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Forest Therapy as a Nature-Based Intervention: An Option for Neurological Rehabilitation?

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Introduction

Forest therapy as a nature-based intervention includes measures for health promotion or preventions as well as for therapy and rehabilitation under the guidance of a medical professional (forest health trainer, forest therapist). It originated in Japan and is called “Shinrin Yoku,” which means “immersion in the atmosphere of the forest” [1]. With the immersion in the atmosphere of the forest, a “coming to rest” takes place which goes along with a reduction of the sympathetic nervous system activity and an activation of the parasympathetic nervous system allowing deepened visual, olfactory, acoustic, and somatosensory perceptions [2]. Combined with additional body-mind and mindfulness exercises [3], health-promoting effects occur that have a positive influence on physical, emotional, and psychological well-being. Theories proposed for how spending time in nature supports human health include the attention restoration and the stress reduction theory [2]. In the meantime, there are numerous studies that prove positive effects of forest therapy on mental illnesses (depression, stress-associated disorders, psychologically induced sleep disorders), on arterial hypertension, cardiac and pulmonary

function, and immune function [1, 2, 4–7]. Based on these positive findings, professional societies have been founded in several countries (Japan, South Korea, USA) and programmes on the benefits of forest therapy have been developed including the professional education of Forest Health Trainers/Forest Therapists/Forest Therapy Guide. Initiatives to develop suitable forest areas have also been initiated in European countries (Finland, Sweden, Denmark, the Netherlands, Ireland, Spain, Austria and Germany). For instance, in the Baltic Sea resort of Heringsdorf on Usedom, Germany’s first healing forest was opened in 2017 and recently 13 recreational forests and 3 healing forest have been established in different Bavarian health resorts [8].

The number of available scientific publications increases strongly every year, also in the field of non-pharmacological studies and complementary medicine, so that the individual physician, clinician, and scientist is strongly challenged to obtain comprehensive and up-to-date information on a medical topic. It is therefore necessary to systematically summarize and critically evaluate individual studies on the same topic. Such summaries are particularly important if the studies are of low case number, inconsistent, or unclear. Thus, the available evidence in the studies can be retrieved, the precision of the effect sizes improved and generalized statements enabled [9].

Neurological disorders such as stroke, Parkinson’s disease, multiple sclerosis and dementia are important causes of disability and will further increase globally, as a result of population growth and ageing [10]. Therefore, besides advances in prevention and management of major neurological disorders, measures to improve health status of neurologically handicapped patients are strongly needed. Complementary and alternative medicine plays an important role here [11]. But more research on its scientific evidence is warranted. Therefore, the subjects of this article are the questions of (1) whether there are clinical studies with evident effects on forest therapy in the treatment of specific chronic neurological diseases are available and (2) whether forest therapy as a nature-based intervention represents a therapeutic option in neurological rehabilitation.

Materials and Methods

The research question was formulated according to the PICO framework: Do patients (P = patients) with below mentioned clinical diagnoses and treated with forest therapy (I = intervention), compared to those without this therapy (C = controls), show a better outcome (O = outcome)? The electronic databases PubMed, Scopus, and Cochrane were searched for the years 1970 to mid-2023 without language restriction on forest therapy for the specific neurological diseases “stroke rehabilitation,” “Parkinson’s disease,” “multiple sclerosis,” and “dementia.” The search was

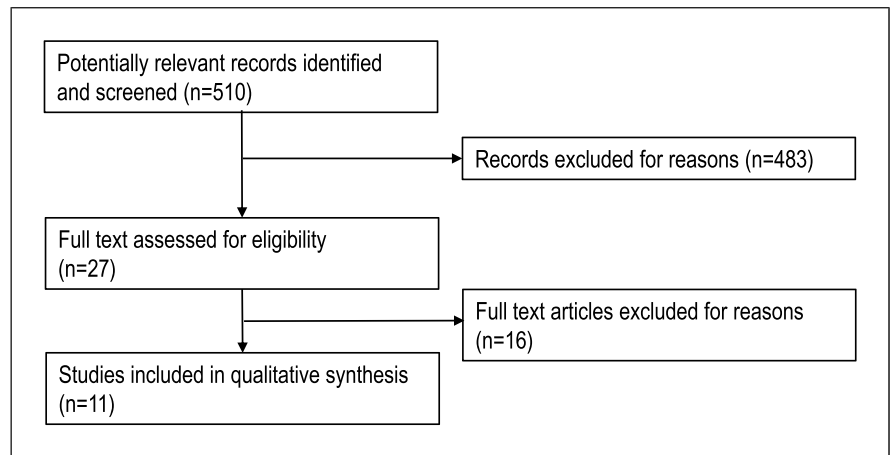


Fig. 1. Flowchart of the study selection process.

narrowed for meta-analyses and randomised clinical trials applying the keywords “forest therapy,” “forest bathing,” “Shinrin yoku,” “nature-based intervention,” “nature-guided therapy,” “nature-based rehabilitation,” “wilderness therapy,” “wilderness medicine,” “tree therapy,” “nature therapy,” “urban forest healing,” “forest healing program” combined with “neurological disorders,” “stroke rehabilitation,” “Parkinson’s disease,” “multiple sclerosis,” and “dementia.” Two investigators (J.G.H., G.I.) performed the search on eligible studies using the above mentioned keywords. To run statistical analyses and demonstrate results via forest plots we used Meta-Mar (1.1.0), a free online meta-analysis service developed by A. Beheshti (<http://www.meta-mar.com>) [12].

Results

A total of 230,510 relevant articles from the primary databases were obtained. Following analysis of titles and abstracts, 211,483 articles were excluded. Thus, 1,927 full articles were assessed for eligibility. Fourteen Sixteen further records had to be excluded as they do not match the preformulated research question. Finally, 8 studies, 2 reviews, and 1 study design paper could be found which gave information on the potential impact of forest therapy on neurological conditions (Fig. 1; Table 1).

Forest Therapy as a Nature-Based Intervention in Stroke Rehabilitation

Only 3 papers have been identified in regard to stroke rehabilitation. Chun et al. [13] conducted a randomised trial with chronic stroke patients who were randomly assigned to a forest group or urban group. In the forest group, activities took place in a forest area suitable for recreational purposes, while the urban group stayed in a hotel. The duration and activities of both groups were the same. The outcome parameters were depression and anxiety scores, which were significantly more favourable in the forest group. The authors concluded that forest therapy is beneficial for treating depression and anxiety syndromes in patients with chronic stroke. There were no

findings on other outcome parameters such as mobility parameters, functional independence, and improvement in activities of daily life. Palsdottir et al. [14] performed a randomized controlled trial of nature-based poststroke fatigue rehabilitation. The nature-based intervention took place in an outdoor environment suitable and adapted for stroke rehabilitation. No statistically significant differences were found between the intervention and the control group. However, fatigue decreased more in the intervention group and participants showed good compliance with the nature-based intervention. The authors conclude that nature-based rehabilitation is feasible and well tolerated. A strong limitation of this well-panned study is probably the statistically underpowerment. However, this study provides a solid foundation of future studies in this field. Both studies presented data of the intervention and control group on the Hamilton Depression Scale before and after program [13, 14]. Thus, at least a limited meta-analysis could be performed on this sub-aspect. A more significant decrease in the Hamilton Depression Scale could be found in the intervention group (Fig. 2).

Wilker et al. [15] presented an analysis of the influences of green space on mortality in stroke survivors in Boston, USA. They found that greater exposure to greenness was associated with higher survival rates. In their analysis, they compared the group with the highest quartile of green space with the group of lowest quartile. However, this was not an interventional study, but an observational study with open-ended questions on exposure-response relationship.

Forest Therapy as a Nature-Based Intervention in Dementia

In 8 articles, some information on forest therapy for dementia was available. Olsson et al. [16] conducted a study in subjects with early stage dementia in Sweden using repeated standardised interviews. The results reflected positive experiences of well-being and

Table 1. Characteristics of the studies included in the systematic review

Author, year	Study design	Intervention	Results and conclusion
Chun et al. [13] (2017)	Randomised trial, 59 chronic stroke patients	Forest group ($n = 30$)/urban group ($n = 29$)	Beneficial with regard to Beck depression inventory, Hamilton depression rating scale and Spielberger State-Trait anxiety inventory. Improvement in biological antioxidative potential-test
Palsdottir et al. [14] (2020)	Randomized trial; $n = 101$ subacute and chronic stroke patients	Nature-based rehabilitation program ($n = 51$); standard care ($n = 50$); 10-week program; intervention based on horticultural therapy	Improvement in both groups without statistically significant differences between the groups. Fatigue decrease to a value below the suggested cut-off for mental fatigue in the intervention group
Wilker et al. [15] (2014)	Retrospective register study, single centre in greater Boston, USA	1,645 participants, 929 deaths over up to 13.2 years (median follow-up of 5 years)	Regarding all-cause mortality following stroke comparison of highest quartile of green space compared to the lowest quartile resulted in hazard ratio 0.78 (95% CI: 0.63–0.97; $p = 0.009$)
Olsson et al. [16] (2013)	Repeated standardized interviews; $n = 11$ patients with early stage dementia, Sweden	Supports feeling of self-worth, intermingled with sense of grief and loss	Subjective being outdoors was of great value
Orr et al. [17] (2016)	Review of qualitative research evidence on sensory experience of the natural world. Inclusion of 27 studies	Six themes emerged: "the window," "vision," "being in nature," "doing in nature," "barriers," "meaning of being and doing in nature"	Older people derive considerable pleasure and enjoyment from viewing, being and doing in nature with positive impact on their well-being and quality of life
Whear et al. [18] (2014)	Systematic review with narrative synthesis of 17 studies (9 quantitative, 7 qualitative, 1 mixed)	Suggesting decreased levels of agitation associated with garden use	Appreciation of a garden for possible relaxation, stimulation of activities and memories; contribution to normalization of interactions Risk of falls and time consuming for the staff
Gray and Clair [19] (2002)	$N = 13$ patients with dementia	Exposition to four different aroma interventions (lavender, sweet orange, tea tree, control)	No significant differences across all aroma conditions for resistive behaviour of the patients and duration of medication administration; no difference based on gender
Schmidt et al. [20] (2022)	Single-cased, quasi- experimental, mixed method study; presentation of a protocol	Nature-based rehabilitation for people with severe dementia	Planned pre- and postintervention effect; evaluation with respect to garden use, questionnaire to staff, clinical score on residents' symptoms, staff's work disturbance, and medication use. Additional process evaluation
Lassell et al. [21] (2021)	Descriptive case study with 8 patients with dementia	4 patients self-selected to adaptive gardening; 4 patients self-selected to adaptive riding; Each hour-long weekly, 8 weeks	Evaluation of video-taped data; both interventions supported emotional well-being and participation. Adaptive riding revealed longer duration of active participation

Table 1 (continued)

Author, year	Study design	Intervention	Results and conclusion
Yi et al. [22] (2021)	Comparative study on elderly individuals on psycho-electrophysiological benefits	3 groups Forest therapy with Qigong (n = 25) Forest therapy with walking (n = 18) Control (n = 26) Twelve 2-h session; 6 weeks	The forest therapy group with walking showed increase in neurocognition, improvement in sympathetic nervous activity and bioimpedance in the lower body. The forest therapy group with Qigong improved in mood and bioimpedance in the upper body
Kim et al. [23] (2023)	11 patients with dementia; impact on emotional health and quality of life; using in-depth interviews	Nature-based virtuality intervention 5 weeks	Increase in participants mean scores for pleasure and alertness; decrease in anxiety, sadness and anger; increase in quality of life. Some challenges in applying the gears and goggles

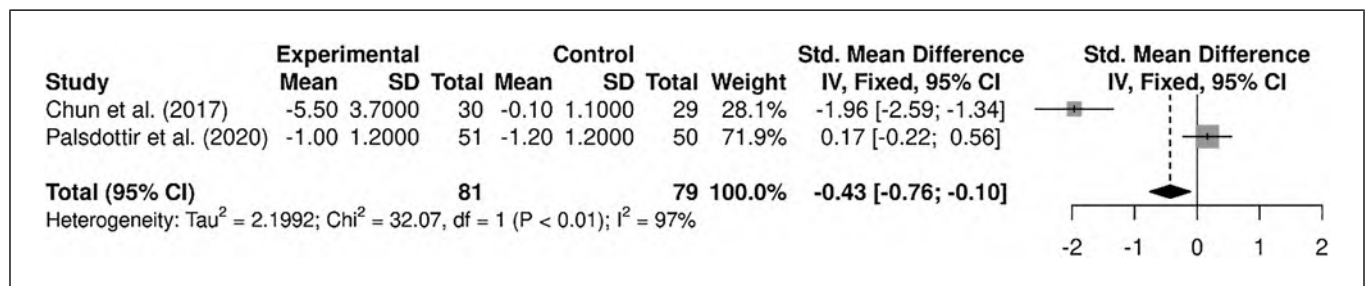


Fig. 2. Forest plot and statistical data on the improvement in the Hamilton Depression Scale in stroke rehabilitation before and after program. A more significant decrease (left of zero) could be found in the forest intervention group.

self-esteem with regard to independent outdoor activity. Outdoor activity was generally rated as positive. Difficulties, however, were encountered when independent outdoor activity skills were limited. The authors encourage outdoor activities in patients with early stage dementia but point out necessary safety aspects to avoid possible orientation problems. Orr et al. [17] summarized qualitative research findings on how older people, including those with dementia, describing their sensory engagement with nature. They concluded that older people experienced considerable pleasure and enjoyment from looking at and being and doing in nature. This in turn would have a positive impact on their well-being and quality of life. Whear et al. [18] presented a systematic review including quantitative, qualitative, and mixed methods. Some evidence was found that garden use led to lower levels of agitation. However, the included quantitative studies were of poor quality overall, and no general conclusions could be drawn from the quantitative studies.

Gray and Clair [19] investigated three different olfactoric conditions (lavender, sweet orange, tea tree) and a control condition on resistive behaviour and on duration of medication administration in 13 dementia

patients without statistically significant differences. The authors suggest future studies with larger sample size. Unfortunately, no exact data on smell capacities of the patients had been presented and no actual forest therapy in an outdoor environment was carried out.

The paper by Schmidt et al. [20] is about nature-based palliative rehabilitation intervention in a Danish nursing home for patients with severe dementia. It is not an actual patient study, but rather a concept for the development of a nursing home with the special characteristics for the implementation of nature-based palliative care. Lassell et al. [21] compared four dementia patients during adaptive gardening with four dementia patients during adaptive riding by evaluation of video-taped data. They conclude that both interventions supported quality of life and merit continued development. The main limitation of this study is the extremely small number of cases.

Yi et al. [22] examined elderly individuals on psycho-electrophysical benefits of forest therapy with Qigong and walking and compared them with controls. They concluded that both, forest therapy with Qigong and forest therapy with walking, have health benefits for the elderly

regarding psychological factors such as cognition and mood and electrophysiological parameters such as bio-impedance, heart rate variability, and electroencephalography. The main limitation is the short study period. In relation to our questions, however, patients with dementia were not included in the study. Kim et al. [23] used a nature-based virtual reality program on emotional health and quality of life in patients with dementia. They found an increase in pleasure and alertness scores, a decrease in anxiety, sadness, and anger scores and an increase in quality of life score. But they also reported on difficulties the patients had in handling the virtual goggles. In this study too, no actual forest therapy took place. No clinical trials could be found on the impact of forest therapy in the treatment of patients with multiple sclerosis and Parkinson's disease.

Discussion

The literature search revealed up to now no major significant randomized trials for forest therapy in the treatment of specific chronic neurological conditions such as stroke rehabilitation, dementia, Parkinson's disease, and multiple sclerosis. The intervention studies found have a small number of patients. Although they show positive effects, they are not suitable for generalizable evidence-based statements due to its different study designs, selection of patients, different interventions, and different outcome parameters. The most interesting approach was chosen by Chun et al. [13] and Palsdottir et al. [14] with a plausible randomization, feasible nature-based intervention, and well useable outcome parameters. And indeed meta-analytically, they also showed a positive signal in favour of forest therapy in the subitem improvement in the Hamilton Depression Scale. It may therefore be assumed that occupational therapists and physiotherapists are interested in such a concept and would like to support future studies [24]. One observational study found an association between mortality of stroke survivors with living in greenness [15]. In two reviews, pleasure and enjoyment from viewing nature and being and doing in nature are reported in elderly people, and use of garden may lead to lesser agitation in dementia patients [17, 18]. Few nature-based interventions in dementia patients showed certain benefits in particular details, but no actual forest therapy was conducted [19, 21, 23].

During the literature search, the authors encountered a major difficulty. How exactly is forest therapy defined, at what point can one speak of forest therapy, where are the boundaries to other nature-based forms of therapy or at what dose is forest therapy useful. These difficulties could not be resolved in either case. The evaluation of this review therefore also included work that not only included forest therapy in the strict sense but also had certain elements of forest therapy, such as being in the

green [16–18], inhaling tree odours [19], adapted gardening and horse riding [21], combination with Qigong and walking [22] or even virtual forest living [23]. At this point, it is therefore extremely important that in the future the professional societies define and operationalize forest therapy precisely in order to be able to conduct more meaningful studies in the future, ideally in multi-center format, in order to achieve statistically sufficiently powered case numbers.

In Germany, neurological rehabilitation is generally carried out as a 3- to 4-week multimodal intensive programme, in which in addition to medical-physical factors, psychological and socio-medical aspects of the disease are also addressed. As indicators of the success of rehabilitation, subjective parameters of health and quality of life are very important. Such parameters cover depressiveness, well-being, physical and psychological quality of life, somatic health, and subjective health prognosis [25]. In all these parameters, a positive influence of forest therapy is reasonably imaginable. Therefore, the following indications can be proposed.

- Stroke rehabilitation following acute care or chronic stadium (with a modified Rankin scale not higher than 4)
- Parkinson disease (stadium less than 4 according to Hoehn and Yahr)
- Dementia, mild to moderate stadium with preserved sufficient orientation and without significant behavioural changes
- Multiple sclerosis with a maximally handicap of 5 on the EDSS scale

Neurobiologically interesting in this context is that even just spending time outdoors already has a positive effect on the brain. Recently, Kühn et al. [26] demonstrated in a magnetic resonance imaging study a connection between time spent outdoors and grey matter in the right dorsolateral prefrontal cortex, a brain region involved in planning actions and cognitive control. Another thought suggests itself; does preventive forest therapy (forest bathing) have similar effects to sauna bathing, which is known to prevent strokes [27]? Certainly, forest bathing does not have the strong vascular training effect of sauna bathing, but Kneipp stimuli and climatotherapeutic exposure to cool air can be used as forest therapy elements to create cardiovascular training effects, too. Finally, the recreational effect of forest air, scent, climate, greenery, forest sounds, and nature connectedness can be just as important as the recreational effect after sauna bathing.

The risks or undesirable side effects of forest therapy seem low and acceptable although there are no exact data on the potential harms of exposure to nature [2]. In patients with panic attacks during deep relaxation, these potentially can be provoked. However, they should be controllable by the therapist through skilful handling. Since forest bathing itself is not accompanied

by sporting activity, negative cardiopulmonary effects due to physical overexertion can be neglected. However, attention should be paid to potential allergens such as pollen and grasses in allergic persons. Furthermore, it is essential to consider the safety aspects in the forest itself respecting the hazards inherent in the forest. Protection against ticks is necessary to avoid transmitting tick-borne encephalitis or Lyme disease [28]. Berries should not be eaten because of the danger of fox tapeworm. If there are visible spider webs of the oak processionary moth, an appropriate distance should be kept. Dangers from wild boars, European adder, hornets, and wasps may be rare but should not be neglected. Toxic plants such as belladonna, woods of the yew family, hogweed, lily of the valley should be recognised and require appropriate attention. In addition, abiotic hazards such as those caused by dead wood, fallen trees, storm damage, forest fire hazards, danger of wood piles and ongoing forestry work, and hunting must receive attention. For these reasons, it is important that a therapy session is led and supervised by a professional trained in forest therapy. Furthermore, mobility and behavioural restrictions of the patients have to be taken into account. Here, it is important to ensure that sufficient care and support is provided during the therapy session. Especially the healing and therapeutic forests are particularly suitable for forest therapy interventions [8]. In general, every forest therapy intervention in Germany requires permission for the therapeutic usage of the forest by the forest owner, supplemented by liability and safety agreements including an emergency concept [29].

Conclusion

So far, it could be shown that forest therapy has positive effects on mood, immune system, stress reduction, sleep hygiene, arterial hypertension, and general well-being. However, only few studies indicate favourable effects on stroke and dementia. Therefore, a proposal for forest therapy as a component of multimodal neurological rehabilitation is presented. A nature-based reha-

bilitation can be principally successfully implemented as shown by pilot studies on garden therapy and outdoor adventure interventions (wilderness therapy) in patients with brain damage (mostly after stroke). This therapy goes along with improvements in sensorimotor functions, cognitive function, and also quality of life [30]. Current “Handbook for Nature on Prescription to Promote Mental Health” gives important guidelines to implement nature as a new therapeutic tool [31]. Especially the newly published structural criteria for the development of certified recreational and therapeutic forests in Bavaria, Germany will strengthen forest therapy as a new innovative nature-based intervention for different disorders in certified forests [8, 29]. In conclusion, it can be assumed that forest therapy has a positive effect on health and well-being in patients in need of neurological rehabilitation based on complex interactions. It seems a cost-effective, easily accessible modality which can be implemented in a multimodal setting of rehabilitation. However, permission of the forest owner to use forests for therapy as well as liability and safety issues needs to be addressed [29]. Nevertheless, further studies are needed to prove the effectiveness of forest therapy.

Conflict of Interest Statement

The authors have no conflict of interest to declare.

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There are no funding sources to declare.

Author Contributions

The idea for this study, the literature searches, and the identification of suitable studies were done by Josef G. Heckmann and Gisela Immich. The first draft was written by Josef G. Heckmann, Gisela Immich, and Martin Kiem provided assistance on how to conduct the study and intellectual recommendations for the evaluation, interpretation, and discussion of the results. All authors read and agreed to the final manuscript.

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