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REVIEW ARTICLE

Nature-assisted therapy: Systematic review of controlled and observational studies

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Abstract

Background: Nature's potentially positive effect on human health may serve as an important public health intervention. While several scientific studies have been performed on the subject, no systematic review of existing evidence has until date been established. *Methods:* This article is a systematic evaluation of available scientific evidence for nature-assisted therapy (NAT). With the design of a systematic review relevant data sources were scrutinised to retrieve studies meeting predefined inclusion criteria. The methodological quality of studies and abstracted data were assessed for intervention studies on NAT for a defined disease. The final inclusion of a study was decided by the authors together. *Results:* The included studies were heterogeneous for participant characteristics, intervention type, and methodological quality. Three meta-analyses, six studies of high evidence grade (four reporting significant improvement), and 29 studies of low to moderate evidence grade (26 reporting health improvements) were included. For the studies with high evidence grade, the results were generally positive, though somewhat ambiguous. Among the studies of moderate to low evidence grade, health improvements were reported in 26 cases out of 29. ***Conclusions:*** **This review gives at hand that a rather small but reliable evidence base supports the effectiveness and appropriateness of NAT as a relevant resource for public health. Significant improvements were found for varied outcomes in diverse diagnoses, spanning from obesity to schizophrenia. Recommendations for specific areas of future research of the subject are provided.**

Key Words: *Biophilia, environmental psychology, evidence, horticulture, intervention, mental fatigue, stress*

Introduction

The premise for utilisation of nature in the treatment of diseases was addressed by Wilson more than two decades ago. His "biophilia hypothesis", that is "the innately emotional affiliation of human beings to other living organisms", spawned research which suggested that our relationships with nature are fundamental components of building and sustaining good health [1,2], and by disrupting the connection with nature (for example like in the case of urbanisation) our psycho-physical health might be altered and potentially damaged. There are several aspects and implications of biophilia, one of them being the therapeutic benefit that interaction with natural elements may have on human health.

Further perspectives on the connection between nature and health are mainly derived from psychology, particularly theories of landscape- and environmental psychology [3,4] many of which are concerned with the negative aspects of stress and mental fatigue to human beings and what natural environments can offer in order to reduce stress or attentional fatigue, and thereby induce health.

Empirically the use of natural environments for promoting health and preventing illness is rather well recognised. Medical/health geography [5], urban–rural differences in aspects of stress relief [6],

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the relationship between urbanisation and mental health [7,8], stress relieving effects of outdoor recreation [7], accessibility to nature [9,10], and how indoor as well as outside design of healthcare environments affect patients and their relatives [11,12] are all examples of areas concerned with the relationship between health and nature. In attempts to summarising findings of nature's health promoting impact three main kinds of public health effects have been identified: short-term recovery from stress or mental fatigue, faster physical recovery from illness, and long-term overall improvement on people's health and well being [13,14]. However, although natural spaces, gardening, and exposure to and interaction with natural environments are recognised as health-promoting settings, little is understood about the use of nature contact in treatment and rehabilitation for individuals experiencing ill health. The research on the subject of "natural treatments" has, until recently, been of a less rigorous character. Quite a few qualitative studies have been performed, but there is a lack of quantitative data and controlled studies. The theoretical models, on which to base research, are neither concisely defined nor utilised for testing and implementation [15].

The main question justifying this review is simply does any kind of nature-assisted therapy (NAT) have any effect on any health outcome? The review is an attempt to summarising and clarifying what natural environments and what activities with what elements (plants, etc.) are especially beneficial to health, as well as what patients, what medical conditions, and under what circumstances any NAT could be advantageous. Our aim was to systematically review the literature regarding effects of NAT, for patients with well-defined diseases, as a treatment option either alone, or together with other evidence-based treatment options.

Definitions

There is a wide array of different treatments that utilise nature as a means of achieving health goals, as well as many varied states of health or illnesses to which this method has been and is applied.

NAT is defined as an intervention with the aim to treat, hasten recovery, and/or rehabilitate patients with a disease or a condition of ill health, with the fundamental principle that the therapy involves plants, natural materials, and/or outdoor environment, without any therapeutic involvement of extra human mammals or other living creatures. Another umbrella term for denoting interventions that use elements of nature is "green care". However, this term has very broad implications, including also social rehabilitation or health promotion, and contains also animal-assisted therapy [16,17].

NAT can be broadly subdivided into social and therapeutic horticulture focusing on horticultural activities for therapeutic benefits (the term horticulture giving a broader perspective than the term gardening by encompassing the art and science of plant care, propagation, and study) and natural environments therapies that emphasise the provision of an environment and activities appropriate for the patients' needs. Common features of these relatively dispersed branches are the underlying themes and theories of nature and nature interaction as therapeutic.

Social and therapeutic horticulture In aspects of horticulture one may include garden therapy or horticultural therapy. The terms "horticultural therapy" and "therapeutic horticulture" are sometimes used interchangeably. However, a distinction between the two has been defined: "Horticultural therapy is the use of plants by a trained professional as a medium through which certain clinically defined goals may be met" and "Therapeutic horticulture is the process by which individuals may develop well being using plants and horticulture. This is achieved by passive or active involvement" [18]. There are also different terms describing gardens used for therapy. Horticultural therapy gardens, therapeutic gardens, and rehabilitation gardens are designed specifically for the use of patients, for the care and cultivation of plants as part of a treatment programme. Wandering gardens are specific gardens designed for patients suffering from Alzheimer's disease. Meditation gardens, restoration gardens, and healing gardens are all examples of gardens not primarily designed for specific therapeutic use [19].

Natural environments therapies Natural environments therapies consist of wilderness therapy and outdoor adventure therapy, both relatively specified therapies most widespread in Australia and in the USA. They have their origin in Outward Bound programmes introduced in the 1960s which are standardised programmes, but with no certain therapeutic aim. Adventure therapy is defined as a "generic term that refers to a class of change-oriented, group-based experiential learning processes that occur in the context of a contractual, empowering and empathetic professional relationship" [19,20]. The importance of physical contact with nature remains critical in most programmes. To define whether an adventure or wilderness programme is therapeutic or not, it has been suggested to consider the goals of the programme, the process or mechanism of change

employed, and the therapeutic environment or milieu in programmes [21]. These therapies constitute a particular spectrum of NAT and are in general more evaluated than other forms (for reviews see, for example, Cason and Gillis 1994, or Hattie et al. 1997 [22,23]).

Health outcome is defined as an indicator or measure of a patient's condition or progress. They can be subjective, such as self-reported mood disturbances and pain, or objective, such as blood pressure, intake of drugs, length of hospital stay, etc. Different types of patients/diagnoses are assessed with different measures. Outcome studies are of major importance in medical research since they provide a sound and accepted basis for evaluating treatments as medically beneficial and cost-efficient. Outcomes can broadly be categorised to be of curative (patient expected to be cured from the current disease), rehabilitative (patient expected to *improve* and achieve maximum functioning), supportive (patient is expected to function semi-independently), or enrichment (patient is expected to respond with improved quality of life) character. Because of the wide range of programmes using NAT for a wide range of outcome goals it should be useful to provide a framework for considering the specific treatment goals of NAT. For treatment purposes of NAT the goals can be divided into psychological, intellectual, social, or physiological or physical outcomes, or outcomes concerned with recidivism [15,24].

Technical background concerning methodology of available evidence

Actions have been taken to increase the scientific knowledge on the best practices for implementing nature and nature-related activities with the aim of improving public health. Frumkin [25] stated that there is a need for "clinical epidemiology of horticulture", horticultural therapy being one of the main therapy forms in the area. The area has also claimed higher actuality and priority in the backwater of climate change and other environmental issues, and there have been calls for clinical and educational services to act to providing evidence of nature's impact on health in order to recognising and demonstrating the interdependence between healthy people and healthy ecosystems [26,27]. A number of specific difficulties for this urge of rigid research design have been listed by Sempik [28], for example the recruitment of sufficient participants for a study of adequate power (assuming that the response to NAT is likely to be rather small and consequently a relatively large sample size would be required to demonstrate an effect). There is also the problem of treatment integrity since, as mentioned above, there are many diverse alternatives of NAT. Unfortunately many approaches within NAT are loosely defined. Neither is it clearly defined which outcome measures are the most appropriate for use in research or which study population is likely to be most responsive.

In Cochrane reviews of therapeutic interventions, most high-quality studies could be identified by searching four standard databases – CENTRAL, Medline, Embase, and Science and Social Sciences Citation Indexes [29]. However, when the evidence is more complex and derived from qualitative as well as quantitative studies the sources are usually more disparate. In systematic reviews of complex evidence it has been found that only 30 % of the sources were obtained from the original protocol and the rest from either "snow-balling" (pursuing references of references) or personal knowledge or contacts [30]. This indicates the importance of being aware of the increased outcome for example serendipity discoveries (like finding a relevant paper when looking for something else) may yield when investigating and summarising a broad and heterogeneous subject. In order to provide sensitivity to the search it may not be sufficient to solely rely on predefined, protocol driven search strategies. No aspect of NAT has until date been treated in any Cochrane review.

Methods

In this systematic review we have collected evidence regarding interventional therapies utilising NAT as defined above. By using the methods recommended by the Cochrane Handbook for Systematic Reviews of Interventions we have used an explicit and systematic method [31]. However, as a consequence of the above mentioned inherent difficulties of exploring such a heterogeneous subject, we have widened the scope sometimes outside the protocol, e.g. by using "snow-balling", in order to render as much adequate information as possible.

The literature search was carried out in several steps from September 2008 to May 2009. First prior reviews of related subjects were scrutinised for relevant evidence. Both simple annotated bibliographies and systematic reviews based on literature scans were included in this search.

As a second step electronic search in five databases (PubMed, Scopus, CSA Illumina, Agricola, Web of Science), and three specialist registers (Cochrane, CENTRAL, CRD) was carried out (Table I).

Table I. Electronic databases or registers searched.

Database	Searched in
PubMed	MeSH terms, title, abstract
Scopus	Title, abstract, keywords
Web of Science	Topic
CSA[a]	Key words
AGRICOLA[b]	Key words
Cochrane	Title, abstract, key words
CENTRAL	Key words
CRD[c]	Key words

[a]ASFA (Aquatic Sciences & Fisheries Abstracts), ASSIA (Applied Social Sciences Index and Abstracts), BioOne Abstracts and Indexes, BioOne Full-text, EconLit, Oceanic Abstracts, PAIS (Public Affairs Information Service) International, PILOTS (Published International Literature on Traumatic Stress Database), PsycINFO.
[b]NAL (National Agricultural Library) Catalog, Article Citation Database.
[c]Centre for Reviews and Disseminations.
Search limitations in certain databases: PubMed: Only clinical trials, randomised controlled trials, meta- analyses, or reviews. Only humans. Only English. No limitations concerning gender, age, or subsets; Scopus: Only articles or reviews. Restricted to the subjects of medicine, social sciences, nursing, health professions, multidisciplinary, undefined, and psychology. English. Only papers dated from 1980 and after; CSA: Only peer-reviewed journals. Only English. Only papers dated from 1980 and after; Web of Science: Only articles or reviews. Only English. Limited by subject areas when necessary and/or relevant.

The website of AHTA (American Horticultural Therapy Association, www.ahta.org) was also searched.

Key words focusing on elements of population (any disease), intervention (nature-assisted), and outcome (e.g. rehabilitation) were used for this search (Table II). The search terms were considered among keywords, topic, title, abstract, or MeSH (Medical Subject Headings) - terms. The primary search terms were searched alone, or in combination with AND or OR and the secondary search terms.

Finally we inspected bibliographies of identified studies for other relevant studies. We aimed at high sensitivity, and could for reasons stated above not stick solely to our predefined search protocol, but used all imaginable sources to obtain as much information as possible. This resulted in rather low precision in our first yield, as is reflected by the number of hits (Figure 1). Titles and abstracts of articles identified by the searches were reviewed by the authors. For all the studies described in this review at least the abstract was retrieved, and if fulfilling the inclusion criteria, the entire article.

Table II. Search terms used in the electronic search.

Primary search terms	Additive terms (AND/OR)
"Horticultural therapy"	Well being
"Nature assisted therapy"	Health
"Therapeutic landscape OR environment OR nature OR setting"	Restoration
"Green care"	Recovery
Wilderness	Rehabilit*
Adventure	Healing
Garden*	Therap*
Horticultur*	Intervention
"Nature based"	Treatment
"Nature assisted"	Stress
Sociohorticultur*	Mental/psychiatr*
Ecotherapy	Disease*
Tree*	Illness*
Plant*	

*Indicates wild card, i.e. any ending is possible.

Inclusion criteria

Studies of the following types were considered for the review:

- systematic reviews and meta-analyses of randomised controlled trials
- randomised controlled trials
- non-randomised intervention studies
- observational studies
- qualitative studies.

The studies meeting the inclusion criteria were:

- reporting results of a scientific intervention study
- on nature-assisted therapy as defined above
- with any design described above
- available via any of the electronic databases described in Table I, or else from other sources as described above
- found via any of the key words described in Table II
- written in English
- including patients with a disease as defined by the International Classification of Diseases (ICD 10, International Classification of Diseases, version 2007, WHO), or otherwise a well defined state of ill health
- published between 1980 and May 2009.

To be included one or several defined end-points of the treatment were to be described in the study. We excluded case studies and studies merely concerned with health promotion or purely disease prevention. Studies containing merely a description of a certain model of NAT, but with no quantitative or qualitative data on a defined study population, were excluded.

Trials with NAT on populations of "older", "inmates", or "adolescents" were not included, nor those reporting results from merely recreational

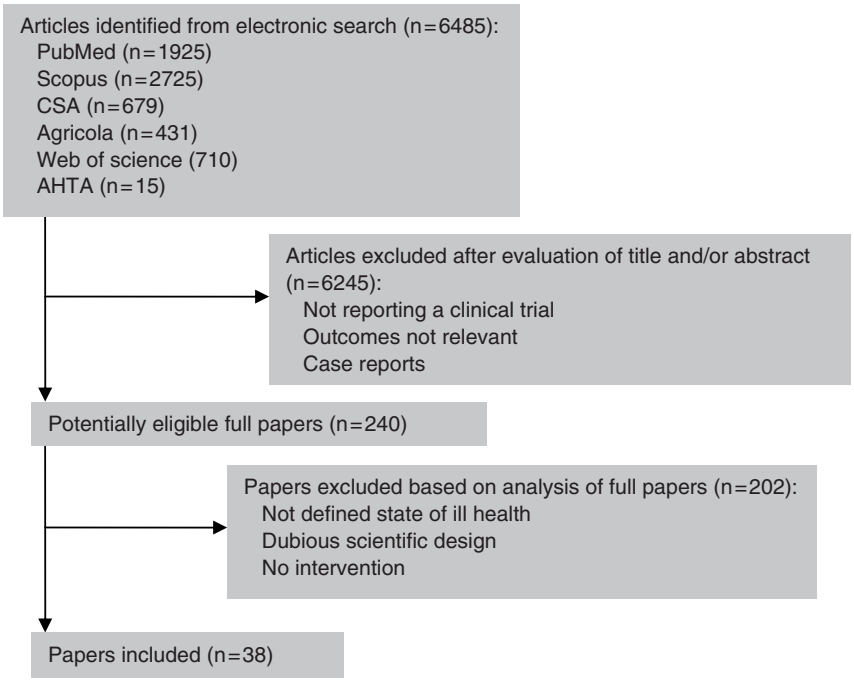

Figure 1. Process of study selection.
Note: Some approximations have been necessary in the estimation of numbers of identified studies, partly due to overlap, but also due to extended serendipity search.

activities in a mixture population. We did not exclude trials due to age, nationality, or gender of participants. No study-type search filters were used. Studies of animal-assisted therapy were not included.

Quality assessment

The assessment of the validity of the findings and the methodological quality of the included studies were performed according to the GRADE system (www.GradeWorkingGroup.org) by both authors.

Data extraction

We used a standardised data extraction sheet to ensure a controlled analysis and data-retrieve from each article included. Disagreements concerning whether to include an article or not were resolved by consensus. All data were extracted from the published studies, and there were no needs to contact any of the authors for complementary information.

Results

Study characteristics

Due to overlap, i. e. the same titles appearing in different databases, it was difficult to determine the exact number of initial hits. However the approximate amounts are listed in Figure 1, with the results for each database or register presented respectively. After screening numerous potentially relevant documents, we finally included 38 full text documents in the review (Table III), whereof three represented systematic reviews and meta-analyses, six randomised controlled trials, 12 non-randomised intervention trials, 14 observational studies, and four qualitative studies.

States of ill health

The states of ill health in the included studies can be grouped into varied kinds of mental disorders, including substance abuse or addiction, dementia, behavioural disturbances, and varied physical disorders (e.g. cancer, obesity, hearing impairment, and other handicaps).

Types of interventions

The varied kinds of interventions offered in the different studies can be grouped according to the categories of NAT, with the addition of other treatments presented in cases of control groups.

Table III. Studies included in the review.

A: Systematic reviews and meta-analyses of randomised controlled trials

Study	Intervention	No. of studies included	End points	Follow-up time	Results
23	Wilderness programmes, adventure programmes, outward bound	96 (15 on patients) (12,057 clients)	1728 effect sizes based on 151 unique samples, 40 categories of outcomes	1–120 days ($\mu = 24$)	Average effect size = 0.34
22	Outdoor adventure programmes	43 (11238 adolescents)	147 effect sizes, 19 outcome measures, 7 categories	Not clear	Average effect size = 0.31
44	Wilderness challenge programmes for delinquent youths	28 (>3000 patients)	60 effect sizes, 6 outcome constructs	Not clear	Average effect size = 0.18

B: Randomised controlled trials

Study	Intervention	Participants	End points	Follow-up time	Results
59	Regular garden walks with guidance	$n = 40/20$, Mild/moderate depression	Depression, interview	6 weeks	NS
33	HT according to Kaplan	$n = 22/22$, CP, children	AAMD	10 weeks	NS
34	HT (including practical gardening)	59/48 post-CS, MI + CHF patients	POMS, heart rate	Direct after intervention	S. improved, s. improved
60	Home-based 120 min exposure to nature	$n = 83/74$ newly diagnosed breast cancer	Capacity to direct attention	After surgery	S. improved
45	3 days wilderness experience	$n = 8/8$ behaviourally disordered adolescents	Aggressive and cooperative behaviour BPC, modified JEQ, direct observations	5 days after, 1 month after	S. improved cooperative behaviour at short-term follow-up, NS impact at 1 month follow-up, NS results on other parameters
46	CBT + PEAT 16 weeks, CBT + EXER 16 weeks (contr.)	$n = 37/39$ obesity	Weight loss (body mass index), SPPA, CPSPP, SSSCA, PEQ	Direct after 16 weeks, 10 months	S. better weight loss after 10 months in PEAT ($\mu = 5.5$ kg), No s. differences in psychosocial variables, equal improvements in both groups, s. higher treatm. satisfaction in PEAT

C: Non-randomised intervention studies

Study	Intervention	Participants	End points	Follow-up time	Results
36	Horticultural	$n = 25/25$ chronic schizophrenia	RCS, SBS, SES, SCL-90-R	5 months	S. improved, s. improved, s. improved, s. improved for depression, anxiety, and interpersonal sensitivity
35	HT 2 hours/week, 12 weeks	$n = 12/11$ depressed	SES, ZDI	3 months	S. improved, s. improved
41	Integrated programme (HT + adventure therapy programme + 12-step addiction recovery	$n = 13/18$ alcoholism, drug abuse	DRIE, stress-arousal, alcohol craving, problem solving, negative thoughts	10 months	S. improved autonomic arousal, frequency of negative thoughts, and alcohol craving. 31 % relapse in exp. group and 58 % in the control group

47	Wilderness therapy, group therapy	$n = 858$ varied DSM-IV diagnoses[a]	Y-OQ, SR Y-OQ	12 months	S. improved behaviour in the parent-reported as well as self-reported sub scores in the Y-OQ and SR Y-OQ
49	Adventure therapy programme (Going beyond)	$n = 23/31$ schizophrenia, schizoaffective	GAF, PANSS, ASIS, SSTICS, SIP, weight	Direct after intervention + 12 months	S. improvements in GAF, ASIS, SIP, SSTICS, s. weight loss
81	Integrated wilderness therapy	$n = 16/37$ avoidant personality disorder	SCID-II, SCL-90, BDI, IIP, PARS, PDQ4+, Self-Efficacy Inventory Measure	Direct after + 12 months	NS
50	Wilderness therapy	$n = 48/30$ chronic mental disorders	Staff personal and social functioning instrument, patient personal and social instrument	Directly after + 3 weeks	S. improvements in formal and informal social interactions, s. improvement in motivation and optimism to learn, s. decreased psychiatric symptoms
82	Outward bound experience as an adjunct to inpatient PTSD treatment	$n = 108/111$ PTSD	Mississippi scale, IOE, HAM-D, HAM-A, SCL-90, GSI, LOC, state trait anxiety scale	After treatment	NS
48	8 days adventure programme	$n = 23/12$ schizophrenia, ment. retard. pers. dis. multiple disab.	CooperSmith self-esteem inventories, internal-external, locus of control scale	Directly after, 3 months, 1 year	S. improvements directly after, NS at follow-up
51	10 days outdoor adventure education	$n = 10/10$ hearing impaired	C-FS-EI, SDSS-C	Directly after, 2 months	S. improved self-concept, maintained at follow-up.
52	9 days outward bound follow-up group work for 3–4 months	$n = 14/8$ ABI	Q OLI, psychosocial adjustment to ABI	6 months or 2 years	S. improved scores on Q OLI, 2 years s. improved psychosocial adjustment
53	9 week therapeutic outdoor adventure	$n = 57/19$ schizophrenia, affective or schizoaffective, other psychiatr. sy.	S-ES, PS-ES, GS-ES, RSEI, S-TAI, BDI, BSI, TCS, MLoCS	Last day of treatment	S. improved, s. improved, s. improved, NS

D: Observational studies

Study	Intervention	Participants	End points	Follow-up time	Results
42	HT+psychotherapy	$n = 33$ drug addicts	SCL-90-R, CRAVE, FSRQ, GESS	6 months	Reduction in psychotism, in the other 11 scales NS, s. improvement in 8/12 scales (arousal, affect etc.), NS changes

(continued)

Table III. Continued.

A: Systematic reviews and meta-analyses of randomised controlled trials

Study	Intervention	No. of studies included	End points	Follow-up time	Results
40	HT, 1 hour day/6 weeks	$n = 13$ mixed psychiatric	Self-esteem, stress reduction, mood, etc.	6 weeks	Subjectively reported overall improvement
38	HT activities regularly	$n = 14$ dementia	Behaviour, affect (DCMS)	9 weeks	Improved, improved
37	HT, 9 weeks scheduled	$n = 48$ dementia	Engagement, affect	During programme	S. improved level of engagement, s. improved mood
39	HT, 3 times/week, 10 weeks	$n = 9$ dementia	Activity, engagement, affect (DCMS)	10 weeks	Improved activity level, improved in productive behaviour after 8 weeks, NS changes
43	HT+cooking activities	$n = 15$ dementia	Observed benefits, ability to complete HT activities	9 weeks	Improved, improved
61	Viewing and spending time in a garden	$n = 34$ dementia	Mood, agitation (CMAI), PRN, QoL	12 months	Improved mood, medium–high improvement, improved, improved
62	Walks in a botanic garden	$n =$ ND	Perceived stress	Immediately after	Improved (?)
54	21-day wilderness therapy, family work + counselling	$n = 124$ drug abusers, mood disorders, anxiety	Family function, adolescent behaviour, adolescent mental health, school success, social relationships	2+12 months	S. improved 2 + 12 months later, s. improved 2 + 12 months later, s. improved 2 + 12 months later, s. improved 2 + 12 months later, s. improved 2 + 12 months later, 12 months results less robust
55	10–13 day wilderness therapy, backpacking trip, counselling, group therapy	$n = 23$ adolescents involved in mental health counselling	Locus of control, self-efficacy, self-esteem, behavioural symptoms	Immediately after	NS, s. improved, s. improved, s. improved
58	3 day adventure programme, sledging trip	$n = 14$ developmental disabilities, traum. brain injury, bipolar dis.	Perceived leisure control scale	Directly after	NS
57	7 weeks wilderness therapy	$n = 93$ mood disorders, disruptive behaviour substance abuse	Adolescent attachment questionnaire, inventory of parent and peer attachment	Directly after	S. less anger, no other s. improvements
56	22 days wilderness treatment including group and individual therapy	$n = 91$ substance use disorders	Relapse, AA/NA- participation, legal problems, well being, rehospitalisation	12 months	S. reduced (compared to 1 year before treatm.), s. improved well being, 38% attending AA/NA regularly, 47% maintained complete abstinence from drugs

E: Qualitative studies

Study	Intervention	Participants	End points	Follow-up time	Results
83	HT	$n = 14$ neurological disorders	Perception of the programme	During activities	The participants described the garden as beneficial, productive, voluntary, and complicated, Beneficial for activity and functional ability
84	10 days adventure therapy	$n = 11$ pediatric cancer	Quality of life	During activities	Videotapes and interviews showed positive experiences, developing connections, togetherness, rebuilding self-esteem, creating memories
85	6 weeks (2 days/week) horticultural programme	$n = 10$ chronic mental illness	Quality of life	Directly after	Overall improved QoL as perceived by the participants and the researchers who participated in the programme
86	Same as 13	$n = 78$, $n = 88$ (parents)	Well being, school performance, communication, social interactions, substance use, legal troubles parents' perspective and assessing role of after care	24 months	Overall positive, including parents perspectives, communication better, school performance better, well being better, substance use still an issue, but more controlled, legal troubles still an issue, Aftercare considered as crucial

Sample size is described as experiment group/control group.

[a]A randomly sampled group of 99 respondents were included in the 12 month follow-up examination.

Dis., disorder; Pers., personality; Disab., disability; Ment. retard., mental retardation; Treatm., treatment; ND, not described; NS, not significant; s., significant on at least 0.05 level.

AA, Alcoholics Anonymous; AAMD, American Association on Mental Deficiency Adaptive Behavior Scale for Children and Adults; ABI, acquired brain injury; ASIS, Adult Self-Image Scale; BDI, Beck Depression Inventory; BPC, Behaviour Problem Checklist; BSI, Brief Symptom Inventory (Anxiety and depression subscale, Interpersonal and hostility subscales); CBT, cognitive behavioural treatment; C-FS-EI, Culture-Free Self-Esteem Inventory; CHF, congestive heart failure; CMAI, Cohen Mansfield Agitation Inventory (short form); CP, cerebral Palsy; CPSPP, Children's Physical Self-Perception; CRAVE, Comprehensive Review of Addiction Variables; CS, cardiac surgery; DCMS, Dementia Care Mapping Scale; DRIE, Drinking Related Locus of Control; EXER, aerobic exercise; FSRQ, Frequency of Self-Reinforcement Questionnaire; GAF, Global Assessment Functioning; GESS, Generalised Expectancy for Success Scale; GS-ES, Generalised Self-Efficacy Scale; GSI, Global Symptom Index; HAM-A, Hamilton Anxiety; HAM-D, Hamilton Depression; HT, horticultural therapy; IIP, interpersonal problems; IOE, Impact of Events Scale; JEQ, Jessor Expectancy Questionnaire; MI, myocardial infarction; MLoCS, Multidimensional Locus of Control Scale; NA, Narcotics Anonymous; PANSS, Positive and Negative Syndromes Scale; PARS, Phobic Avoidance Rating Scale; PDQ4+, Personality Diagnostic Questionnaire; PEAT, peer-enhanced adventure therapy; PEQ, Peer Experiences Questionnaire; POMS, Profile of Mood States; PRN, (pro re nata), use of "as needed" medication; PS-ES, Physical Self-Efficacy Scale; PTSD, post-traumatic stress disorder; QoL, quality of life; Q OLI, Quality of Life Inventory; RCS, Relationships Change Scale; RSEI, Rosenberg Self-Esteem Inventory; SBS, Social Behaviour Scale; SCID, Statistical Clinical Interview for DSM-IV; SCL-90-R, Symtom Check List 90 – revised version; SDSS-C, Semantic Differential Scale of Self-Concept; S-ES, Self-Efficacy Scale; SES, Self-Esteem Scale (Rosenberg); SIP, Sickness Impact Profile; SPPA, Self-Perception Profile for Adolescents; SR Y-OQ, Self-reported Youth Health Outcome Questionnaire; SSSCA, Social Support Scale for Children and Adolescents; SSTICS, Subjective Scale to Investigate Cognition in Schizophrenia; TCS, Trust and Cooperation Scale; Y-OQ, Youth Outcome Questionnaire; ZDI, Zung Depression Inventory.

Horticultural therapy (HT) Diverse descriptions/definitions of this intervention included varied institutions' more or less specified approach (described as e.g. performing horticultural activities in gardens, HT in combination with psychotherapy, Montessori-influenced HT, procedure of HT based on Kaplan's theories). However all programmes involved horticultural activities with plants and nature and all were under supervision of a trained professional. This review was mainly concerned with horticultural therapy (implying that the therapy was directed towards a pre-defined clinical condition), rather than therapeutic horticulture (more generally directed towards improving well being, not always with a defined clinical goal). The programme duration and number of interventional sessions during one programme varied a lot between the studies.

Wilderness therapy Diverse wilderness programmes, adventure programmes, or outward bound programmes with or without group therapy, family therapy, peer enhancement, or cognitive-behavioural treatment were considered. The programmes were of varied length and varied group sizes.

Nature-assisted therapy with no further specification Viewing or spending time in garden, walking in a botanical garden, home-based exposure to nature are examples of these therapies.

Treatments for comparison (in case of control groups) These consist of: no certain treatment or activity, Haymarket Relapse Prevention Program (alcohol and drug treatment programme), activities in ordinary living rooms, art therapy, cognitive stimulation games, exercise, craft working and current events discussions, standard care for schizophrenia with recreational activities, group programmes, relaxation training programmes, and aerobic exercise.

Types of outcome measures:

The goals of NAT are sometimes described in less technical terms than what is usually the case in medical intervention studies. In an attempt of systemising the varied goals of outcome and the outcome measures we slightly modified a classification suggested by Relf [32] for plant- and animal-based health programmes, according to the list below (for some outcomes there is an inevitable overlap between the classes. For example we chose to list outcomes concerned with addiction and stress in the physiological category, though they could of course as well have belonged to the psychological group): (1) Psychological outcomes: independency, confidence, self-efficacy, well being, quality of life, self-understanding, neurosis reduction, emotional stability, reduced aggression, internal locus of control, reduced symptoms of depression, mood, frequency of negative thoughts, and agitation level; (2) Intellectual outcomes: capacity to direct attention, increased problem solving, learning new skills, communication, and school success; (3) Social outcomes: level of engagement, behaviour, cooperation, relating skills, social competence, attitude, school attendance, socialisation, family function, legal problems, and parents' perspectives; and (4) Physiological and physical outcomes and outcomes concerned with recidivism: vulnerability and resistance to addiction, alcohol craving, stress level, stress arousal, heart rate, body mass index, rehospitalisation, and reoccurrence of disease.

Effects

The effects reported are all indicating response to treatment as measured immediately after intervention, in case of long-term follow up this is noted particularly.

1. Effects of interventions defined as merely horticultural therapy No systematic reviews of horticultural therapy as intervention met the inclusion criteria. Two randomised controlled trials were included; one showing no significant effect [33], the other with significantly improved results on Profile of Mood State (POMS), and heart rate [34]. In the non-randomised intervention studies [35,36], most end-points were significantly improved at follow-up time 5 and 3 months respectively. Four observational studies reported improved results, in one of them significant improvements were estimated on level of engagement and mood [37]. In the other three the results were not reported as significant [38–40] at 6, 9, and 10 weeks follow-up respectively.

2. Effects of interventions defined as horticultural therapy in combination with other forms of therapy There were neither any systematic reviews nor randomised controlled trials of combined horticultural therapy that met the criteria to be included in the review. Among the non-randomised intervention studies one study of an integrated programme of HT, adventure therapy programme, and 12-step addiction recovery [41] reported significant improvements in autonomic arousal, frequency of negative thoughts, and alcohol craving at 10 months follow-up. Two observational studies, HT combined with psychotherapy [42], and HT combined with cooking activities [43], reported

significant improvements in reduced psychoticism and in eight of 12 subscales of Comprehensive Review of Addiction Variables (CRAVE) [42] at 6 months follow-up, and observed benefits and improvements in ability to complete HT activities (not reported as significant) [43] at 9 weeks follow-up.

3. Effects of wilderness or adventure programmes Three meta-analyses concerned with wilderness programmes were included [22,23,44]. The effect sizes were 0.34, 0.31, and 0.18 on 40 categories, seven categories, and 60 categories of outcomes respectively. The follow-up times were on average 24 days [23], or not clearly defined [22,44]. Two randomised controlled trials of wilderness/adventure therapy were included. One demonstrated significantly improved cooperative behaviour at short-term follow-up [45], but no significant change at 1 month follow-up, and the other trial proved significantly better weight loss at 10 months follow-up as well as significantly higher treatment satisfaction compared to control group [46]. One non-randomised intervention study of wilderness therapy in combination with group therapy reported significantly improved behaviour and improved scores in Youth Outcome Questionnaire (Y-OQ), and Self-Reported Youth Outcome Questionnaire (SR Y-OQ) [47] at 12 months follow-up. One other non-randomised study of outward bound treatment in combination with inpatient Post Traumatic Stress Disorder (PTSD)-treatment revealed no significant improvements [48]. Six non-randomised studies reported significant results at 1 year follow-up [49], 3 weeks follow-up [50], directly after [48], after 2 months [51], 6 months or 2 years [52], and immediately after [53]. One observational study of wilderness therapy, family work, and counselling reported significant improvements in several aspects – family function, adolescent behaviour, mental health, school success, and social relationship at 2 and 12 months follow-up, though the 1 year follow-up results were less robust [54], two other wilderness programmes in combination with group therapy showed mainly significant improvements [55,56] immediately after, and after 12 months follow-up respectively. The other two observational studies showed no significant results [57,58], except from significantly less anger [57].

4. Effects of loosely defined nature-assisted interventions Two randomised controlled trials reported results of regular garden walks with guidance [59] and home-based 120 minutes exposure to nature [60]. The former showed no significant improvements, the latter reported significantly improved capacity to direct attention. One observational study reported improved mood, Cohen Mansfield Agitation Inventory (CMAI), Pro Re Nata (PRN), and Quality of Life (QoL) after viewing and spending time in a garden [61] at 1 year follow-up. The other observational study reported unclear results of walks in a botanical garden [62].

5. Effects on different outcomes Altogether most significant results were reported on clinical scales. For the treatment purposes stated by Relf [32] we found 13 significant improvements for psychological goals, six for social goals, four for physical goals, and finally two for intellectual goals.

6. Effects on different populations/diagnoses Several of the studies evaluated the effects of NAT to numerous different diagnoses (Table IV). Most studies reported outcomes of NAT on schizophrenia, whereof five

Table IV. States of ill health in the included studies.

Category	Diseases
Generally psychiatric	Depression, chronic schizophrenia, schizoaffective, bipolar disorder, mood and anxiety disorders, behavioural disturbance, personality disorders
Substance abuse	Alcoholism, other substance abuse or addiction
Stress related	Post-traumatic stress disorder, mental fatigue, attentional fatigue
Adolescence problems	Juvenile delinquency, antisocial behaviours, disruptive behaviour diagnosis, mood disorders, substance abuse
Ageing	Dementia
Somatic disorders and developmental disabilities	Physically handicapped, multiple disabilities (e.g. orthopaedic), hearing impairment, breast cancer, paediatric cancer, cardiac surgery, myocardial infarction, congestive heart failure, cerebral palsy, obesity, developmental disabilities
Others	Attachment- and adjustment disorders, opposition defiance, conduct disorders, cognitive impairment, emotionally handicapped

showed significant improvement and one was unclear. Five studies reported outcomes of NAT on populations with dementia, four of them showing improvements (two defined as significant), and one reporting no significant change. Four studies of depressed patients were included – one of them reporting significant positive results, the others showing no significance. Two studies of schizoaffective patients reported significant improvements. For alcoholism and other substance abuse the results were significantly positive in five studies. Other diagnoses, for which there were found significant improvements on diverse outcomes, were mood and anxiety disorders, behavioural disorders, acquired brain injury, youth delinquency, mental retardation, personality disorders, and hearing impairment. For the group of patients with newly diagnosed breast cancer and the group with cardiac failure (post cardiac surgery, myocardial infarction, and congestive heart failure) the positive results of NAT were significant on capacity to direct attention and POMS/heart rate, respectively.

7. Effects described in meta-analyses Three studies reported meta-analyses of NAT, all of them in aspects of wilderness/adventure therapy. The average effect sizes for all measured outcomes (like self-concept, self-confidence and locus of control) provided from these studies were 0.34, 0.31, and 0.18 respectively. One of the meta-analyses [23] included a follow-up measure, revealing even further effects of the therapy (average effect size = 0.17), with the highest effect size score for aggression reduction among multiple groups (effect size = 0.72). An exceptional effect size (1.05) was reported for "clinical scales" used with adolescents [22]. Especially clinical scales of depression and anxiety revealed the most statistically significant effect. In the same study [22], it was estimated that adolescents participating in adventure treatment were better off than 64 % of those who did not participate (control groups). It was also found that the longer the programme the more positive the result. In the study with the lowest reported average effect size [44], it was however considered significantly proved that wilderness programmes are effective for reducing antisocial and delinquent behaviour among adolescents.

8. Adverse effects and economic evaluation One study [52] reported number of "critical incidents" per child per day in a wilderness therapy programme. The critical incidents were defined as verbal or physical attacks, harming oneself or another, running away, or refusing to cooperate. Thus this was not a true adverse-effects outcome, but at least to some extent gave a measure of negative effects experienced in an NAT. Another article, focusing merely on risks acquainted with wilderness treatment of adolescents [63], found a remarkable low risk incidence in wilderness treatments, even lower than going on a general summer adventure camp, without connection to any treatment. In our study of included articles we have noted few risks to health.

Only one study considered the cost–benefit perspective [16] and reported a cost effectiveness of a therapeutic adventure camp as compared to hospitalisation for chronically mental ill patients. No other reports of cost–benefit analyses were found.

Discussion

Principal findings

In aspects of effectiveness and utility we found evidence from some studies that NAT can have significant effect on psychological, social, physical, and intellectual therapeutic goals in diverse patient categories, with significantly reduced measurable symptoms of disease. For the more rigid designs (high-evidence grade) the results were generally positive, though somewhat ambiguous (two out of six showing no significant result of the treatment). Among the non-randomised trials (moderate to low evidence grade), the observational studies, and the qualitative study, health improvements were reported in 26 cases out of 29. There was a general tendency of more positive results reported immediately after treatment compared to follow-up. The three meta-analyses showed modest effect sizes (considering an effect size of 0.20 as small, 0.50 as moderate, and 0.80 or greater as large [64]) of wilderness therapy. No kind of intervention was reported to be associated with any negative effects.

Due to lacking information about cost-effectiveness no conclusions can be drawn on this aspect.

Strengths and weaknesses of the review

This review provides a comparative inclusivity. The searching procedure was broad and evidence was searched for in diverse fields, from diverse sources. In combination with our wide inclusion criteria, enabling collection of proof of any potential approach to NAT, this diminishes the risk for overlooking any important evidence. However we may still have missed some relevant evidence because of poor indexing in some databases (especially concerning wilderness and adventure therapy), and due to the fact of varied terms to describe different forms of NAT and a broad vocabulary in general, complicating the search process and augmenting the risk for

neglecting some relevant key words. Although we made an intensive effort to achieve all papers potentially relevant, for a few cases it turned out impossible to access the original article.

There is also a risk by searching from diverse sources, instead of keeping strictly to selected databases. The comprehensiveness of the very search process becomes more difficult to assess and it is hard to describe it in a manner that makes it completely replicable. However, we found this approach the most relevant one, in regard of the specific complex intervention characters. Because of the heterogenic character of interventions, outcome measures, and of studies examined we were not able to pool our results and generalise any estimate of effect size, but preferred to present our findings in tables and discuss the results.

We were also restricted by including only studies with a defined population with a defined state of ill health. This made us unable to examine data of specific health benefits in more general studies, without any specified disease, concerned with relation between nature, environment, and health.

Our restriction to include only articles published in English may have resulted in some shortcomings, since a few studies of NAT have been performed in Japan and Korea [e.g. 65], but not translated to English. However to our knowledge the number of articles meeting the inclusion criteria except for the language (English) is not high and we believe that the final outcome of the review would not have been changed to any substantial degree.

Any conclusion from a literature review, including this one, is also destined to undergo the issue of publication bias, as it is expressed by the tendency from researchers and editors to submit and publish manuscripts with positive study findings. We are aware of this risk, and it needs to be integrated in the interpretation of the results from this review. Due to the complex and broad field of studies, as well as the lack of traditionally performed clinical trials included in the review it was difficult to apply any control or prevention method for this bias, like examination in a funnel plot [66], or a search through trial registries [67], or for unpublished trials [68]. However, since the search process was of an inclusive character it would still be relevant to believe in the general positive tendency of the results.

Concerning other possible bias effects at least the outcome reporting bias seems to be rather small. In most cases the varied outcome measures were reported in the studies' results, whether they were positive or not.

In general it is important to be aware that, as in any systematic review, our planning process and our choice of key words and inclusion criteria may indeed have affected the outcome; hence there is always a risk for some subjectivity. For example we did not extract data about age or gender from the articles, and an analysis of subgroups based on these variables might add some knowledge to the field. Further attempts to systematically review the literature of NAT should be encouraged, in order to address slightly different aspects of the subject as well as making comparisons between reviews possible. This would also increase the comprehensiveness of the literature search, by facilitating an indirect evaluation and comparison between search yields.

Strengths and weaknesses of the available evidence

The main weakness in the available evidence of NAT is shortly the study design and hereby the grade of evidence. Even though quite a lot of research has been reported on the association between human health and environment, only a few have been defined in a strict therapeutic or intervention pattern. Among these many are insufficiently sound or too poorly reported to permit evaluation. To our knowledge, scarcely any systematic research has previously been performed into the effectiveness of stated goals of NAT for specific patient populations. In one of the randomised controlled trials proving significant results [34], the control group was not exposed to any treatment at all, augmenting the risk for bias due to sense of neglecting in the control group. In another randomised controlled trial [33] the population consisted of a limited and homogenous population, resulting in a risk for selection bias. Due to the relatively new/modern research area the amount of studies meeting inclusion criteria was rather small. Other common limitations in some of the selected studies, mainly in aspects of study quality, were small samples, poorly validated instruments for measuring outcomes, vaguely defined methods and interventions, statistical models not incorporating factors that may lead to indirect selection (like socio-economic status), no power analyses, no information about side effects or safety issues, and varied degrees of subjectivity in the interpretations of results. Another frequent problem is that the results reported were often short term.

From the included articles it is also difficult to draw any conclusion of what are the underlying explanatory mechanisms behind NAT's functionality and why certain programmes or therapies are more efficient than others. This is often rather vaguely discussed and no determined explanations are given. For HT there exist theoretical fundaments (within the discipline of environmental psychology).

For wilderness therapy we have not found any comparable accepted psychological theory, but it has been considered as integrating, to varied extent, concepts from Adlerian therapy, reality therapy, and behavioural therapy [69]. Some of the characteristics of effective wilderness therapy (e.g. development of trust, in an order of physical trust preceding emotional trust, and problem-solving) are fraught with challenge (on the concept "challenge by choice") [70], and stress [48]. Considering these factors as motivators for personal development, the wilderness therapy may engage a therapeutic process to prompt individual change and growth. When NAT has been compared to indoor institutional treatment, it has been reported that the very act of moving patients outside has a large effect [71], something that would also support a theory of nature as beneficial itself, or at least bolstering any other therapy.

Nevertheless, in comparison with many other alternative methods in health care, the available evidence of NAT is often of a higher quality. In addition the area is broad and complex and does as such provide dynamic evidence from diverse disciplines.

Complex intervention

Considering NAT as a complex intervention (including several interconnecting components) would be in accordance with the view of the Medical Research Council's (MRC) guidelines [72]. Thus, the certain difficulties associated with this kind of therapy, like documenting and reproducing the intervention, must be recognised. Aspects of this have been thoroughly examined and analysed by MRC ("Developing and evaluating complex interventions: new guidance", downloaded 2009–03–24 from www.mrc.ac.uk/complexinterventionsguidance). Several dimensions of complexity have been documented, e.g. number of and interactions between components, number and variability of outcomes, and degree of flexibility or tailoring of the intervention permitted. MRC's recommendations for development and evaluation of complex interventions are:

(1) to provide a good theoretical understanding of how the intervention causes change
(2) a thorough process evaluation to identify any implementation problems
(3) sample sizes may need to be relatively large to account for any extra variability in individual level outcomes, and cluster, rather than individually randomised designs should be considered
(4) a range of measures, instead of a single primary outcome, may make best use of the data, and unintended consequences should be picked up where possible
(5) adaptation to local setting should be allowed, if ensuring strict fidelity to a protocol is inappropriate.

From this review, the conclusion could be drawn that available evidence follows, to some extent at least, recommendations 1, 4, and 5. The main issues remaining are those of sample size and process evaluation. In accordance with this guidance of how to evaluate complex interventions one might, even though its limitations concerning well-conducted clinical trials, from this review cautiously assume that the results have a positive tendency and the focus of interest should perhaps be shifted towards fine-tuning of the intervention, in order to make comparisons within a certain treatment possible (by varying one element of the intervention, while keeping the other elements constant).

Many of the trials have been published in non-traditional medical journals, hence not formally guided by the conventional methods and judgements. This might lead to a discussion of whether the Cochrane principles for systematic reviews are actually applicable for these kinds of interventions. This would not be a radically new discussion and it is actually stated in the introduction to the Cochrane Handbook for Systematic Reviews that it is mainly aimed for synthesis of clinical trials and particularly randomised clinical trials. The assessment of methodological quality consistency and the relevance in the established evidence hierarchy have also been debated before [73,74], and the contribution of this review in this aspect can only be a support of the flexible approach in which randomised controlled trials and observational studies have at least complementary roles. In any new attempt of performing a systematic review of NAT alternative guidance for judging of the quality of available evidence should perhaps be applied to give a complementary perspective.

Implications for policy and practice

Our modern society and the modern life style with many stressful events and several stressors at home as well as at work result in new states of ill health. Due to this scenario it is of paramount importance to acknowledge new methods for promoting health as well as new forms of therapy and rehabilitation in aspects of public health. As is demonstrated by increasing amounts of persons on sick leave in many European countries, and lots of suffering due

to mental illnesses like burnout syndrome, sleep disturbance, and depression, the traditional health care has to some extent become insufficient, and prospects of the future [75,76] give us reason to believe that these problems will continue escalating. In this perspective any new approach to treatment and healing processes must be considered carefully and evaluated scientifically. The concept of health has more and more become an issue of adapting, the individual's capacity to adjust oneself to his/her environment [75].

Experimental evidence from environmental psychology has given support to the theoretical framework for therapeutic horticulture [3,77–80]. Recent epidemiological research has reported significant health impact by exposure to natural environments [9,10]. By shedding light on these issues, and by implementing more rigorous or adequate research methods with proper quality assessment of the subject of NAT, the use of nature in therapy and rehabilitation might prove to be an efficient alternative in health care for varied states of ill health (mainly psychiatric diagnoses). Regarding the effect sizes derived from the meta-analyses of wilderness therapy programmes, one must consider the character of measured outcomes, often difficult states to change (like dysfunctional behaviour or social functioning), and as such even a smaller effect size may be rather impressive. What is also interesting is the reported follow-up effect [23], since many of the conditions treated in a wilderness programme have a high rate of recidivism [71], and many of the outcomes registered, like self-esteem and locus of control, contribute to lower rates of recidivism.

No clear or definite information regarding costs and safety of the treatments was provided. Hence it is difficult to make any clear statement concerning trade off between benefits and costs. One may argue that considering the substantial amount of suffering mental health problems contribute to, and the high amount of sick leaves due to these conditions, any treatment aiming at those illnesses would be worth to evaluate thoroughly. However, since NAT is not only applied for psychiatric diagnoses, trade off assessments of NAT for any kind of outcome need to be carefully valued.

Our findings showed rather high consistency of results across studies as well as a support to the assumption that NAT is an efficient intervention in certain cases of ill health. Nonetheless, we are still not satisfied in aspects of evidence, quality, or causality, what specific natural elements are most beneficial, and to what population with what diagnoses.

Since no systematic review has previously been performed on the subject, or any clear statement of existing knowledge, it has been difficult to predict to researchers what method would be most useful, and what precise outcomes to evaluate. Future evaluation and research of NAT should take advantage of the framework provided by MRC for complex interventions. This would assure some conformity among studies and provide a more solid fundament onto which further implications, recommendations, and policies could be based.

Forthcoming reviews might aim at specifying the research questions of any nature-assisted therapy, in relation to what health condition is studied, in what population, what intervention and finally what outcomes. We do not claim to have produced a, traditionally speaking, strong review due to reasons of heterogeneity, but partly with the guidance of MRC in mind, we have tried to imply a slightly different approach to the subject. What this review might contribute to is, by making a very broad summary including many aspects of the above mentioned components, a better understanding of where to focus and what to explore more precisely in future investigations, evaluations, and research.

Conclusions

This review gives at hand that a rather small but reliable evidence base supports the effectiveness and appropriateness of NAT as a relevant resource for public health. Significant improvements were found for varied outcomes in diverse diagnoses, spanning from obesity to schizophrenia. These findings highlight the importance of considering nature as an important resource in mental and public health care and the value of putting further efforts into research of this subject. Since the Cochrane principles might not be applicable in a review of this kind next step would be either to further developing complementary evaluation methods or to considering how to establish traditionally high-quality research standards on the issue of NAT. For this purpose we would also suggest more basic science to be performed within this field in order to clarify the causal relationship between nature and health. Future studies should concentrate on detailed aspects of NAT and delineate in more detail the associations between specified aspects of nature and specified health factors. Further studies need to be adequately powered, should use strict diagnoses, should present results for clearly defined interventions, and should provide information on side effects as well as cost efficiency.

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