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Article

Short-term Psychological Effects of Forest Therapy: Early Evidence in Italy

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Abstract: Immersion in forest environments was shown to produce beneficial effects to human health, in particular psychophysical relaxation, so much that this practice is increasingly recognized as a form of integrative medicine. Limited evidence exists about both statistical significance and size of the effects conditioned on personal characteristics, as well as on the main external variables. The primary purpose of this study was to substantiate the very concept of forest therapy by means of the quantification and significance of the psychological effects, stratified by gender, age groups and place of residence. A preliminary qualitative analysis of the main determinants, in particular the method of conducting, the meteorological comfort and the concentration of volatile organic compounds in the forest atmosphere, was afforded. Seven forest therapy sessions were performed in late summer though early fall, resulting in 150 psychological self-assessment questionnaires administered before and after each session. The results were comparable or even better than others reported in the international literature. Moreover, preliminary evidence arose about different functionality towards specific psychological indexes conditioned at least on gender and age groups, as well as meteorological comfort, structured programs and, possibly, volatile organic compounds showed an impact on the outcomes.

Keywords: anger; anxiety; confusion; depression; fatigue; forest therapy; mental health; vigor; volatile organic compounds

1. Introduction

The direct exposure to forest environments was attributed a wide range of straight benefits to human health [1–4]. Such benefits cover primarily the psychological sphere (mental processes, stress, anxiety and emotions), cognitive processes, social life (skills, interactions, behavior and lifestyle), and spiritual wellbeing. On the physiological side, significant effects emerged with regards to the improvement of the cardiovascular

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functions and the hemodynamic, neuroendocrine, metabolic, immune, inflammatory and oxidative indexes [5,6]. However, as pointed out by a recent comprehensive review, the impact on the psychophysical well-being of human immersion in forest environments was by far the most studied and revealed statistically significant and sometimes intense results [7].

Individual benefits turn into advantages for the society as a whole due to cost savings for healthcare systems, insurance and safety, as well as gains in productivity. A recent study showed that the economic value of natural protected areas, assessed on the basis of the mental health of visitors, amounts to about 8% of global gross domestic product, i.e., around 6 trillion US$. [8]. Such amount, being 100 to 1,000 times greater than the budget of the agencies managing the natural protected areas, could justify any scientifically based effort aimed at increasing the efficiency and expanding the functions and ecosystem services of the natural and protected areas towards human mental and physiological health.

The preventive and healing effects directly delivered by forest environments have been widely documented in the scientific literature, and, in most cases, concern experiences of free walking or meditation in the absence of appreciable physical exercise [9]. The beneficial effects towards psychological and physiological aspects of human health are often significant, dose-dependent (e.g., duration and frequency of the experiences and concentration of airborne bioactive substances), related to the structure and tree species composition of the forest and to the season and time of the day. Personal characteristics such as gender, age, psychological traits and physical health contribute to modulate the extent of the effects. In particular, a recent study performed in Hungary showed that, walking in the forest for 2 hours, with minimal guidance aimed at maintaining a slow pace, resting, observation, breathing and touching the wood, produced a significant decrease of systolic blood pressure both in late spring and winter [10]. As well, a significant stimulation of NK^{bright} cells and activation of various immune cell subsets was observed in late spring, while a slight activating and a balancing effect regarding TIM-3, an inhibitory immune checkpoint molecule, were observed in winter, thus suggesting positive forest healing effects throughout the year.

The forest healing effects can be wide-spectrum, such as in the case of the immune system [11], long-lasting and devoid of undesirable side effects. Just 15-20 minutes of forest immersion are enough to convey at least significant psychological benefits, two hours (even not continuously) allow enhanced wellbeing for a week, irrespective of individual characteristics such as age and presence of chronic diseases [12]. Three or more days of forest immersion can reinforce the immune defense system for a month [13].

An additive effect (constantly growing benefits) deriving from the regular repetition of sessions was observed, which was larger in the case of subjects with depressive tendencies [14]. A recent study, consisting of free forest immersion sessions (four weekly sessions each lasting four hours), suggests the persistence of psychological benefits (indicators of stress, wellbeing and positive emotions) up to a month after the end of the sessions, contrary to virtual immersion experiences [15]. Indeed, virtual experiences showed significant psychological effects but only in the short term [16].

Forest experiences, where professionals assist participants according to structured protocols, often based on psychotherapy, meditation and mindfulness practices [17], showed significant and remarkable therapeutic superiority over both similar activities carried out in non-forested environments and free immersion in forest, for example in the treatment of depressive symptoms [9,18]. The actual forest therapy foresees not only the individual immersion in a forest environment, but also the guidance by suitable professionals, such as psychologists and psychotherapists, according to protocols aimed at boosting the health outcomes. Indeed, the very possibility to issue green prescriptions in the frame of phytotherapy protocols was conditioned on the availability of forest therapy providers [19].

The benefits of forest immersion are mediated by all human senses. Viewing repetitive natural structures (fractals), such as trees, and hearing the typical sounds of forests convey the perception of a relaxing and unchallenging environment, in which it is much easier to adapt and increase one's own perceptive fluidity [20,21], even in virtual experiences [16]. Touching the wood of the trees induces significant physiological and psychological relaxation [22].

Smell plays a key role through the inhalation of biogenic volatile organic compounds (BVOC) emitted by plants and soil in the forest atmosphere, in particular certain terpenes endowed with antioxidant and anti-inflammatory activities, as well as beneficial to psychological and cognitive processes [23]. First of all, the concentration and type of such substances in the forest atmosphere depends on the emission rate by plants, thus on tree species [24], and their vegetative status (thus, the season) [25]. At any forest site and in any season (especially during the warm season), the time of the day plays a very important role due to changing atmospheric conditions (temperature, solar irradiance and surface stability), leading to distinct and regular peaks and troughs in the total BVOC concentration levels [26,27].

The benefits and potential of forest therapy were officially recognized by the United Nations in the framework of the green recovery from the COVID-19 pandemics [28]. The main challenges were identified in informing, educating and persuading healthcare systems and professionals and citizens with regard to green prescriptions, for example based on those that have been issued for years in Japan and South Korea [5,29,30]. In those countries, but also in Taiwan and China, green prescriptions have been framed into preventive medicine, as a means to improve physiological health and ease stress levels [31]. Another urgent challenge was identified in the certification of professional providers of services related to forest therapy, meant to effectively enable green prescriptions and allow interested people to access a widespread and high quality offer [19,32].

Despite the growing scientific evidence, Italy, along with many other countries especially in the western world, lags behind in the rigorous identification of sites and trails for forest therapy practices, including preliminary selection and qualification based on actual functionality (observed psychological and physiological benefits) according to structured programs of activities. First, the following consolidated evidence was seldom incorporated: while exposure to most of greenspaces allow improvements of mood and wellbeing, specific and significant preventive effects with regard to the risk of depression were attributed only to natural environments, in particular forested ones, remote from urban areas [33,34]. This is particularly important because depression is a pandemic illness especially in the developed world, with immense human, social and economic costs, thus natural remedies such as forest therapy performed in suitable locations can lead to substantial savings for healthcare and welfare systems and gains in terms of productivity.

Second, especially in the western world, forest therapy experiences in remote forest areas involving large numbers of participants , according to structured and repeatable programs, were seldom performed, let alone the search for the main determinants of health outcomes that would allow the generalization of qualification criteria. Despite recent improvements in methodological rigor, the recommendations issued in a comprehensive review published in 2017 are still relevant [35].

The main motivations of this study were the following:

- Contribution to the still relatively scarce international datasets of psychological outcomes of forest therapy sessions performed according to standardized programs;
- Preliminary search for the main determinants of the psychological outcomes of forest therapy sessions, aimed also at providing a framework for future studies;
- Preliminary functional qualification of sites for forest therapy practices in Italy.

2. Materials and Methods

2.1. Forest therapy sessions: measures and basic features

The Italian Alpine Club and the Institute of Bioeconomy of the National Research Council arranged seven forest therapy sessions during August-October, 2020. All sessions were performed in Italy at remote forest areas (at least 20 km from the nearest town with more than 10,000 inhabitants or trafficked road). All sessions had a duration of 3.5±0.5 hours, along paths with total lengths not exceeding 4 km and uphill gradients smaller than 150 m.

During each session, the concentration of total volatile organic compounds (TVOCs) was continuously collected by means of a portable (0.72 kg) photoionization detector (PID, model Tiger VOC detector, Ion Science Ltd., Fowlmere, Royston, UK), with detection limits from 0.001 ppm (1 ppb) to 20,000 ppb. The PID was equipped with a pump, sucking in ambient air at a rate of 220 mL/min, and an ultraviolet, 10.6 eV lamp allowing the ionization of organic substances present in the sampled air, including all the monoterpenes (MTs) found in biogenic VOCs (BVOCs). The resulting electric current flowing between two electrodes was measured, amplified and transformed into a concentration level of the ionized substance or group of substances. TVOC concentration could be considered representative for BVOC concentration, although clearly higher due to the presence of VOCs other than MTs, at least at forest sites far from anthropogenic pollution sources, where the change in TVOC concentration is mainly driven by plants emissions, as explained in a previous study [26]. Finally, the average temperature during each session was assessed based on data collected at nearby weather stations.

In each session, after collecting the informed consent, every participant was presented with a reduced Profile of Mood States (POMS) questionnaire, consisting of 34 questions about moods perceived at that precise moment, recommended for the analysis of psychological outcomes of forest therapy sessions [36], derived from previous studies on sport psychology [37]. The same questionnaire was recently used in an investigation of stress reduction of healthcare staff after a short break in nature [38].

The reduced POMS questionnaire, which was completely anonymous and included information about gender, age, and place of residence, was filled immediately before and after the session. The participants were all adults, not previously selected, admittedly healthy and generally representative of both genders and all age groups.

For each questionnaire, single answers to any of the 34 items were grouped to provide synthetic indexes for the states of anxiety, depression, anger, vigor, fatigue and confusion, according to the recommended classification [36]. Only completely filled questionnaires were considered for further analyses.

No control sessions in non-forested environments were performed. First of all, this was due to the relative remoteness of the forest areas, most of which were located in mountainous areas far from urban centers, thus precluding the possibility to perform meaningful comparisons due to confounding factors (e.g., weather). Moreover, the main aim of this study was the intercomparison of forest therapy experiences performed according to standardized programs explicitly requiring a forest environment for their implementation. Last, several studies focused on parallel sessions in forest and urban (control) environments; as documented in a recent comprehensive review, those studies provided a clear and unambiguous evidence of no or significantly lower effects on psychological health and general well-being generated by control compared to forest sessions [7].

Figure 1 shows the location of the forest therapy sites in central and northern Italy. The basic information about forest therapy sessions, including participants (194 in total, returning 150 valid questionnaires), are shown in Table 1. The first session (FTS1) was performed without professional guidance, suggesting participants to relax in the woods during two stops lasting between 20 and 30 min each, and providing scientific information about the surrounding environment (botany and geology) and the sessions meaning for

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one's own health. All the other sessions were performed with professional guidance, according to the method of conducting illustrated in Section 2.2. Participants were allowed to attend only one session, to prevent any contribution from the possible persistence of the effects.

Figure 1. Location of the forest therapy sessions (FTS1 to FTS7) in central and northern Italy.

Table 1. Basic features of forest therapy sessions performed in Italy.

Session	Place, Municipality / Date / Initial time [1]	Lat / Lon / Altitude	Weather, Temperature / Tree species / Water bodies – streams	TVOCs Average (µg/m3, or ppb) [2]	Participants / Valid questionnaires	Gender / Age [3]
FTS1	Torre dei Sogni, Empoli and Montespertoli (FI) August 22nd, 2020 14:30	43°41'11.77"N 11° 0'0.69"E 100-200 m	Sunny, weak wind, 30°C Cypress, maritime pine, holm oak, lentisk	68 (120)	35 24	M: 11; F: 13 52.4±10.3
FTS2	Monte Duro, Vezzano sul Crostolo (RE) September 6th, 2020 08:30	44°32'34.49"N 10°32'26.49"E 500-600 m	Sunny, calm, 23°C Scots pine, field maple, black and white hornbeam, elderberry, dogwood	27 (50)	35 21	M: 8; F: 13 52.9±10.0
FTS3	Parco del Respiro, Fai della Paganella (TN) September 11th, 2020 13:30	46°10'33.25"N 11° 4'39.98"E 900-1,000 m	Sunny, calm, 22°C Spruce, beech Water streams, waterfalls	38 (108)	39 33	M: 8; F: 25 45.6±16.8
FTS4	Parco del Respiro, Fai della Paganella (TN)	46°10'33.25"N	Sunny, calm, 17°C	28 (65)	22	M: 5; F: 12

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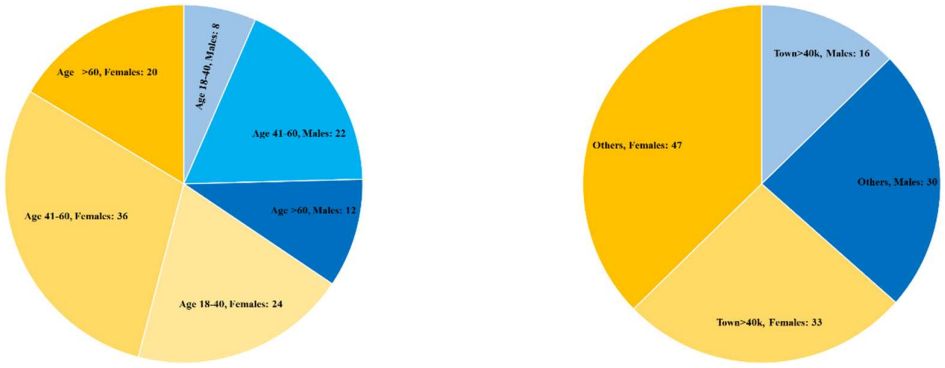
	September 12th, 2020 08:30	11° 4'39.98"E 900-1,000 m	Spruce, beech Water streams, waterfalls		17	44.9±15.2
FTS5	Battisti Refuge, Ligonchio (RE) September 27th, 2020 08:00	44°15'42.24"N 10°24'45.58"E 1,750 m	Cloudy, windy, 4°C Beech, silver fir, mountain pine	10 (20)	9 8	M: 5; F: 3 64.4±7.9
FTS6	Torre dei Sogni, Empoli and Montespertoli (FI) October 17th, 2020 14:00	43°41'11.77"N 11° 0'0.69"E 100-200 m	Partly cloudy, weak wind, 15°C Cypress, maritime pine, holm oak, lentisk	50 (90)	21 18	M: 11; F: 13 49.7±14.1
FTS7	Fonte del Borbotto, San Godenzo (FI) October 18th, 2020 09:00	43°52'57.78"N 11°41'10.65"E 1,250-1,350 m	Sunny to cloudy, calm, 7°C Beech, scattered silver fir Water streams, pond	15 (30)	33 29	M: 12; F: 17 55.3±23.2

[1] Local solar time
[2] Average concentration; in parenthesis, peak concentration
[3] Data referred to valid questionnaires (M: male; F: female; Age: average ± standard deviation)

Figure 2(a)–(b) shows the basic demographic features of participants, limited to the participants that returned valid questionnaires and complete demographic data.



(**a**) (b)

Figure 2. Basic demographic features: (**a**) Distribution by age group and gender; (**b**) Distribution by residence and gender.

2.2. The method of conducting the forest therapy sessions

Except for session FTS1, a professional psychologist or psychotherapist took part to each of the other forest therapy sessions, according to a program named Forestfulness®, partly based on mindfulness practices, in particular on the Mindfulness-Based Stress Reduction (MBSR) program developed since 1982 [17]. Mindfulness-based meditation is a way to pay attention to the present moment by observing and accepting whatever experience is occurring.

Mindfulness was shown to reduce pain in a wide range of clinic and non-clinic problems [39], improve immune functions [40], mental health in breast cancer patients [41], create an higher subjective wellbeing and attenuate the emotive reactivity [42],

reduce relapses into depression and blood pressure [43], reduce anxiety and improve mood state [44]. Mindfulness practiced in forest environments showed significant and remarkable therapeutic superiority over similar activities carried out in non-forested environments, for example in the treatment of depressive symptoms [18].

In the forest environment, mindfulness can be practiced by means of walking mindfully, using breathing as the center of attention, observing the surrounding environment with acceptance and creating a deep connection with nature using the five senses. Walking meditation is one of MBSR main practices, while walking in forests can lower blood pressure and reduce the concentration level of cortisol (also named the stress hormone), resulting in relaxation [45,46]. Walking meditation is performed by bringing the attention to the physical sensations coming from the breathing and walking. Although this exercise could produce good results also indoor or in urban environments, higher benefits were observed in the woods, including improvement in mood state [47].

Conscious and focused use of all human senses – sight, hearing, smell, touch and taste – is another milestone of the MBSR program, as a means to increase the awareness of the experience and amplify the effects of forest immersion. Through the perception of the surroundings, senses provide orientation, rooting into the present and interpretation of our experiences [48,49]. Indeed, benefits for health from the exposure to forest environments are effectively conveyed by the mediation of all human senses [31,50,51], which further motivates the conscious focusing on human senses during forest therapy sessions.

Moreover, in the conduction of the forest therapy sessions, a method of communication was adopted, which alternated metaphorical speeches with literal verbalizations, in order to stimulate increased emotional involvement in the participants [52]. In the past, the use of metaphor was considered more an art than a scientific instrument [53], although with therapeutic value [54]. However, more recently this classification has been questioned, with interesting practical implications. For example, it was established that the educational metaphors are useful for simplifying difficult concepts during class lessons [55], in the clinical field metaphors help understanding delicate health conditions [56], as well as can be useful for developing scientific theories [57]. In everyday life, the metaphorical language is a tool able to promote and guide thought processes and to activate cognitive maps for problem solving [58]. From a therapeutic point of view, metaphorical discourses represent a cornerstone of Ericksonian and Neo-ericksonian Hypnotic Psychotherapy; for example, a recent study demonstrated the effectiveness of Mindful Hypnotherapy to reduce stress and create mindfulness [59].

In the context of forest therapy sessions, the attention of the participants to the present moment was stimulated in order to promote a more effective immersion, also through the conscious use of the five senses, the breath and the movement, looking for the deep connection with the surrounding environment. Both mindfulness practices and metaphorical discourses contributed to this purpose, as they could anticipate or deepen the proposed experience at an imaginative and evocative level, and prepare neural maps for what will be physically practiced. Few neuroimaging studies showed that metaphors activated cortical areas corresponding to the suggested action; for example, the expression "she grabbed the idea" could activate the motor cortex [60].

During the structured forest therapy sessions (FTS2 to FTS7 listed in Table 1), in order to stimulate the sensory activities, the participants were invited to "savor the experience", to "touch with the eyes the surrounding environment", to "listen to their emotions", to name a few. The words chosen in these verbalizations aimed at several purposes:

- Generating a sensation of coherence between the internal dimension (feeling), and the external dimension (acting calmly). The sense of coherence (internal-external), in accordance with temperament and emotional intelligence, seems predictive of the individual's ability to cope with stressful situations [61];
- Facilitating processes of introspection and decoding of the feelings and emotions of the participants, to feed a condition of conscious presence;

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- Promoting processes of identification with the elements of nature, which are in dynamic balance and can offer more effective learning and working models [62];
- To stimulate the transformative activity of any dysfunctional aspects detected [63].

The method of conducting the forest therapy sessions was structured in six main steps, briefly:

- Right attitude and entrance in the wood: leave behind challenging thoughts, smile, like meeting with an old friend;
- Wearing the most beautiful dress: embrace the silence, leave planning and commitments, gain space for the emergence of one's own best part;
- Walking mindfully: involves bringing attention to any sensation coming from the feet in order to keep the wandering mind anchored;
- Breathing the wood: by observing the breathing it is possible to tune in with the environment and to be aware of the state of mind and body as well; consequently, let it all go, such as tensions, thoughts and feelings;
- Using the senses: intentionally looking at the surrounding environment or a natural object that is found relaxing, recognizing wood fragrances during breathing, concentrating on typical forest soundscape (birds, wind through the trees, crunch of branches and leaves underfoot, etc.), touching wood and trees, and, when possible, tasting products of the undergrowth;
- Meditating with the tree: choosing a specific tree as the most faithful mirror of oneself, and approaching it with the right attitude and intentions, towards the identification with the tree and its qualities such as resilience, vitality and projection towards the sky and the light.

2.3. Data analysis

Data reported on the reduced POMS questionnaires described in Section 2.1 were transferred to Microsoft Excel worksheets. Psychological indexes were obtained from the questionnaires data by adding the values of the corresponding items, and the results were further stratified according to gender, age group and place of residence. In addition, the BVOC data collected from the PID were transferred from the proprietary software of the instrument to Microsoft Excel and average and peak concentration levels along the forest therapy paths were computed.

Besides the straightforward computation of the pre-post average percentage differences across all sessions, as well as stratified for gender, age group and place of residence, pre-post average percentage differences were computed for each session and for each of such differences the Cohen's d index was computed. Cohen's d was used in psychological research for the assessment of the size of the effect, i.e. the difference between the averages of two samples [64]. Cohen's d includes averages and standard deviations of both considered samples, specifically the indexes computed from the responses to the POMS questionnaires administered before and after the forest therapy sessions. The level d=1 means that the groups of data differ by a standard deviation. The size of the effect was assessed based on the following thresholds: very small up to d=0.1, small up to d=0.2, average up to d=0.5, big up to d=0.8, very big up to d=1.2, huge for d>1.2.

Cohen's d was reported only in the cases that showed statistical significance of the average percentage differences greater than 95%, in turn assessed based on the classical two-tailed Student's t test ($p<0.05$). The Student's t test was two-tailed based on the prudential assumption of unknown sign of the effects.

3. Results

3.1. Overall psychological outcomes

Figure 3 shows results from each session, including FTS1 that was performed non-professionally, i.e., under non-structured techniques. The results are expressed as pre-post

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percentage changes averaged over all the valid questionnaires and the labels next to each bar represent the Cohen's d, reported only for statistically significant changes.

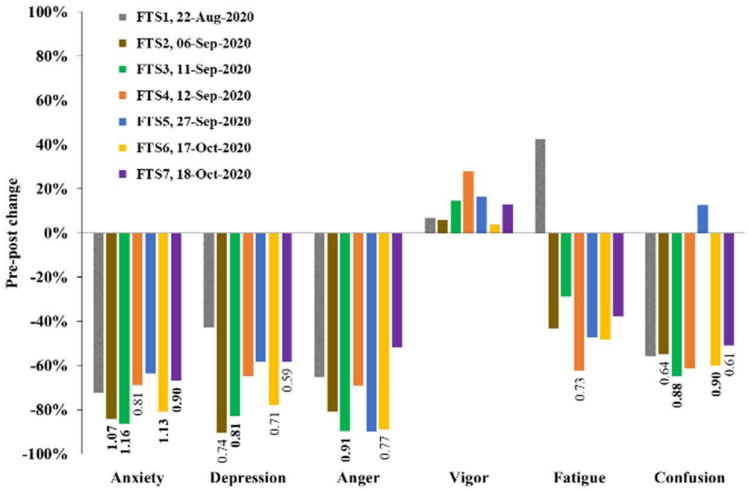

Figure 3. Percentage change of synthetic mood indexes across each forest therapy session. Cohen's d indexes are reported next to each bar in case of statistical significance ($p<0.05$) and are marked in bold whenever the statistical significance exceeds 99% ($p<0.01$).

Based on the extent of changes and the effect size estimated according to the Cohen's d in case of statistical significance, it can be observed that:

- Forest therapy sessions that produced the best results were FTS3 > FTS6 > FTS2, followed by FTS7 > FTS4 and, finally, FTS5 > FTS1, the latter two sessions without statistical significance for the change of any mood index. In particular, FTS3 showed $p<0.01$ for the change of the first three indexes (anxiety, depression and anger) as well as for confusion.
- Irrespective of the percentage change, sessions FTS1 and FTS5 did not show statistically significant results. However, while for the former this outcome derived from the answers to 24 questionnaires, the outcome of the latter could be ascribed to the insufficient number of valid questionnaires (only 8), as well as possibly to the remarkably higher average age compared to the other sessions. However, for FTS5, the significance was close to 90% ($p=0.1$) for the reduction of anxiety and anger.
- The drastic difference between the outcomes of FTS1 (non-professional), which were not statistically significant, and FTS6, which were very significant ($p<0.01$) for anxiety and confusion and significant ($p<0.05$) for depression and anger, performed at the same site and with similar distribution of gender and age, was particularly notable.
- The differences between the sessions FTS3 and FTS4, performed at the same site, both with a relatively large number of participants and with similar distribution of gender and age, were notable not only in terms of percentage changes but also of statistical significance and size effect, in particular for depression, anger and confusion, while for fatigue the effect was the opposite.
- Overall, the forest therapy sessions carried out professionally (FTS2 to FTS7) produced beneficial effects to the different mood indexes according to the following order of statistical significance: anxiety > confusion > depression > anger > fatigue > vigor.

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3.2. Stratification by gender and age group

Figure 4(a)–(d) show results averaged over all the sessions excluding FTS1 (non-professional session) and further stratified according to gender and, for each gender, according to age groups (18-40, 41-60, >60). The results are expressed as pre-post percentage changes averaged over all the valid questionnaires and the labels next to each bar represent the Cohen's d, reported only for statistically significant changes.

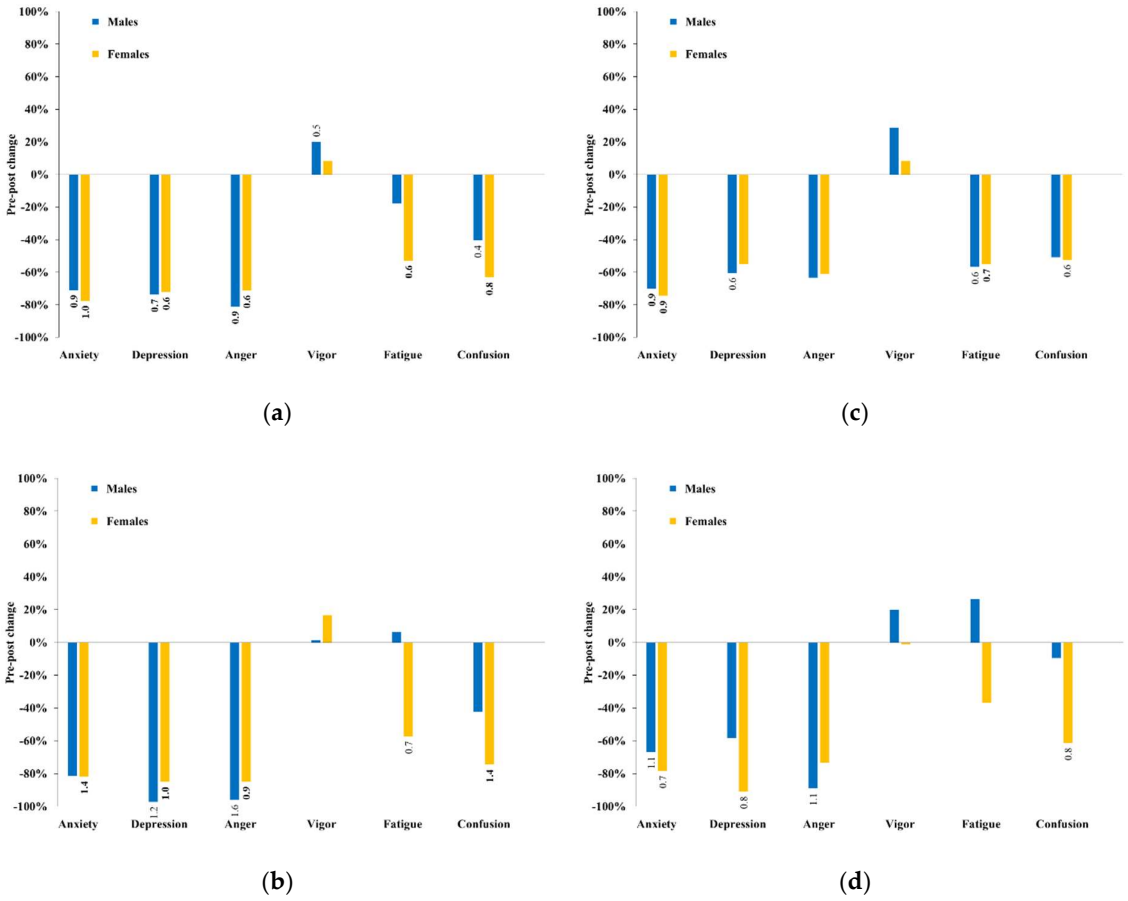

Figure 4. Percentage change of synthetic mood indexes averaged over all the forest therapy sessions, stratified according to: (**a**) Gender; (**b**) Gender and age group 18-40 years; (**c**) Gender and age group 41-60 years; (**d**) Gender and age group >60 years. Cohen's d indexes are reported next to each bar in case of statistical significance ($p<0.05$) and are marked in bold whenever the statistical significance exceeds 99% ($p<0.01$).

Based on the extent of changes and the effect size estimated according to the Cohen's d in case of statistical significance, it can be observed that:

- As shown in Figure 4(a), results for anxiety, depression and anger were comparable for both genders, the reduction of fatigue was significant ($p<0.01$) only for females, the reduction of confusion was more significant and greater in size for females, and increase in vigor was significant ($p<0.05$) only for males.
- Figure 4(b) shows that the effects were generally greater in size in the age group 18-40 years compared to the all-age group, yet less significant due to the smaller size of the samples, especially for males (see Figure 2). Patterns were similar to the all-age group, with greater differences between males and females for fatigue and confusion.
- Based on Figure 4(c), in the age group 41-60 years, the reduction of anxiety was similar to the all-age group for both genders, while benefits for depression and anger

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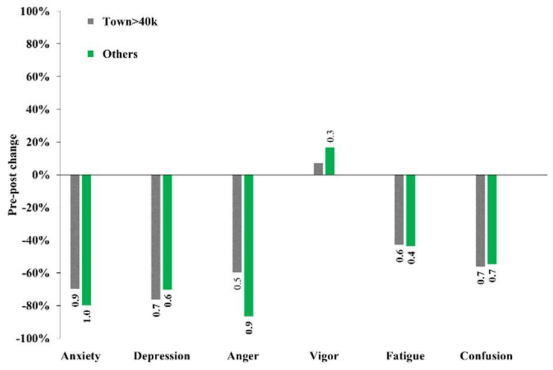
were far smaller and less significant (only the reduction of the depression index for males was significant). As for fatigue and confusion, benefits were similar to the all-age group for females, while they were far greater and significant for males in the case of fatigue.

- In the age group >60 years, as shown Figure 4(d), the size of the significant effects was comparable to the all-age group for both genders, greater for depression in the case of females and not significant for males, while the opposite occurred for anger. No significance emerged for fatigue, while the reduction of confusion was comparable to the all-age group for females and not significant for males. However, the small sample size for males (12 valid questionnaires) could represent a limitation.

3.3. Stratification by residence and gender

Figure 5(a)–(c) show results averaged over all the sessions excluding FTS1 (non-professional session) and further stratified according to residence and, for each residence type, according to genders. Participants were stratified only according to residence in towns with more than 40,000 inhabitants and other places of residence (smaller towns, countryside) due to the limited sample size (see Figure 2). The results are expressed as pre-post percentage changes averaged over all the valid questionnaires and the labels next to each bar represent the Cohen's d, reported only for statistically significant changes.



(**a**)

(**b**)

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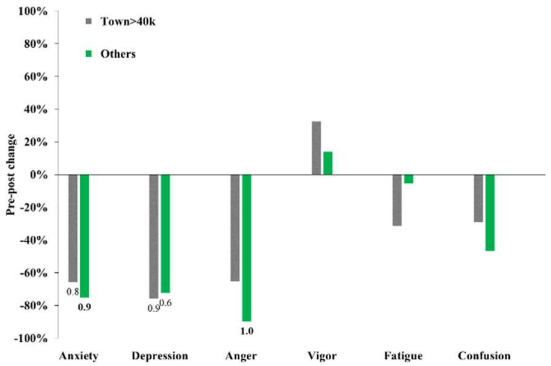

(**c**)

Figure 5. Percentage change of synthetic mood indexes averaged over all the forest therapy sessions, stratified according to: (**a**) Residence (towns greater than 40,000 inhabitants); (**b**) Residence and female gender; (**c**) Residence and male gender. Cohen's d indexes are reported next to each bar in case of statistical significance ($p<0.05$) and are marked in bold whenever the statistical significance exceeds 99% ($p<0.01$).

Based on the extent of changes and the effect size estimated according to the Cohen's d in case of statistical significance, it can be observed that:

- As shown in Figure 5(a), results for anxiety, depression, fatigue and confusion were comparable for both residence types, while benefits for anger were more significant and greater in size for residents outside larger towns, and vigor increased significantly for the same participants.
- Figure 5(b) shows that, for females, the effects on anxiety, depression and fatigue were comparable, while anger decreased significantly only for residents outside larger towns, and the effect size for confusion was larger for residents in larger towns.
- Based on Figure 5(c), while the reductions in anxiety and depression for males were significant and comparable, the reduction of anger was significant only for residents outside larger towns. No other significant effects were shown.

4. Discussion

4.1. Overall psychological outcomes

Based on data presented in Section 3.1 and shown in Figure 3, the average percentage reductions of the indexes of anxiety (-77%), depression(-73.8%), anger (-76.7%) and confusion (-54%), computed over professionally-conducted sessions (FTS2 to FTS7) after weighting for the number of participants to each session, were generally higher than reported in other studies, such as in a recent systematic review [65], where results derived from the administration of reduced POMS questionnaires, including in Europe. A recent systematic review on the effects of nature walks on state anxiety and depression evidenced clear and significant effects on anxiety but somehow inconclusive effects on depression [66]. Figure 3 shows that, although anxiety was the most significantly and strongly reduced index, depression was significantly lowered in three out of six professionally conducted forest therapy sessions, which could be considered an especially promising result.

A research was performed in 2018, based on a 3-days structured forest therapy session at a semitropical forest in Taiwan, mainly aimed at checking the effects on creativity and involving 21 participants (8 males, 13 females) across all age groups (52.0±12.54 years, from 25 to 70 years old) [67]. The analysis of POMS questionnaires returned the following changes (in brackets, the effect size): anxiety, -49% (0.64); depression, -42% (0.42); anger, -38% (0.54); vigor, 18% (0.57); fatigue, -14% (0.16);

confusion, -33% (0.64). With the exception of vigor, which increased slightly more than the average from sessions FTS2 to FTS7 (13.1%), such results were remarkably lower than in this study, including fatigue that, averaged over FTS2 to FTS7, decreased by 41.8%. Limited to anxiety, depression, anger and confusion, the size of the effects were much lower compared to Figure 3, especially for highly significant effects ($p<0.01$). It should be noted that sessions FTS2 to FTS7 had much shorter duration (around 3.5 hours), adding significance to the observed differences in the reported effects.

In a recent study performed in Italy over healthcare staff during the COVID-19 pandemic, 77 participants filled the same reduced POMS questionnaires used in this study, before and after short breaks (20-30 min) in nature (green areas nearby hospital facilities) [38]. The results showed significant improvements in all the psychological indexes, greater for staff directly involved in COVID-19 treatment areas, who were likely more stressed. Throughout all participants, anxiety, depression and anger reduced by 60-66%, 53-56% and 47 to 84%, while fatigue decreased by 46-56% and confusion by 35-53%. For the first three indexes, the reductions were smaller than in this study, which could be ascribed to either the shorter experiences or their unstructured conduction, while confusion reduced by a similar percentage.

With reference the outcomes for the sessions FTS3 and FTS4 shown in Figure 3, barring the outcome for fatigue, the changes of anxiety, depression, anger and confusion were much more significant and higher in size for FTS3 than FTS4. While the difference in sample size could have affected the level of statistical significance, but likely not the size of the effect, the site and path were the same, and the levels of meteorological comfort were quite similar. As the only remarkable difference was the TVOC concentration, which was on average 26% higher and with peak level 66% higher during FTS3 than FTS4, TVOC concentration could be a candidate for explaining the differences in the psychological outcomes. However, further experimental research including ad-hoc forest therapy sessions, is needed to assess the impact of TVOC concentration on short-term psychological outcomes.

This matter is further complicated by partially contrasting results about the systemic absorption of MTS, which represent most of BVOCs emitted by plants. To the best knowledge of the authors, only two studies dealt with this important topic. In 2015, Japanese scholars found that the serum concentration of α-pinene, but not of other monoterpenes, increased by several folds after walking in a conifer forest for 1 hour [68]. In 2021, Spanish scholars found that the blood concentration of α-pinene, but not of other monoterpenes, increased by a much slighter extent and only in subjects starting from the lowest baselines levels, after walking in an evergreen broadleaves forest (holm oak as the most representative species) for 2 hours [69].

Although very important and innovative, both studies [68] and [69] were affected at least by small sample sizes, by unknown individual levels of metabolic transformation rates and by limited exposure time. Moreover, the health effects produced by MTs could follow pathways other than by systemic absorption, such as direct effects on the upper respiratory tract and on the central nervous system through brain absorption [23]. However, due to the great importance of α-pinene as anti-inflammatory, analgesic, antioxidant, anxiolytic, antidepressant and sedative, as well as antiproliferative agent [23], the results obtained in this study, although quite limited, could point to some impact of this BVOC concentration on the psychological outcomes even after forest therapy sessions lasting about 3.5 hours. Clearly, the detailed analysis of the relative and absolute concentration of the different monoterpenes available in TVOCs during many more forest therapy sessions, involving large numbers of participants, will help clarifying any possible impact of different BVOCs on short-term psychological outcomes.

With reference to Figure 3, the best results were shown by FTS2, FTS3 and FTS6, under similar meteorological comfort and TVOCs concentration levels similar in FTS3 and FTS6 and remarkably lower in FTS2. This might suggest similar effectiveness of the visual- and soundscapes in FTS3 and FTS6, despite the very different forest environments (alpine

in FTS3 and Mediterranean in FTS6), and possibly even higher effectiveness of the fascinating Scots pine forest in FTS2. If the health impact of BVOCs at the concentration levels found in the forest atmosphere will be confirmed by our future research, the Scots pine forest might turn out to be even more effective during late spring and early summer, when young sprouts emit far more BVOCs than mature needles in late summer [25], i.e., the time when FTS2 was performed.

Despite the limited meteorological comfort and the low concentration levels of TVOCs, the session FTS7 showed a very significant decrease of anxiety, although with a comparatively lower effect size (-66.9%), and significant decrease of depression and confusion. These results might suggest a very good effectiveness of the local visual landscape, characterized by an almost pure beech forest with scattered silver firs, small water streams and a fascinating natural pond.

Finally, session FTS5, carried out at the highest altitude, under poor meteorological comfort and with the lowest TVOCs concentration levels, did not return significant results. However, the significance levels around 90% ($p=0.1$) for the changes in anxiety and anger could suggest that, with a sufficient number of participants (only 8 valid questionnaires were returned in FTS5), significance might have been achieved at least for the above indexes, as well as that the local forest environment and impressive landscape might be effective enough on their own.

The overall results obtained in this study and their comparison with past experiences performed in other countries with similar or longer durations, might suggest a good effectiveness of most of the considered forest environments, either Mediterranean forest (FTS6), high hill (FTS2), mid-mountain (FTS3, FTS4 and FTS7) or, likely, high mountain next to the tree line (FTS5).

A final remark about the overall results concerns the very significant and large effects obtained in FTS6 in comparison with FTS1, which did not return significant results. Both sessions were performed at the same site, with moderate meteorological comfort and high concentration levels of TVOCs (slightly higher in FTS1). This evidence might suggest a remarkable role of professional guidance with a structured method of conducting for the generation of significant and larger effects even in apparently fascinating forest environments endowed with high concentration levels of TVOCs.

4.2. Stratification by gender and age group

Following the presentation of results in Section 3.2, which are shown in Figure 4, the overall outcomes of forest therapy sessions were largely independent of gender for the indexes of anxiety, depression and anger, while women got significantly higher benefits for fatigue and confusion, especially in the age groups of the youngest and the oldest. To the best knowledge of the authors, these results were presented for the first time in this study, at least with reference to the outcomes from POMS questionnaires.

In a study performed in Taiwan, 128 middle-aged to elderly subjects were recruited (43 males and 85 females, age range 45 to 86 years, on average 60.0±7.44 years), to attend structured forest therapy sessions focused on the activation of the senses [70]. Each session included around 10 participants during 3 hours, such duration being comparable to FTS2 to FTS7, under conditions of high meteorological comfort. The analysis of reduced POMS questionnaires returned the following changes (in brackets, the effect size): anxiety, -59% (1.08); depression, -50% (0.68); anger, -55% (0.97); vigor, 29% (0.80); fatigue, -54% (0.71); confusion, -44% (0.92). These results can be compared with results obtained in this study for subjects in middle-aged and older groups, shown in Figure 4(c) and 4(d), respectively. In this study, anxiety decreased significantly and on average by about 75%, with effect size around 0.9; depression decreased on average around 65%, with effect size greater for middle-aged males (0.6) and older females (0.8); anger decreased significantly only for older males, by about 90% with effect size 1.1. Overall, anxiety, depression and anger decreased more in this study but with comparable effect size. Fatigue decreased significantly only for middle-aged individuals, by almost 60% with effect size about 0.7,

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while confusion decreased only in females, by almost 60% with effect size around 0.7. Overall, also the results for fatigue and confusion obtained in FTS2 to FTS7 were generally comparable with [70]. However, the details provided in this study allowed a more detailed interpretation of the outcomes.

In a study performed in Poland on young adults (21 participants, of which 12 males and 9 females, age range between 21 and 29 years, average age 23.86±2.67 years), according to a forest therapy program structured over two days (indoor and in forest), the analysis of reduced POMS questionnaires returned the following changes (in brackets, the effect size): anxiety, -56% (1.42); depression, -54% (1.26); anger, -43% (1.27); vigor, 5% (0.34); fatigue, -34% (0.81); confusion, -36% (1.07) [71]. These results can be compared with results obtained in this study for young adults, shown in Figure 4(b). In this study, anxiety decreased significantly for females and on average by about 80%, with effect size around 1.4; depression decreased significantly, on average around 90%, with effect size greater than 1; also anger decreased significantly by about 90%, with effect size far greater than 1. Overall, anxiety, depression and anger decreased more in this study but with comparable effect size. Fatigue and confusion decreased significantly only for females, by almost 60% with effect size about 0.7 and by almost 80% with effect size 1.4, respectively. Overall, also fatigue and confusion decreased more in FTS2 to FTS7, with effect size comparable with [71]. Again, the details provided in this study allowed a more detailed interpretation of the outcomes. Moreover, sessions FTS2 to FTS7 were much shorter than in [71], making the obtained results even more remarkable.

Another study performed again in Poland on young adults, based on structured 30-minutes walks, reported only percentage changes without effect size [72]. The analysis of reduced POMS questionnaires, referred to the best situation encountered in the study (conifer forest) returned the following changes: anxiety, -53%; depression, -35%; anger, -34%; vigor, 25%; fatigue, -28%; confusion, -30%. With the exception of the increase in vigor, all other figures were remarkably lower than all the significant results obtained in FTS2-FTS7 for young adults, as shown in Figure 4(b).

In a study performed in South Korea, 38 university students with mean age around 22 years, with 24 males and 14 females, were assigned in equal numbers to a forest therapy group or a control group [73]. The experimental group performed eight, one-hour long sessions once a week, according to a structured program although to be implemented without active guidance. Reduced POMS questionnaires were presented to the participants at the beginning of the first session and the end of the last session. Except for anger, all other indexes improved significantly: anxiety (-34%), depression (-42%), vigor (+22%), fatigue (-38%) and confusion (-31%). Although quite significant, the decreases in anxiety and depression were much smaller than the results obtained in this study, as shown in Figure 4(b), where also anger decreased significantly and remarkably. However, results of the Korean study were significant for vigor, contrary to this study, and altogether comparable for fatigue and confusion. The latter two indexes decreased with maximum significance in the Korean study, in which no stratification by gender was presented, while in this study only young females enjoyed significant and remarkable improvements. The hypothesis might be advanced, that short-term improvements in vigor and possibly in fatigue and confusion would benefit from regularly repeated experiences more than anxiety, depression and anger, at least for young adults.

In this study, it is interesting to note that, across all the age groups and except for anxiety and fatigue, the latter decreasing much more significantly and largely for men, the other indexes decreased less significantly and to a lesser extent for middle-aged women and men than for the other age groups. As well, considering older individuals, the most important differences in comparison to the all-age group were for depression, with larger effect size for depression in females, and smaller in males. In a recent study performed in South Korea, 30 out of 60 subjects aged over 65 years old participated to a total of 11 sessions of forest therapy activities in a forest once a week, with the other 30 people in the control group [74]. A significant decrease in the index of depression was observed for the

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experimental group, confirmed by physiological measurements such as Electroencephalography and heart rate variability. The authors concluded that the forest therapy program could reduce the cognitive, psychological and physical risk factors of dementia for the elderly at risk of cognitive decline.

Overall, young adults (age group 18-40 years) appeared to benefit from forest therapy sessions significantly more than individuals in other age groups, followed by older adults (age group >60 years), except for anxiety, which was apparently unaffected by age, and fatigue, which showed the statistically most significant reduction for both middle-aged males and females (41-60 years).

4.3. Stratification by residence

Following the presentation of results in Section 3.3, the overall outcomes of forest therapy sessions were practically independent of residence type for both significance and effect size, except for anger and vigor, which improved more significantly and largely for participants coming from places other than towns with more than 40,000 inhabitants. The fact that residents in larger towns did not receive greater benefits from forest therapy sessions is somehow unexpected.

Stratifying by gender allowed finding that any effect on vigor lost statistical significance for both females and males, while the reduction in anger preserved significance ($p<0.01$) only for residents in places outside larger towns (>40,000 inhabitants). No significant effects on fatigue and confusion were revealed for males, while females retained significant effects, with a slightly greater effect size for confusion observed for women coming from larger towns. To the best knowledge of the authors, these results were presented for the first time in this study, at least with reference to the outcomes from POMS questionnaires.

Thus, irrespective of gender, place of residence did not affect the outcome of forest therapy sessions except for anger, which decreased significantly and largely only for residents outside larger towns. Alternative or concurrent hypotheses might be advanced: i) the contact with nature, especially forest environments, in everyday life is scarcely affected by the place of residence, perhaps except for people living in the outer countryside, which were underrepresented in the sample of participants; ii) immersion in the forest environment represents a sort of shocking experience for people living in larger towns, preventing them from fully exploiting the benefits of short (on average 3.5 hours) forest therapy sessions. The second hypothesis seems to be corroborated by the results for anger, which might be a mood state requiring more time to reduce by exposure to a relaxing environment very different from environments experienced in everyday life in larger towns.

4.4. Llimitations and preliminary guidelines

Few important limitations affected this study. No control group was used and the performance of the forest therapy sessions was assessed based on comparisons with literature data and intercomparison among different sessions. All the forest therapy sessions lasted 3.5±0.5 h, thus the dose effect could not be investigated. All professionally conducted forest therapy sessions followed the same program, thus the effect of different programs could not be investigated. In this respect, a recent Korean study performed with elderly individuals showed that forest therapy programs focused on Qigong or active walking produced distinctive neuropsychological and electrophysiological benefits, although both beneficial for preventing dementia and relieving related health problems [75].

Participants were allowed to attend only one session, thus the frequency effect could not be investigated. Neither baseline conditions (traits) nor follow-on conditions of the participants were collected, thus the possible persistence of the effects could not be investigated. The administration of the POMS questionnaires to the participants allowed collecting instantaneously perceived mood states, not corroborated by any measure on physiological parameters. Only admittedly healthy participants were recruited, thus the

effects on individuals affected by psychological or physiological disorders could not be assessed.

Although representative enough of different outdoor forest environments in central and northern Italy, the study sites could not be considered representative of all the possible environments; for example chestnut forests, widespread in mid-mountain areas in the Italian Apennines, were not investigated, along with coastal Mediterranean forests. Moreover, elements other than forest species and few other natural features (e.g., water streams) were not considered, such as artificial elements (fences, tables and chairs, mountain retreats and their architecture, etc.). Although large enough in comparison with other experiences reported in the literature, the investigated sample (sites, sessions and number of participants) could not allow disentangling all the possible factors affecting the considered psychological outcomes, as well as representing adequately all the relevant age groups, gender and places of residence. Finally, only TVOCs concentration was measured, while individual monoterpenes are known to potentially produce different and specialized health effects [23], which could be related to the outcomes of forest therapy sessions.

It is planned to overcome most of the above-listed limitations in the continuation of the study across many other sites, which will be more comprehensively characterized. Many more participants will be involved, whenever possible using control groups in environments other than outdoor forests, performing sessions across different seasons and with different duration, and performing more comprehensive measures, both psychological (trait and state) and physiological, including follow-on, and measuring relative and absolute concentrations of individual BVOCs and MTs. Besides extending the performance database, the continuation of the study will allow further linking the medical and forestry research, to identify rigorously the factors affecting the observed healing effects, including forest species and structures, volatile organic compounds, type, duration and timing of the human-forest interaction (types of exercises, methods of conducting, season, time of the day, etc.), age, gender, previous conditions and other features of the participants, as suggested in a recent study [9].

Based on the results obtained in this study and within its limitations, after involving 194 participants, with 150 valid questionnaires, across seven forest therapy sessions each lasting about 3.5 hours and performed at five different sites in Italy from August to October 2020, the following preliminary guidelines concerning the short-term amelioration of psychological indexes can be advanced:

- Meteorological comfort, structured and professional guidance were important to fully exploit the benefits of forest therapy sessions;
- Structured and professional forest therapy sessions performed under suitable meteorological comfort at fascinating sites, such as those considered in this study, produced very significant and large short-term effects on anxiety, depression, anger and confusion, with lower effects on fatigue and even lower on vigor;
- TVOCs, likely most ascribed to emissions of BVOCs from plants due to the relative remoteness of the investigated forest areas with regards to sources of anthropogenic atmospheric pollution, could have significantly and positively affected at least the reductions in anxiety, depression and anger, although their possible effect could be assessed based on only two sessions performed at the same site;
- Anxiety could be effectively reduced across all genders, age groups and places of residence, with slightly greater effects for women;
- Depression could be more effectively reduced in young adults (18-40 years) and in older women (>60 years), irrespective of residence;
- Anger could be more effectively reduced in young adults (18-40 years) and in older men (>60 years), as well as in residents outside larger towns (> 40,000 inhabitants);
- Vigor was barely affected, although slightly enhanced for middle-aged (41-60 years) and older (>60 years) men;

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- Fatigue could be significantly reduced in young women (18-40 years) and in middle-aged individuals (40-60 years), with more significant effects for women;
- Confusion could be effectively reduced only in women, with young women (18-40 years) and older women (>60 years) benefitting more than middle-aged women (40-60 years), as well as with slightly larger effect for women resident in larger towns (> 40,000 inhabitants).

Despite the limitations affecting this study, the above-listed preliminary guidelines could help planning suitable forest therapy sessions targeted to specific groups of participants, for example belonging to a given age group and gender, or aimed at improving specific psychological indexes.

5. Conclusions

The results achieved in this study confirm and expand the knowledge about the healing effects of forests by means of structured forest therapy sessions. The large number of participants attending seven sessions generated significant results, influenced by site, conduction method, level of meteorological comfort, gender, age group and place of residence.

The short-term reductions in the levels of anxiety, depression and anger were generally comparable or greater than those reported in the scientific literature. Sometimes, the observed effects were even greater than results obtained elsewhere with longer sessions. Moreover, significant differences in the forest healing effects arose with age groups and gender, as well as the role of the main factors affecting the outcomes of forest therapy sessions was preliminarily elucidated. Despite several limitations, preliminary guidelines could be issued, which could help designing and optimizing forest therapy sessions targeted to specific groups of participants, or to improve specific psychological indexes.

The mobilization of financial resources and the introduction of specific legislative elements aimed at promoting, standardizing and regulating forest therapy programs were deemed essential to the effective management of the forest ecosystems towards human health [5]. More specifically, based on the evidence shown in this study, further fundamental challenges consist in the information, education and motivation of health facilities and professionals, as well as of citizens, towards green prescriptions, which have been issued for years in countries like Japan and South Korea [29]. Further unavoidable tasks concern the sites certification , based on structural and environmental characteristics and direct functionality (observation of health effects), as well as the certification of professional providers of services connected to forest therapy [32]. In the western world, the Parks Prescription program introduced by the British Columbia Parks Foundation in Canada, aimed at the prescription of short and slow walks in protected forest areas, as a “superfood of exercise”, could serve as a useful model [76].

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References

1. Hansen, M. M.; Jones, R.; Tocchini, K. Shinrin-yoku (Forest bathing) and nature therapy: A state-of-the-art review. *Int. J. Environ. Res. Public Health* **2017**, *14*, doi:10.3390/ijerph14080851.
2. Li, Q. Effect of forest bathing (shinrin-yoku) on human health: A review of the literature. *Sante Publique (Paris).* **2019**, *31*, 135–143, doi:10.3917/spub.190.0135.
3. Twohig-Bennett, C.; Jones, A. The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environ. Res.* **2018**, *166*, 628–637, doi:10.1016/j.envres.2018.06.030.
4. Corazon, S. S.; Sidenius, U.; Poulsen, D. V.; Gramkow, M. C.; Stigsdotter, U. K. Psycho-physiological stress recovery in outdoor nature-based interventions: A systematic review of the past eight years of research. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1711, doi:10.3390/ijerph16101711.
5. Dodev, Y.; Zhiyanski, M.; Glushkova, M.; Shin, W. S. Forest welfare services - the missing link between forest policy and management in the EU. *For. Policy Econ.* **2020**, *118*, 102249, doi:10.1016/J.FORPOL.2020.102249.
6. Andersen, L.; Corazon, S. S.; Stigsdotter, U. K. Nature Exposure and Its Effects on Immune System Functioning: A Systematic Review. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1416, doi:10.3390/ijerph18041416.
7. Antonelli, M.; Donelli, D.; Carlone, L.; Maggini, V.; Firenzuoli, F.; Bedeschi, E. Effects of forest bathing (shinrin-yoku) on individual well-being: an umbrella review. *Int. J. Environ. Health Res.* **2021**, 1–26, doi:10.1080/09603123.2021.1919293.
8. Buckley, R.; Brough, P.; Hague, L.; Chauvenet, A.; Fleming, C.; Roche, E.; Sofija, E.; Harris, N. Economic value of protected areas via visitor mental health. *Nat. Commun.* **2019**, *10*, 5005, doi:10.1038/s41467-019-12631-6.
9. Doimo, I.; Masiero, M.; Gatto, P. Forest and Wellbeing: Bridging Medical and Forest Research for Effective Forest-Based Initiatives. *Forests* **2020**, *11*, 791, doi:10.3390/f11080791.
10. Peterfalvi, A.; Meggyes, M.; Makszin, L.; Farkas, N.; Miko, E.; Miseta, A.; Szereday, L. Forest Bathing Always Makes Sense: Blood Pressure-Lowering and Immune System-Balancing Effects in Late Spring and Winter in Central Europe. *Int. J. Environ. Res. Public Heal.* **2021**, *18*, 2067, doi:10.3390/ijerph18042067.
11. Li, Q. Effect of forest bathing trips on human immune function. *Environ. Health Prev. Med.* **2010**, *15*, 9–17, doi:10.1007/s12199-008-0068-3.
12. White, M. P.; Alcock, I.; Grellier, J.; Wheeler, B. W.; Hartig, T.; Warber, S. L.; Bone, A.; Depledge, M. H.; Fleming, L. E. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Sci. Rep.* **2019**, *9*, 7730, doi:10.1038/s41598-019-44097-3.
13. Tsao, T. M.; Tsai, M. J.; Hwang, J. S.; Cheng, W. F.; Wu, C. F.; Chou, C. C. K.; Su, T. C. Health effects of a forest environment on natural killer cells in humans: An observational pilot study. *Oncotarget* **2018**, *9*, 16501–16511, doi:10.18632/oncotarget.24741.

14. Rajoo, K. S.; Karam, D. S.; Abdullah, M. Z. The physiological and psychosocial effects of forest therapy: A systematic review. *Urban For. Urban Green.* 2020, *54*, 126744.
15. Markwell, N.; Gladwin, T. E. Shinrin-yoku (Forest Bathing) Reduces Stress and Increases People's Positive Affect and Well-Being in Comparison with Its Digital Counterpart. *Ecopsychology* **2020**, *12*, 247–256, doi:10.1089/eco.2019.0071.
16. Zabini, F.; Albanese, L.; Becheri, F. R.; Gavazzi, G.; Giganti, F.; Giovanelli, F.; Gronchi, G.; Guazzini, A.; Laurino, M.; Li, Q.; Marzi, T.; Mastorci, F.; Meneguzzo, F.; Righi, S.; Viggiano, M. P. Comparative Study of the Restorative Effects of Forest and Urban Videos during COVID-19 Lockdown: Intrinsic and Benchmark Values. *Int. J. Environ. Res. Public Health* **2020**, *17*, 8011, doi:10.3390/ijerph17218011.
17. Kabat-Zinn, J. An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results. *Gen. Hosp. Psychiatry* **1982**, *4*, 33–47, doi:https://doi.org/10.1016/0163-8343(82)90026-3.
18. Rosa, C. D.; Larson, L. R.; Collado, S.; Profice, C. C. Forest therapy can prevent and treat depression: Evidence from meta-analyses. *Urban For. Urban Green.* **2020**, 126943, doi:10.1016/j.ufug.2020.126943.
19. Buckley, R. C.; Brough, P.; Westaway, D. Bringing Outdoor Therapies Into Mainstream Mental Health. *Front. Public Heal.* **2018**, *6*, 119, doi:10.3389/fpubh.2018.00119.
20. Joye, Y.; van den Berg, A. Is love for green in our genes? A critical analysis of evolutionary assumptions in restorative environments research. *Urban For. Urban Green.* **2011**, *10*, 261–268, doi:10.1016/j.ufug.2011.07.004.
21. Van den Berg, A. E. From green space to green prescriptions: Challenges and opportunities for research and practice. *Front. Psychol.* **2017**, *8*, 268, doi:10.3389/fpsyg.2017.00268.
22. Ikei, H.; Song, C.; Miyazaki, Y. Physiological effects of touching wood. *Int. J. Environ. Res. Public Health* **2017**, *14*, 801, doi:10.3390/ijerph14070801.
23. Antonelli, M.; Donelli, D.; Barbieri, G.; Valussi, M.; Maggini, V.; Firenzuoli, F. Forest Volatile Organic Compounds and Their Effects on Human Health: A State-of-the-Art Review. *Int. J. Environ. Res. Public Health* **2020**, *17*, 6506, doi:10.3390/ijerph17186506.
24. Šimpraga, M.; Ghimire, R. P.; Van Der Straeten, D.; Blande, J. D.; Kasurinen, A.; Sorvari, J.; Holopainen, T.; Adriaenssens, S.; Holopainen, J. K.; Kivimäenpää, M. Unravelling the functions of biogenic volatiles in boreal and temperate forest ecosystems. *Eur. J. For. Res.* **2019**, *138*, 763–787, doi:10.1007/s10342-019-01213-2.
25. Taipale, D.; Aalto, J.; Schiestl-Aalto, P.; Kulmala, M.; Bäck, J. The importance of accounting for enhanced emissions of monoterpenes from new Scots pine foliage in models - A Finnish case study. *Atmos. Environ. X* **2020**, 100097, doi:10.1016/j.aeaoa.2020.100097.
26. Meneguzzo, F.; Albanese, L.; Bartolini, G.; Zabini, F. Temporal and Spatial Variability of Volatile Organic Compounds in the Forest Atmosphere. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4915, doi:10.3390/ijerph16244915.
27. Bach, A.; Y, A. M.; Llusi, J.; Filella, I.; Maneja, R.; Penuelas, J. Human Breathable Air in a Mediterranean Forest : Characterization of Monoterpene Concentrations under the Canopy. *Int. J. Environ. Res. Public Health* **2020**, *17*, 4391, doi:10.3390/ijerph17124391.
28. FAO and UNEP *The State of the World's Forests 2020. Forests, biodiversity and people*; Food and Agriculture Organization of the United Nations: Rome, 2020; ISBN 9789251324196.
29. Nabhan, G. P.; Orlando, L.; Smith Monti, L.; Aronson, J. Hands-On Ecological Restoration as a Nature-Based Health Intervention: Reciprocal Restoration for People and Ecosystems. *Ecopsychology* **2020**, *12*, 195–202, doi:10.1089/eco.2020.0003.
30. Sen, M. *Forests: at the heart of a green recovery from the COVID-19 pandemic*; 2020;
31. Song, C.; Ikei, H.; Miyazaki, Y. Physiological effects of nature therapy: A review of the research in Japan. *Int. J. Environ. Res. Public Health* 2016, *13*.

32. Buckley, R. C. Therapeutic mental health effects perceived by outdoor tourists: A large-scale, multi-decade, qualitative analysis. *Ann. Tour. Res.* **2019**, *77*, 164–167, doi:10.1016/j.annals.2018.12.017.
33. van den Bosch, M.; Meyer-Lindenberg, A. Environmental Exposures and Depression: Biological Mechanisms and Epidemiological Evidence. *Annu. Rev. Public Health* **2019**, *40*, 239–259, doi:10.1146/annurev-publhealth-040218-044106.
34. Bratman, G. N.; Anderson, C. B.; Berman, M. G.; Cochran, B.; de Vries, S.; Flanders, J.; Folke, C.; Frumkin, H.; Gross, J. J.; Hartig, T.; Kahn, P. H.; Kuo, M.; Lawler, J. J.; Levin, P. S.; Lindahl, T.; Meyer-Lindenberg, A.; Mitchell, R.; Ouyang, Z.; Roe, J.; Scarlett, L.; Smith, J. R.; van den Bosch, M.; Wheeler, B. W.; White, M. P.; Zheng, H.; Daily, G. C. Nature and mental health: An ecosystem service perspective. *Sci. Adv.* **2019**, *5*, eaax0903, doi:10.1126/sciadv.aax0903.
35. Lee, I.; Choi, H.; Bang, K. S.; Kim, S.; Song, M. K.; Lee, B. Effects of forest therapy on depressive symptoms among adults: A systematic review. *Int. J. Environ. Res. Public Health* **2017**, *14*, 321, doi:10.3390/ijerph14030321.
36. Li, Q. *Into the Forest. How trees can help you find HEALTH and HAPPINESS.*; Penguin Books Limited, 2019; ISBN 9780241377604.
37. Grove, R.; Prapavessis, H. Preliminary evidence for the reliability and validity of an abbreviated Profile of Mood States. *Int. J. Sport Psychol.* **1992**, *23*, 93–109.
38. Gola, M.; Botta, M.; D'Aniello, A. L.; Capolongo, S. Influence of Nature at the Time of the Pandemic: An Experience-Based Survey at the Time of SARS-CoV-2 to Demonstrate How Even a Short Break in Nature Can Reduce Stress for Healthcare Staff. *Heal. Environ. Res. Des. J.* **2021**, *14*, 49–65, doi:10.1177/1937586721991113.
39. Grossman, P.; Niemann, L.; Schmidt, S.; Walach, H. Mindfulness-based stress reduction and health benefits: A meta-analysis. *J. Psychosom. Res.* **2004**, *57*, 35–43, doi:10.1016/S0022-3999(03)00573-7.
40. Davidson, R. J.; Kabat-Zinn, J.; Schumacher, J.; Rosenkranz, M.; Muller, D.; Santorelli, S. F.; Urbanowski, F.; Harrington, A.; Bonus, K.; Sheridan, J. F. Alterations in brain and immune function produced by mindfulness meditation. *Psychosom. Med.* **2003**, *65*, 564–570, doi:10.1097/01.PSY.0000077505.67574.E3.
41. Cramer, H.; Lauche, R.; Paul, A.; Dobos, G. Mindfulness-based stress reduction for breast cancer- A systematic review and meta-analysis. *Curr. Oncol.* 2012, *19*, e343.
42. Keng, S. L.; Smoski, M. J.; Robins, C. J. Effects of mindfulness on psychological health: A review of empirical studies. *Clin. Psychol. Rev.* 2011, *31*, 1041–1056.
43. Chiesa, A.; Serretti, A. A systematic review of neurobiological and clinical features of mindfulness meditations. *Psychol. Med.* 2010, *40*, 1239–1252.
44. Hofmann, S. G.; Sawyer, A. T.; Witt, A. A.; Oh, D. The Effect of Mindfulness-Based Therapy on Anxiety and Depression: A Meta-Analytic Review. *J. Consult. Clin. Psychol.* **2010**, *78*, 169–183, doi:10.1037/a0018555.
45. Li, Q.; Otsuka, T.; Kobayashi, M.; Wakayama, Y.; Inagaki, H.; Katsumata, M.; Hirata, Y.; Li, Y.; Hirata, K.; Shimizu, T.; Suzuki, H.; Kawada, T.; Kagawa, T. Acute effects of walking in forest environments on cardiovascular and metabolic parameters. *Eur. J. Appl. Physiol.* **2011**, *111*, 2845–2853, doi:10.1007/s00421-011-1918-z.
46. Antonelli, M.; Barbieri, G.; Donelli, D. Effects of forest bathing (shinrin-yoku) on levels of cortisol as a stress biomarker: a systematic review and meta-analysis. *Int. J. Biometeorol.* **2019**, 1–18, doi:10.1007/s00484-019-01717-x.
47. Farrow, M. R.; Washburn, K. A Review of Field Experiments on the Effect of Forest Bathing on Anxiety and Heart Rate Variability. *Glob. Adv. Heal. Med.* **2019**, *8*, 216495611984865, doi:10.1177/2164956119848654.
48. Nisbet, E. K.; Zelenski, J. M.; Murphy, S. A. Happiness is in our Nature: Exploring Nature Relatedness as a Contributor to Subjective Well-Being. *J. Happiness Stud.* **2011**, *12*, 303–322, doi:10.1007/s10902-010-9197-7.
49. Franco, L. S.; Shanahan, D. F.; Fuller, R. A. A review of the benefits of nature experiences: More than meets the eye. *Int. J. Environ. Res. Public Health* **2017**, *14*, doi:10.3390/ijerph14080864.
50. Bang, K. S.; Kim, S.; Song, M. K.; Kang, K. I.; Jeong, Y. The effects of a health promotion program using urban forests and nursing student mentors on the perceived and psychological health of elementary school children in vulnerable populations.

Int. J. Environ. Res. Public Health **2018**, *15*, doi:10.3390/ijerph15091977.

51. Tsunetsugu, Y.; Park, B. J.; Miyazaki, Y. Trends in research related to "shinrin-yoku" (taking in the forest atmosphere or forest bathing) in Japan. *Environ. Health Prev. Med.* **2010**, *15*, 27–37, doi:10.1007/s12199-009-0091-z.
52. Citron, F. M. M.; Goldberg, A. E. Metaphorical sentences are more emotionally engaging than their literal counterparts. *J. Cogn. Neurosci.* **2014**, *26*, 2585–2595, doi:10.1162/jocn_a_00654.
53. Kirmayer, L. J. Word magic and the rhetoric of common sense: Erickson's metaphors for mind. *Int. J. Clin. Exp. Hypn.* **1988**, *36*, 157–172, doi:10.1080/00207148808410505.
54. Halley, J. Uncommon Therapy: The Psychiatric Techniques of Milton H. Erickson, M.D. *Fam. Process* **1973**, *12*, 467–467, doi:10.1111/j.1545-5300.1973.467_1.x.
55. Low, G. Metaphor and education. In *The Cambridge Handbook of Metaphor and Thought*; Gibbs, R. J., Ed.; Cambridge University Press, 2012; pp. 212–231.
56. Curran, J. Illness as Metaphor; AIDS and its Metaphors. *Bmj* **2007**, *335*, 517, doi:10.1136/bmj.39325.562176.94.
57. Kuhn, T. S. Metaphor in Science. In *Metaphor and Thought*; Ortony, A., Ed.; Cambridge University Press, 1993; pp. 533–542.
58. Keefer, L. A.; Landau, M. J. Metaphor and analogy in everyday problem solving. *Wiley Interdiscip. Rev. Cogn. Sci.* **2016**, *7*, 394–405, doi:10.1002/wcs.1407.
59. Olendzki, N.; Elkins, G. R.; Slonena, E.; Hung, J.; Rhodes, J. R. Mindful Hypnotherapy to Reduce Stress and Increase Mindfulness: A Randomized Controlled Pilot Study. *Int. J. Clin. Exp. Hypn.* **2020**, *68*, 151–166, doi:10.1080/00207144.2020.1722028.
60. Boulenger, V.; Shtyrov, Y.; Pulvermüller, F. When do you grasp the idea? MEG evidence for instantaneous idiom understanding. *Neuroimage* **2012**, *59*, 3502–3513, doi:10.1016/j.neuroimage.2011.11.011.
61. Szcześniak, M.; Strochalska, K. Temperament and sense of coherence: emotional intelligence as a mediator. *Int. J. Environ. Res. Public Health* **2020**, *17*, 219, doi:10.3390/ijerph17010219.
62. Kirmayer, L. J. Healing and the invention of metaphor: The effectiveness of symbols revisited. *Cult. Med. Psychiatry* **1993**, *17*, 161–195, doi:10.1007/BF01379325.
63. Spurio, M. G. Words that heal. *Psychiatr. Danub.* **2015**, *27 Suppl 1*, S21—7.
64. Menardo, E.; Brondino, M.; Hall, R.; Pasini, M. Restorativeness in Natural and Urban Environments: A Meta-Analysis. *Psychol. Rep.* **2019**, 003329411988406, doi:10.1177/0033294119884063.
65. Kotera, Y.; Richardson, M.; Sheffield, D. Effects of Shinrin-Yoku (Forest Bathing) and Nature Therapy on Mental Health: a Systematic Review and Meta-analysis. *Int. J. Ment. Health Addict.* **2020**, 1–25, doi:10.1007/s11469-020-00363-4.
66. Kotera, Y.; Lyons, M.; Vione, K. C.; Norton, B. Effect of Nature Walks on Depression and Anxiety: A Systematic Review. *Sustainability* **2021**, *13*, 4015, doi:10.3390/su13074015.
67. Yu, C. P. (Simon); Hsieh, H. Beyond restorative benefits: Evaluating the effect of forest therapy on creativity. *Urban For. Urban Green.* **2020**, *51*, 126670, doi:10.1016/j.ufug.2020.126670.
68. Sumitomo, K.; Akutsu, H.; Fukuyama, S.; Minoshima, A.; Kukita, S.; Yamamura, Y.; Sato, Y.; Hayasaka, T.; Osanai, S.; Funakoshi, H.; Hasebe, N.; Nakamura, M. Conifer-Derived Monoterpenes and Forest Walking. *Mass Spectrom.* **2015**, *4*, A0042–A0042, doi:10.5702/massspectrometry.a0042.
69. Bach, A.; Maneja, R.; Zaldo-Aubanell, Q.; Romanillos, T.; Llusià, J.; Eustaquio, A.; Palacios, O.; Penuelas, J. Human absorption of monoterpenes after a 2 -hs forest exposure: a field experiment in a Mediterranean holm oak forest. *J. Pharm. Biomed. Anal.* **2021**, 114080, doi:10.1016/j.jpba.2021.114080.
70. Yu, C. P.; Lin, C. M.; Tsai, M. J.; Tsai, Y. C.; Chen, C. Y. Effects of short forest bathing program on autonomic nervous system activity and mood states in middle-aged and elderly individuals. *Int. J. Environ. Res. Public Health* **2017**, *14*, doi:10.3390/ijerph14080897.

71. Bielinis, E.; Bielinis, L.; Krupińska-Szeluga, S.; Łukowski, A.; Takayama, N. The Effects of a Short Forest Recreation Program on Physiological and Psychological Relaxation in Young Polish Adults. *Forests* **2019**, *10*, 34, doi:10.3390/f10010034.
72. Janeczko, E.; Bielinis, E.; Wójcik, R.; Woźnicka, M.; Kędziora, W.; Łukowski, A.; Elsadek, M.; Szyc, K.; Janeczko, K. When urban environment is restorative: The effect of walking in suburbs and forests on psychological and physiological relaxation of young Polish adults. *Forests* **2020**, *11*, 591, doi:10.3390/f11050591.
73. Kim, J. G.; Jeon, J.; Shin, W. S. The influence of forest activities in a university campus forest on student's psychological effects. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1–16, doi:10.3390/ijerph18052457.
74. Lim, Y.-S.; Kim, J.; Khil, T.; Yi, J.; Dong-jun, K. Effects of the Forest Healing Program on Depression, Cognition, and the Autonomic Nervous System in the Elderly with Cognitive Decline. *J. People, Plants, Environ.* **2021**, *24*, 107–117.
75. Yi, J.; Kim, S. G.; Khil, T.; Shin, M.; You, J. H.; Jeon, S.; Park, G. H.; Jeong, A. Y.; Lim, Y.; Kim, K.; Kim, J.; Kang, B.; Lee, J.; Park, J. H.; Ku, B.; Choi, J.; Cha, W.; Lee, H. J.; Shin, C.; Shin, W.; Kim, J. U. Psycho-electrophysiological benefits of forest therapies focused on qigong and walking with elderly individuals. *Int. J. Environ. Res. Public Health* **2021**, *18*, 1–16, doi:10.3390/ijerph18063004.
76. Remick, R. A. A walk in nature: The superfood of physical activities | British Columbia Medical Journal. *BC Med. J.* **2021**, *63*, 74.