; Almost Never [3]; Sometimes [2]; Fairly Often [1]; Very Often [0]	
8	In the last month, how often have you felt that you were on top of things?	Never [4]; Almost Never [3]; Sometimes [2]; Fairly Often [1]; Very Often [0]	
9	In the last month, how often have you been angered because of things that happened that were outside of your control?	Never [0]; Almost Never [1]; Sometimes [2]; Fairly Often [3]; Very Often [4]	
10	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	Never [0]; Almost Never [1]; Sometimes [2]; Fairly Often [3]; Very Often [4]	

D. Attitudes Toward Spending Time in Nature Scale [ALL SURVEYS]

N/A	Maddock et al Scale (under review)		[No Header]

1	When I am in nature, I am in awe.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	Mix order
2	When I am in nature, I am relaxed.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
3	When I am in nature, I feel energized.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
4	When I am in nature, my mind is clear.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
5	When I am in nature, I forget my troubles.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
6	When I am in nature, I feel healthier.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
7	When I am in nature, I am excited.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
8	When I am in nature, I feel good about myself.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
9	When I am in nature, I am bored.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
10	When I am in nature, I feel uncomfortable.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
11	When I am in nature, I feel anxious.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
12	When I am in nature, I get angry easily.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
13	When I am in nature, I think that other activities are more valuable than being in nature.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
14	When I am in nature, I am worried about wild animals.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
15	When I am in nature, I am worried about the weather.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	

16	When I am in nature, I am worried about bugs.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
17	When I am in nature, I am worried about my safety.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
18	When I am in nature, I am worried about a lack of clean restrooms.	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	

E. Nature-Related Habits [ALL SURVEYS]

1	During the previous week, did you spend any time outdoors in nature?	Yes; No	If no, skip to next block
2	During the previous week, how many days did you spend at least 10 minutes outdoors in nature?	1; 2; 3; 4; 5; 6; 7	
3	During the previous week, which activities did you do outdoors in nature?	Walking; Hiking; Running; Bicycling; Roller skating; Skateboarding; Meditating; Playing a sport (basketball, tennis, etc.); Other (please describe)	Check all that apply
4	For the previous week, estimate the total amount of time you spent outdoors in nature.	Text entry with validation	

EE.Nature-Related Habits [3W, 6W, 9W]

1	OUTSIDE OF THE ORGANIZED STUDY ACTIVITIES, during the previous week, did you do any forest bathing?	Yes; No	If no, skip to next block
2	OUTSIDE OF THE ORGANIZED STUDY ACTIVITIES, during the previous week, how much time did you spend forest bathing?	Text entry with validation	

F. Intentions Toward Spending Time in Nature Scale [ALL SURVEYS]

N/A	Maddock et al Scale		[No Header]
1	In the next three months do you intend to spend more time at neighborhood and community parks	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
2	In the next three months do you intend to spend at least two hours per week outside	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
3	In the next three months do you intend to visit state or national parks	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
4	In the next three months do you intend to schedule trips to natural areas	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
5	In the next three months do you intend to go on a hike	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
6	In the next three months do you intend to go on a walk outdoors	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
7	In the next three months do you intend to visit water recreation areas (i.e. lakes, oceans)	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	
8	In the next three months do you intend to spend more time in nature	Strongly disagree(1); Somewhat disagree (2); Neither agree nor disagree (3); Somewhat agree (4); Strongly agree (5)	

G. Self-Efficacy to Spend Time in Nature Scale [ALL SURVEYS]

N/A	Maddock et al Scale		[No Header]
1	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if it is really hot outside	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
2	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if it is really cold outside	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
3	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if it is raining or snowing	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
4	How confident are you right now that you could spend at least 2	Not at all confident (1); Slightly confident (2); Somewhat confident (3);	

	hours a week in green and natural spaces if daylight hours are shorter	Very confident (4); Extremely confident (5)	
5	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if you are busy	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
6	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if you are stressed	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
7	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if nature is far away	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
8	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if you feel tired	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
9	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if there are no people around	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
10	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if you have no one to go with	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
11	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if you are in pain	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
12	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if you lack transportation to natural areas	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
13	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if it feels unsafe	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	
14	How confident are you right now that you could spend at least 2 hours a week in green and natural spaces if there is an expense involved (like a park pass or entrance fee)	Not at all confident (1); Slightly confident (2); Somewhat confident (3); Very confident (4); Extremely confident (5)	

H. Demographics [BASELINE ONLY]

1	How do you currently describe your gender identity?	Female; Male; Non-binary; Other (please describe)	
2	As of today, what is your age in years?	Text entry with numeric validation.	
3	During your childhood, how often did you spend time outdoors in nature?	Every Day Several Days Per Week Once Per Week Less Than Weekly Less Than Monthly Never	

I. Openness to Follow-Up [9W ONLY]

1	Is it okay for study staff reach out to you in the future to ask about your experience participating in this study?	Yes; No	

J. Perceived Benefits, Barriers, and Facilitators [6W ONLY; INTERVENTION ARM ONLY]

1	During this study, did you find forest bathing to be helpful in managing your stress?	5-point Likert: 1=not helpful at all; 5=extremely helpful	
2	Forest bathing was worth my time.	5-point Likert: 1=not at all worth my time; 5=extremely worth my time	
3	Did any factors make it difficult for you to participate in the forest bathing sessions? Please briefly list those factors.	Free text	
4	Did any factors help you, or make it easier for you to participate in the forest bathing sessions? Please briefly list those factors.	Free text	
5	What benefits did you experience from forest bathing, if any?	Free text	
6	What harms did you experience from forest bathing, if any?	Free text	

Appendix H: Session Survey

A. Self-Appraisal [PRE AND POST]

1	In the present moment, how stressed do you feel?	0-10 scale; 0=not at all stressed; 10=as stressed as possible	
2	In a sentence or less, briefly describe how you are feeling at the present moment.	Free Text	

B. Session Activities [POST only]

1	Consider the time you just spent in the forested environment. Of the time that you spent, approximately what percentage of the time did you spend doing the following activities? (Responses should total 100%)	Sitting/Still; Low/Moderate Intensity (Walking); High Intensity (Running) Text entry for each category; must total 100%	
2	Consider the time you just spent in the forested environment. Of the time that you spent, approximately what percentage of the time did you spend alone versus with another person(s)? (Responses should total 100%)	Alone; With Someone Else Text entry for each category; must total 100%	
3	Did you encounter any negative experiences while spending time in the forested environment?	Insect bite; allergic reaction; sunburn; fall; negative experience with wildlife; negative experience with other humans; negative experience with pets; other (please describe)	

PRE Exit Message: Thanks for checking in! Consider setting a phone timer to prompt you to check out in 40 minutes.

Appendix I: Semi-Structured Interview Guide

Consent

Thank you for agreeing to meet today. My name is Samantha Moyers, and I'm a PhD Candidate with the WVU School of Public Health, Department of Social and Behavioral Sciences. I'm hoping to learn more about [the experiences of participants of the ForeST Study/the reception of the ForeST Study by students who chose not to enroll], which conducted a pilot study of a forest bathing intervention program for the management of stress among health professions students. This project will contribute key data to my dissertation. I'm working under the supervision of my instructor, Dr. Christiaan Abildso.

Before we get started, it's important to discuss your rights as a participant. If you decide to participate, you will participate in an approximately 1 hour focus group discussion. To be eligible to participate, you must be 18 years of age or older and enrolled in a degree program at the WVU Health Sciences Campus. You will receive $15 for participating in the focus group.

Your participation in this project will be kept as confidential as legally possible. In all notes, transcripts, and other documents, you will be identified only by an alias. I do ask for permission to record the session so that I can focus on our discussion and draft an accurate transcript after we conclude. I will transcribe the interview within 1 week of our meeting, at which point I will delete the recording.

Considering that this is a group discussion, I also ask that you agree to maintain the privacy of the other focus group participants. Please do not share anything that was said inside this room.

Your participation is entirely voluntary. You may skip any question that you do not wish to answer, and you may stop participating at any time. Your class standing will not be affected if you decide not to participate or withdraw. The WVU Institutional Review Board has ethics oversight of this study, and approval is on file.

Do you have any questions?

Do you consent to move forward with the focus group discussion, to maintain the privacy of your co-participants, and to have the discussion audio recorded?

Introduction

Thank you for agreeing to participate. For the next hour, I'm interested in learning more about your experiences participating in the ForeST Study [ONLY for the participant group], factors that influence you to or not to spend time outdoors in nature, and your perceived impact of that time spent outdoors in nature. Your insight will be helpful in informing the future directions of programs aimed to help manage stress among clinical health professions students.

Before we get started, let's go around the room and get to know each other. Could each person share your discipline, degree program, and year in your program?

Questions

Experiences with the ForeST Study

1. I'm curious of the factors that led you [to sign up/to not sign up] for this study. Could you share about your thoughts and motivations around that decision?
    - Probes: stress, affinity toward nature, peer influence

2. We advertised that we would randomize participants into intervention and control groups to help us assess the outcomes. Did this impact your decision of whether or not to enroll in the program? [INTERVENTION ONLY: What was it like going through the randomization process and being given your assignment?]
    - Probes: friends in other arm, wanted treatment but didn't get it

Barriers and Facilitators to Time in Nature

3. [INTERVENTION ARM ONLY] Thinking about this study in particular, what helped ensure that you participated on a regular basis (if you did)?
    - Probes: peer influence, commitment to the study, regularly scheduled activity

4. [INTERVENTION ARM ONLY] What made it difficult for you to participate on a regular basis?
    - Probes: school commitments, job, socialization, transportation, weather

5. Thinking broadly about spending time in nature, outside of this study, what factors influence you to spend time outdoors, and ensure that you follow through on those plans?
    - Probes: peer influence, pet needs, find it restorative

6. Again, thinking broadly about spending time in nature, outside of this study, what factors make it difficult for you to spend time outdoors, and inhibit you from following through on those plans?
    - Probes: school commitments, job, transportation, weather

Perceived Benefits and Harms

7. In your experience, what benefits, if any, come from spending time outdoors in nature?
    - Probes: restoration, mental break, physical activity

8. In your experience, what harms, if any, come from spending time outdoors in nature?
    - Probes: takes time away from school, insect bites, sunburn

9. How do you feel like these benefits and harms balance out?
    - Does one surpass the other? Does this calculation influence your behavior?
    - [INTERVENTION ONLY]: Has your conceptualization of perceived benefits and harms shifted since you started the study?

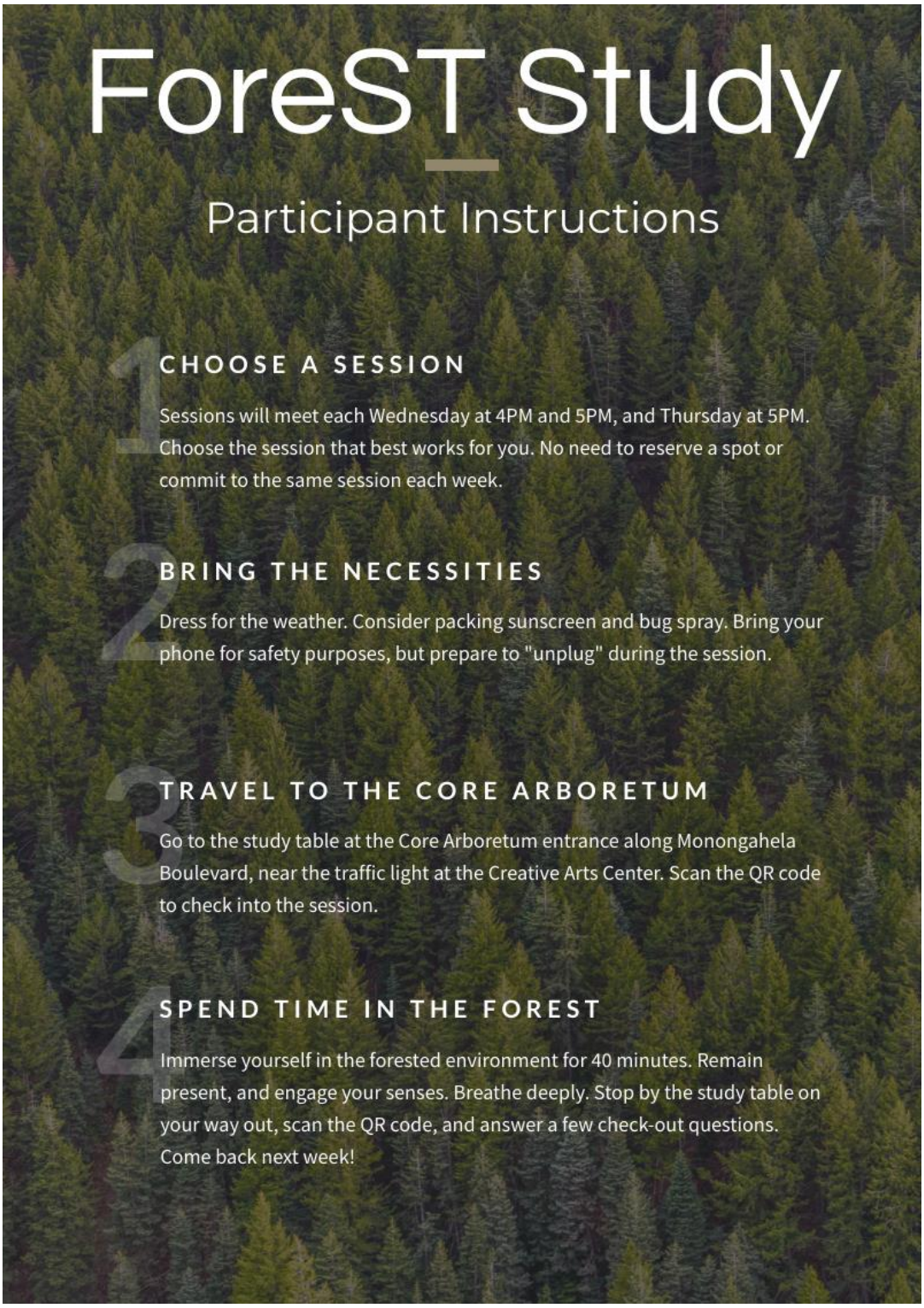
10. If we run this program in the future, what you recommend that we do differently?

Closing

Thank you for sharing your thoughts and experiences with me. Do you have anything else that you would like to share before we wrap up the discussion?

I truly appreciate your willingness to speak with me today. It's been a pleasure to hear your thoughts and experiences. This concludes the discussion. Thanks and have a wonderful rest of your day!

Appendix J: Program Instructions



Appendix K: Forest Bathing Instructions

Appendix L: CONSORT Checklist – Aim 2

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility trial

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a pilot or feasibility randomised trial in the title	107
	1b	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	107-108
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	109-111
	2b	Specific objectives or research questions for pilot trial	111
Methods			
Trial design	3a	Description of pilot trial design (such as parallel, factorial) including allocation ratio	113
	3b	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	113, 133
Participants	4a	Eligibility criteria for participants	113
	4b	Settings and locations where the data were collected	116
	4c	How participants were identified and consented	113-114, 119
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	115-116
Outcomes	6a	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	117-119
	6b	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	N/A
	6c	If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	N/A

Sample size	7a	Rationale for numbers in the pilot trial	114
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	N/A
	8b	Type of randomisation(s); details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	N/A
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	N/A
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	N/A
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12	Methods used to address each pilot trial objective whether qualitative or quantitative	119-120
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	114, 204
	13b	For each group, losses and exclusions after randomisation, together with reasons	204
Recruitment	14a	Dates defining the periods of recruitment and follow-up	113-114
	14b	Why the pilot trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	120
Numbers analysed	16	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	120
Outcomes and estimation	17	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	120-128

Ancillary analyses	18	Results of any other analyses performed that could be used to inform the future definitive trial	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	123
	19a	If relevant, other important unintended consequences	N/A
Discussion			
Limitations	20	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	130-131
Generalisability	21	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	131
Interpretation	22	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	128-130
	22a	Implications for progression from pilot to future definitive trial, including any proposed amendments	131
Other information			
Registration	23	Registration number for pilot trial and name of trial registry	113
Protocol	24	Where the pilot trial protocol can be accessed, if available	113
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	132
	26	Ethical approval or approval by research review committee, confirmed with reference number	119

Appendix M: CONSORT Checklist – Aim 3

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility trial

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a pilot or feasibility randomised trial in the title	142
	1b	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	142-143
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	144
	2b	Specific objectives or research questions for pilot trial	145
Methods			
Trial design	3a	Description of pilot trial design (such as parallel, factorial) including allocation ratio	145
	3b	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	145
Participants	4a	Eligibility criteria for participants	145-146
	4b	Settings and locations where the data were collected	147-149
	4c	How participants were identified and consented	146,151
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	147
Outcomes	6a	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	149-151
	6b	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	N/A
	6c	If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	N/A

Sample size	7a	Rationale for numbers in the pilot trial	146
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	N/A
	8b	Type of randomisation(s); details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	N/A
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	N/A
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	N/A
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12	Methods used to address each pilot trial objective whether qualitative or quantitative	151-153
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	153, 204
	13b	For each group, losses and exclusions after randomisation, together with reasons	204
Recruitment	14a	Dates defining the periods of recruitment and follow-up	146-147
	14b	Why the pilot trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	153
Numbers analysed	16	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	153-157
Outcomes and estimation	17	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	153-157

Ancillary analyses	18	Results of any other analyses performed that could be used to inform the future definitive trial	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	129
	19a	If relevant, other important unintended consequences	N/A
Discussion			
Limitations	20	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	158-159
Generalisability	21	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	158
Interpretation	22	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	156-157
	22a	Implications for progression from pilot to future definitive trial, including any proposed amendments	158
Other information			
Registration	23	Registration number for pilot trial and name of trial registry	145
Protocol	24	Where the pilot trial protocol can be accessed, if available	145
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	159
	26	Ethical approval or approval by research review committee, confirmed with reference number	151