JHCE*in*P

Journal of Health Care Education in Practice (May 2026)

Scientific article – DOI: 10.25430/pupj-jhcep-2026-1-17

Illuminating conceptual heterogeneity and the information pandemic in forest therapy: A preliminary systematic review

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Abstract: Forest Therapy (FT), described as an evidence-based intervention inspired by forest environments, is gaining increasing attention. Despite its progress, the effects of heterogeneous FT definitions remain under-investigated. This systematic review aimed: (1) to compare FT definitions by considering whether they mention (a) the FT evidence-based roots (resource 'valuability'), (b) public-health targets ('concentration' or 'rarity'), (c) links to forest bathing ('inimitability'), (d) links to outdoor-health institutions ('non-substitutability'); and (2) to comprehend the process through which such heterogeneity can trigger value co-destruction processes. Our search of the Scopus database on 25 February 2023 yielded 88 studies containing the search term 'forest therapy' in title; they had been published from 2011 to 2023. Of these, we included only articles (69 studies). After selecting 36 articles, we assessed the FT definitions by performing content analysis. We rated a definition with '1' when it satisfied one or more of the above-mentioned requisites through applying the well-rooted Hollerith model. The results include a discussion and a quantitative assessment of the definitions. FT definitions represent a new research object in the FT research field. We categorised those definitions and discussed their heterogeneity by implementing a theoretically rooted methodology. We operationalised value co-destruction processes triggered by heterogenous definitions without the aforementioned quality attributes. We identified negative externalities and a high risk of an information pandemic. Finally, we discuss additional research directions.

Keywords: Conceptual ambiguity, Evidence-based medicine, Forest therapy, Infodemics, Sustainable Development Goals

Sinossi: La Forest Therapy (FT), descritta come un approccio basato su evidenze scientifiche e ispirato agli ambienti forestali, sta ricevendo un'attenzione crescente. Nonostante i progressi compiuti, gli effetti dell'eterogeneità delle definizioni di FT rimangono poco indagati. Questa revisione sistematica si è posta i seguenti obiettivi: (1) confrontare le definizioni di FT considerando se menzionano (a) le radici evidence-based della FT (valore della "risorsa"), (b) gli obiettivi di salute pubblica ("concentrazione" o "rarità"), (c) i collegamenti con il forest bathing ("inimitabilità"), (d) i collegamenti con le istituzioni per la salute all'aria aperta ("non sostituibilità"); e (2) comprendere il processo attraverso cui tale eterogeneità può innescare processi di co-distruzione di valore. La nostra ricerca nel database Scopus, effettuata il 25 febbraio 2023, ha individuato 88 studi contenenti il termine "forest therapy" nel titolo, pubblicati dal 2011 al 2023. Di questi, abbiamo incluso soltanto gli articoli scientifici (69 studi). Dopo aver selezionato 36 articoli, abbiamo valutato le definizioni di FT mediante un'analisi del contenuto. Abbiamo attribuito un punteggio pari a "1" a una definizione quando soddisfaceva uno o più dei requisiti sopra menzionati, applicando il consolidato Modello di Hollerith. I risultati includono una discussione e una valutazione quantitativa delle definizioni.

Le definizioni di FT rappresentano un nuovo oggetto di ricerca nel campo degli studi sulla FT. Abbiamo categorizzato tali definizioni e discusso la loro eterogeneità implementando una metodologia teoricamente fondata. Abbiamo operazionalizzato i processi di co-distruzione di valore innescati da definizioni eterogenee prive dei suddetti attributi qualitativi. Abbiamo identificato esternalità negative e un elevato rischio di una "pandemia informativa". Infine, abbiamo discusso ulteriori direzioni di ricerca.

Parole chiave: ambiguità concettuale, medicina basata sull'evidenza, terapia forestale, infodemia, Obiettivi di sviluppo sostenibile

Introduction

A healthy adult inhales over 8,000 liters of air daily (Pleil et al., 2022), underscoring the vital role of air quality in human and environmental health (WHO, 2021). This has stimulated interest in forest bathing and forest therapy; however, their growing popularity has generated heterogeneous definitions and conceptual ambiguity (Liu et al., 2023).

South Korea (Jung, Woo and Ryu, 2015) Germany (Immich & Schuh, 2021), and several other countries have adopted health-oriented definitions, whereas Italy, for example, defines forest therapy (FT) as "guided tours including specific sites at which structured activities are organized, such as mindful walking, meditation, breathing exercises, yoga, qi-gong, and simple craftwork" (Meneguzzo & Zabini, 2021, p. 36. These definitional variations underscore the substantial risk of conflating FT with forest tourism (Ohe et al., 2017).

Currently, FT is conducted in certified Forest Therapy Bases (FTBs), which are sites where the psychophysiological effects of forest immersion have been scientifically validated (Li, 2023; FTS, 2023a; ISFT, 2024). Japan counts 65 FTB (FTS, 2023b), with further expansion in South Korea (Shi et al., 2023) and Europe (Zhang & Ye, 2022; Droli, Radivo & Iseppi, 2020). Despite these achievements, heterogeneous intervention labels may hinder comparability across clinical studies, limiting methodological standardization and constraining the development of consistent clinical and managerial applications in health tourism (Nachin et al., 2022).

This ambiguity may also affect collaboration among the major professional associations. For instance, although the Japanese Forest Therapy Society, the International Society of Forest Therapy, the Association of Nature and Forest Therapy Guides, or the Forest Therapy Hub promote evidence-based certification standards, persistent definitional heterogeneity in FT may contribute to communication ambiguities and potentially limit effective institutional collaboration (Hansen, Jones & Tocchini, 2017).

This study aims to: (1) categorize FT definitions based on the presence or absence of prior supporting conceptualizations; (2) classify these definitions according to their reference to medical evidence; (3) determine whether they specify distinct public health targets; (4) assess their acknowledgment of forest immersion practices (i.e., 'forest bathing'); (5) examine references to the substitutability of FT in the establishment of forest therapy stations; and (6) operationalize FT definitions in relation to value co-creation and co-destruction processes arising from definitional heterogeneity.

Materials and methods

Differences in how the FT concept is applied in FB and forest medicine (FM)

Introduced in 1982 in Japan, Forest Bathing (Shinrin-yoku) was established as a national health initiative to reduce stress and promote well-being through immersion in forest environments and exposure to phytoncides (Li et al., 2007; Li et al., 2008; Li, 2022). Differently, FT refers to its scientifically validated health effects (Li, 2012), encompassing human, forest, and community health, and has evolved into Forest Medicine (FM), a preventive medical framework integrating these dimensions (Fig. 1).

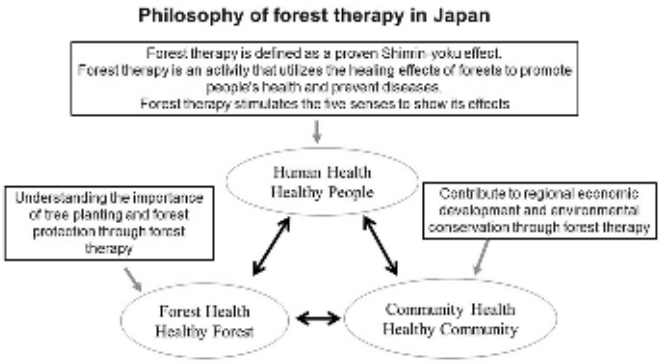

Fig. 1. The philosophy of forest therapy in Japan (adapted from authors Li, 2023).

Table 1 outlines the scientific evolution of FB, FT), and Forest Medicine (FM) between 1982 and 2023. Collectively, these concepts bridge forest ecosystem research and evidence-based medical science (Li, 2022, p. 1). However, uncertainty persists regarding the evidentiary standards for FT—whether claims may be investigator-declared or must rely on rigorously designed clinical trials consistent with Evidence-Based Medicine (EBM) criteria (Immich & Schuh, 2021; Immich & Robl, 2023). Moreover, awareness of FT as both an ecosystem service and an Evidence-Based Medical Treatment (EB-MT) remains limited and heterogeneous, even among participants (Shi et al., 2023).

Year introduced	Term	Definition	References
1982	Forest Bathing (FB)	In 1982, the Forest Agency of Japan established forest bathing (Shinrin-yoku) as a national health initiative to reduce occupational stress and promote well-being through immersion in forest environments and exposure to phytoncides, akin to natural aromatherapy.	(Li et al., 2007; Li et al., 2008; Li, 2022)
2004	Forest Therapy (FT)	Forest Therapy is an evidence-based practice derived from forest bathing, involving guided immersion in forest environments to promote health and prevent disease. Its institutionalization has been supported by the establishment of certification bodies in Japan and Europe, responsible for designating Forest Therapy Bases and "healing forests," respectively.	(FTS, 2023a; ISFT, 2024; Li, 2022; Li, 2012)
2007–2012	Forest Medicine (FM)	Forest Medicine is an interdisciplinary field examining the health effects of forest environments. Emerging from forest bathing and Forest Therapy, it integrates principles of alternative, environmental, and preventive medicine and is conceptualized as an evidence-based approach to disease prevention.	(Li, 2022; Li et al., 2012)
2023	A new concept of Forest Medicine	Forest Medicine represents a preventive approach targeting the psycho-neuro-endocrino-immune network, with potential application in rehabilitation medicine.	(Li, 2023; Li, 2022; Li, 2012)

Table 1. A summary of the history of forest bathing, forest therapy, and forest medicine (adapted from Li, 2023)

FT as Evidence-based medicine and Evidence-based medical treatment

Evidence-based medical treatment (EB-MT) and evidence-based medicine (EBM) adopt circumscribed, clinically oriented frameworks. EB-MT integrates clinical expertise with the best available external evidence derived from systematic research to guide healthcare decisions (Sackett, 1997, p. 3), acknowledging the value yet insufficiency of individual experience. Similarly, EBM is defined as the conscientious and judicious use of current best evidence in patient care [ibidem].

Although the evidence-based orientation of FT aligns with the principles of EBM and EB-MT, its conceptual integrity may be compromised when FT is used interchangeably with FB FB (Li, 2010, p. 9). The distinction is clear: while the wellness benefits of FB are established, FT requires medical evidence derived from specific forest settings (Lee et al., 2012; Ohe et al., 2017). As emphasized by Festinger, incongruent cognitions compel individuals who interact with one another to make additional

efforts in order to resolve these 'cognitive dissonances' and restore coherence, an essential resource in human activities (Festinger, 1957; Vaidis & Alexandre, 2019, p. 2). In short, a reduction in coherence is unlikely to foster processes of value co-creation (Hsu et al., 2011). Moreover, inconsistent definitions—particularly when FT is characterized merely as a guided excursion lacking medical evidence—introduce conceptual ambiguity into the field, may trigger processes of value co-destruction, and should therefore be regarded as misleading (Droli et al., 2022).

Value co-creation and value co-destruction processes in the FT research field

Value Co-Creation (VCC) in healthcare has shifted from provider-centred models to collaborative approaches involving patients and professionals (Batalden, 2018). However, focusing on isolated components of innovation may limit the full realization of their knowledge-generating potential and trigger Value Co-destruction Processes (VCD), by following the Service-Dominant Logic (SDL) (Vargo & Lusch, 2008).

VCC entails reciprocal, mutually beneficial relationships (ibidem), whereas increasing service complexity has fostered VCD processes, defined as interactions that diminish the well-being of at least one participating system (Prior & Marcos-Quevas, 2016, p. 431).

For instance, VCD processes may occur when risks associated with forest recreation are insufficiently communicated or managed, underscoring the necessity of properly managing VCC and VCD processes in running FB-FT sessions.

VCD can also be caused through the activation of the placebo effect (Rosenthal & Frank, 1956), particularly when expected benefits or the term "therapy" are communicated before primary intervention studies, potentially compromising research efficiency and resource allocation. For this reason, VCC and VCD are conceptualized as distinct but interconnected processes (Hansen, Jones & Tocchini, 2017; Hsu, Nguyen & Huang, 2021). Moreover, inconsistent definitions—particularly when FT is characterized merely as a guided excursion lacking medical evidence—may introduce conceptual ambiguity into the field, potentially trigger processes of value co-destruction, and should therefore be regarded as misleading, as suggested by theoretical perspectives that emphasize the strategic role of knowledge as a productive resource (Smith, 2013)..

The Resource Based View (RBT) as theoretical approach

According to RBT, only resources that are Valuable, Rare, Inimitable, and Non-substitutable (VRIN) generate sustained advantage. Such resources should be efficiently utilized and integrated into organizational processes to enhance performance (Peteraf, 1993; Barney, 1991; Sirmon et al., 2011).

The presence of evidence-based definitions of Forest Therapy has been assumed as a facilitating factor for the inclusion of this approach within the framework of Evidence-Based Medicine.

In this study, FT definitions are considered valuable when they explicitly reference "evidence," aligning with RBT and the control definition. They are rare when specifying integrative, preventive, rehabilitation, or public health objectives, thereby narrowing clinical outcomes. Definitions become inimitable by emphasizing immersive forest experiences as distinctive therapeutic mechanisms, and non-substitutable when highlighting the establishment of dedicated FTBs or destinations to structure FT delivery.

FT definitions were categorized according to four criteria: evidence-based foundation (valuability), specificity of health targets (rarity), linkage to forest immersion or FB (inimitability), and reference to certified Forest Therapy Bases (non-substitutability). The Japanese Forest Therapy Society's original definition served as the control.

Based on this approach, we formulated six Research Hypotheses (RHs).

RH1: both scientifically supported FT definitions and not scientifically supported definitions coexist.

RH 2: The heterogeneity of evidence-based FT definitions is high and scattered.

RH 3: The heterogeneity of the FT definitions regarding public health targets is high and scattered.

RH 4: The heterogeneity of FT definitions regarding the central role of FB activities is high and scattered.

RH 5: The heterogeneity of FT definitions regarding the central role of FB in sustainable development at FT destinations is high and scattered.

RH 6: The VCC and VCD processes can be operationalised owing to the very high heterogeneity of the FT definitions.

Thirty-six preselected Forest Therapy (FT) definitions (D1–D36) were assigned a score of "1" when they exhibited the quality attributes of value, rarity (or concentration), inimitability, and non-substitutability, in accordance with the Resource-Based Theory (RBT) framework. Table 2 illustrates the theoretical framework we adopted to analyse the FT definitions; it presents the roots supporting the coding strategy and methodology.

	Heterogeneity of FT definitions (D) RESOURCE BASED THEORY											
VRIN model	Valuability			Rarity-Concentration			Inimitability			Non-substitutability		
1st step	'evidence'			'health'			'immersions'			'destination'		
2nd step	No. … synonym			No. … synonym			No. … synonym			No. … synonym		
Definitions	D1	D2	Dn	D1	D2	Dn	D1	D2	Dn	D1	D2	Dn
presence	1	1	1	1	1	1	1	1	1	1	1	1
absence	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. The theoretical framework adopted for to analyse forest therapy (FT) definitions. (Source: authors)

Below, we describe the process followed to conduct this review.

Systematic review: inclusion and exclusion criteria

This study adhered to PRISMA 2020 guidelines (Page et al., 2021) and employed a three-stage quantitative content analysis (Neuendorf, 2017). Two independent reviewers minimized selection bias. This study examines selected definitions of FT by adopting a multidisciplinary perspective. The Scopus database was searched due to its multidisciplinary coverage since 1996 and inclusion of MEDLINE and EMBASE records, supporting comprehensive retrieval across medical and social science domains.

The article title represents a key element of any study (Tullu , 2019, p. S13). In the first stage of the content analysis, the term "forest therapy" was searched without publication type restrictions, including all English-language, peer-reviewed articles published up to 16 February 2023. A total of 88 records (2011–2023) were retrieved. Two authors independently screened records, resolving disagreements through a third reviewer. Non-article publications were excluded, and all investigators disclosed relevant information to ensure methodological rigor.

Ultimately, 69 articles were retained after excluding 10 due to title or language issues. 36 articles remained, after excluding studies lacking explicit FT definitions (n = 17) or employing temporally or spatially restricted terms (n = 7). Two investigators independently evaluated precision and certainty before final inclusion, resulting in 36 FT definitions for systematic review.

Table 3 illustrates the inclusion and exclusion criteria.

Criteria	Inclusion criteria	Exclusion criteria
Type of scientific publication	Study published as a scientific (peer-reviewed) article	Study published as a contribution in book, book chapter, conference proceedings, etc.
Integrity of the term 'forest therapy' in title	The term 'forest therapy' is included in the title	The title contains 'forest therapies' or other terms that are similar to 'forest therapy' but not exactly the same
Language used in the manuscript	The article is published in English	The article is published in a language other than English, and thus would require professional translation, despite using English in title and/or abstract
Presence/absence of any forest therapy definition in the manuscript	The article (except the title and abstract) contains any general forest therapy definition in the manuscript	The article (except the title and abstract) does not contain any general forest therapy definition
Integrity of the 'forest therapy' concept in definition (1)	The article defines the forest therapy concept without prefixes	The article defines forest therapy with a prefix – for example, 'actual forest therapy', 'modern forest therapy', or others – but does not define forest therapy
Integrity of the 'forest therapy' concept in definition (2)	The article defines the forest therapy concept without suffixes	The article defines forest therapy with the suffix 'programme', 'activity', 'experience', 'strategy', or any other variation, but not forest therapy
Order of appearance of the forest therapy definition	The authors use the first forest therapy definition that appears in the article	The authors use a different forest therapy definition than the first one that appears in the article

Table 3. The inclusion and exclusion criteria used in this systematic review. (Source: authors)

The second stage of content analysis analysed these 36 FT definitions using the freely accessible word clouds and content analysis software (https://www.wordclouds.com) (Roe, 2018). Only the first FT definition appearing in each article was analysed. Two investigators independently screened the definitions for four primary keywords: "evidence" (representing the core value attribute of FT when assessed by health professionals), "health" (denoting the specific and concentrated thus relatively 'rare 'field of research), "immersion" (serving as the conceptual link between FB and FT, and contributing to the inimitability of FB for FT purposes), and "destination" (representing the non-substitutable organizational entity managing FT activities), in accordance with the VRIN criteria of the Resource-Based Theory (RBT).

To broaden the scope of the preliminary analysis, 100 synonyms were identified for each primary keyword—yielding a total of 400 terms—using Power Thesaurus.

The third stage of content analysis was undertaken in instances where the primary keywords were not present, by using Microsoft Excel. Heterogeneity was then assessed through the Hollerith proximity-distance model (Brillouin, 2013), coding presence as "1" and absence as "0." For the purposes of this study, we quantify the heterogeneity of definitions and, conversely, their degree of consistency. Definitions containing at least one synonym were coded "1" and excluded from further analysis. Data were publicly shared (see the Data availability statement) to ensure transparency and support quali-quantitative evaluation.

Fig. 2 provides an overview of the flowchart adapted to perform the first stage of that content analysis–based review protocol.

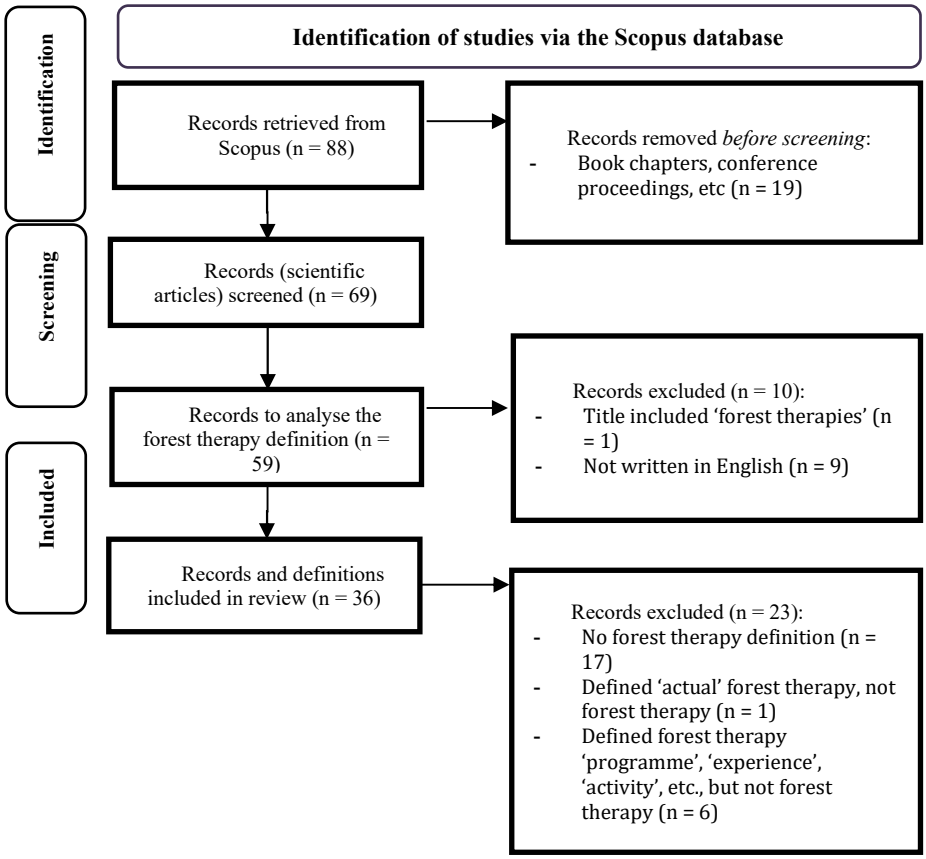

Fig. 2. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart used for this systematic review (adapted from Page et al., 2021)

Table 4 illustrates the theoretically supported coding strategy and methodology we adopted to analyse FT definitions.

Theoretical framework	**Heterogeneity of productive inputs (forest therapy definition = 'D') adopted in the same research area**			
	Resource-based theory			
Resource-analysis model – coding strategy for forest therapy definitions	Valuabilty	Rarity-concentration	Inimitability	Non-substitutability
Coding methodology for the primary key terms	'Evidence'	'Health'	'Immersions'	'Destination'
Coding methodology for the secondary key terms	First 100	First 100	First 100	First 100

Table 4. The theoretically rooted coding strategy and methodology adopted for to analyse forest therapy definitions. (Source: authors)

Two investigators analysed FT definitions : (I) by following a 'particular-atomistic' approach (Reinert & Reinert, 2006); (II) a 'dynamic-relational' approach (Smelser, 1962); and (III) a 'general-

holistic' approach (Schumpeter, 1949). All investigators assessed the findings to identify anything that was missing, inconsistent, and/or unclear. Two investigators independently assessed reporting biases and then discussed the results to improve the manuscript. The database associated with this study have been made publicly available at the Harvard Dataverse.

In approach I, we analysed the FT definitions by rating rated them '1' when they cited previous scientific definitions as support. Furthermore, we ranked each scientifically supported FT definition by quantifying the number of previous studies it cited, which we assumed measures the width of their scientific support, to achieve RT 1. In approach II, we qualitatively described the selected definitions by considering the above mentioned VRIN attributes, as suggested by RBT (RT 2-5). In approach III we operationalised the heterogeneity of the FT definitions and VCC and VCD processes to achieve RT 6.

For the particular-atomistic approach, FT definitions achieve ≤ 3 VRIN quality attributes. The dynamic-relational and general-holistic approach consider the average total scores of the FT definitions adopted in the same research area. For the dynamic-relational approach, the average FT definitions have ≤ 2 VRIN quality attributes. Finally, for the general-holistic approach, the average FT definition has ≤ 1 VRIN quality attribute (Table 5).

Particular-atomistic approach					**Dynamic-relational approach**	**General-holistic approach**
Research area	V	R	I	N	The average forest therapy definition has a heterogeneity threshold of ≤ 2 VRIN quality attributes	The average forest therapy definition has a heterogeneity threshold of ≤ 1
FT1						
FT2						
FT*n*						
Avg						
Heterogeneity threshold ≤ 3 VRIN quality attributes						

Table 5. Operationalising the heterogeneity of forest therapy definitions based on the valuability–rarity–inimitability–non-substitutability (VRIN) analysis model. (Source: authors)

To adopt the approach III, we observed the VCC and VCD processes potentially enacted by heterogeneous FT definitions. Here we classified the content of several definitions based on their focus on FT evidence-based roots, public health aims, forest immersions, and connections to outdoor health destinations, representing theoretically supported quality attributes as follows: valuable/not valuable, concentrated-rare/not concentrated-rare, inimitable/imitable, and non-substitutable/substitutable.

Finally, we positioned each FT definition by considering whether it fit or do not fit, respectively, the key quality requisites suggested by the VRIN analysis model. Fig. 6 illustrates the way in which heterogeneity of FT definitions have been assessed for RT 6 purposes.

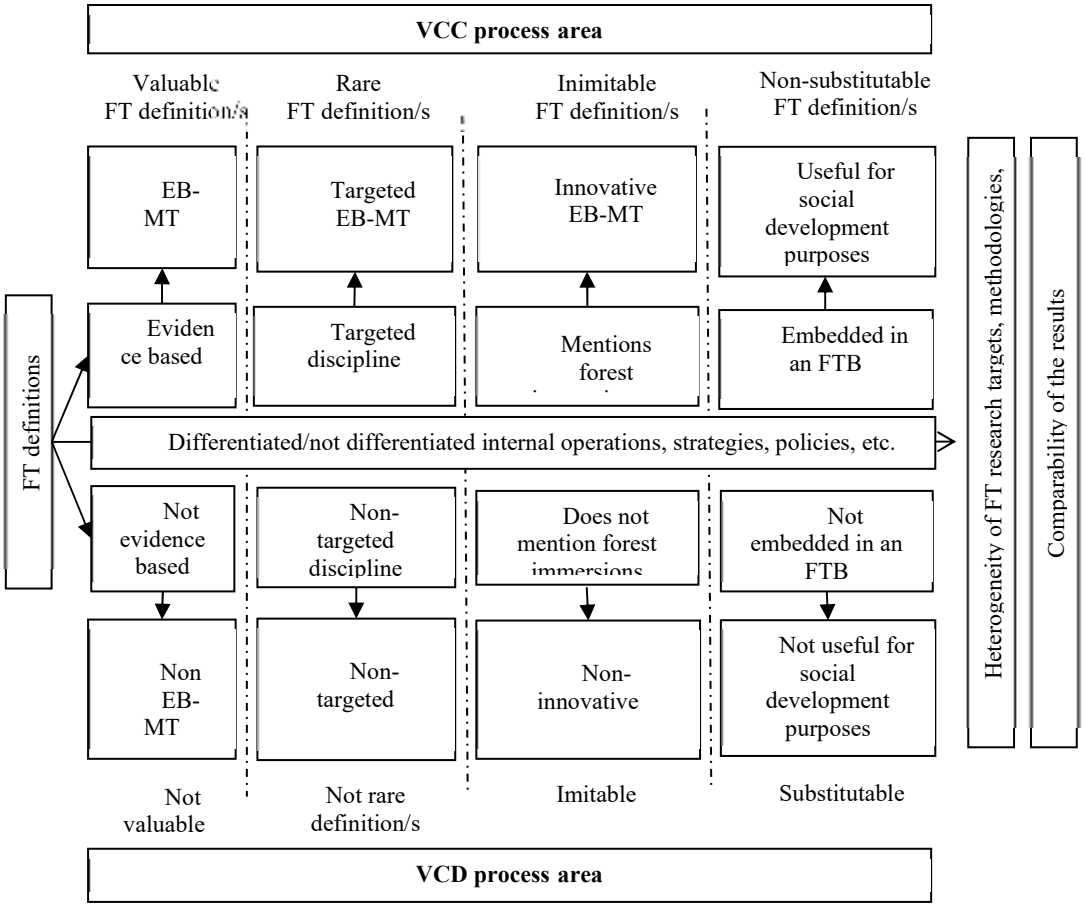

Fig. 6. Value co-creation (VCC) versus value co-destruction (VCD) processes enacted by the co-adoption of forest therapy (FT) definitions. EB-MT, evidence-based medical treatment; FTB, forest therapy base. Source: authors.

Results

APPROACH 1: FT definitions grounded in prior conceptual formulations

Fig. 4 rates the 36 assessed FT definitions in chronological order. Of these, 23 cite previous studies and thus are scientifically supported; 13 definitions are not scientifically supported. The frequency of scientifically supported definitions has tended to increase over time.

Fig. 4. Rating the forest therapy definitions in chronological order based on whether they are scientifically supported (1) or not scientifically supported (0). Source: authors.

Fig. 5 ranks the 23 scientifically supported FT definitions, which are from studies published between 2015 and 2023. Fifteen of these definitions are scientifically supported by, at least, one previous study. The most supported FT definition is by Song, Ikei & Miyazaki, 2017, (pp. 246–247).

Of note, the majority of the most supported definitions were published in the first half of the considered period. The graph suggests that the number of studies supporting a new FT definition seems gradually increasing, in the same period.

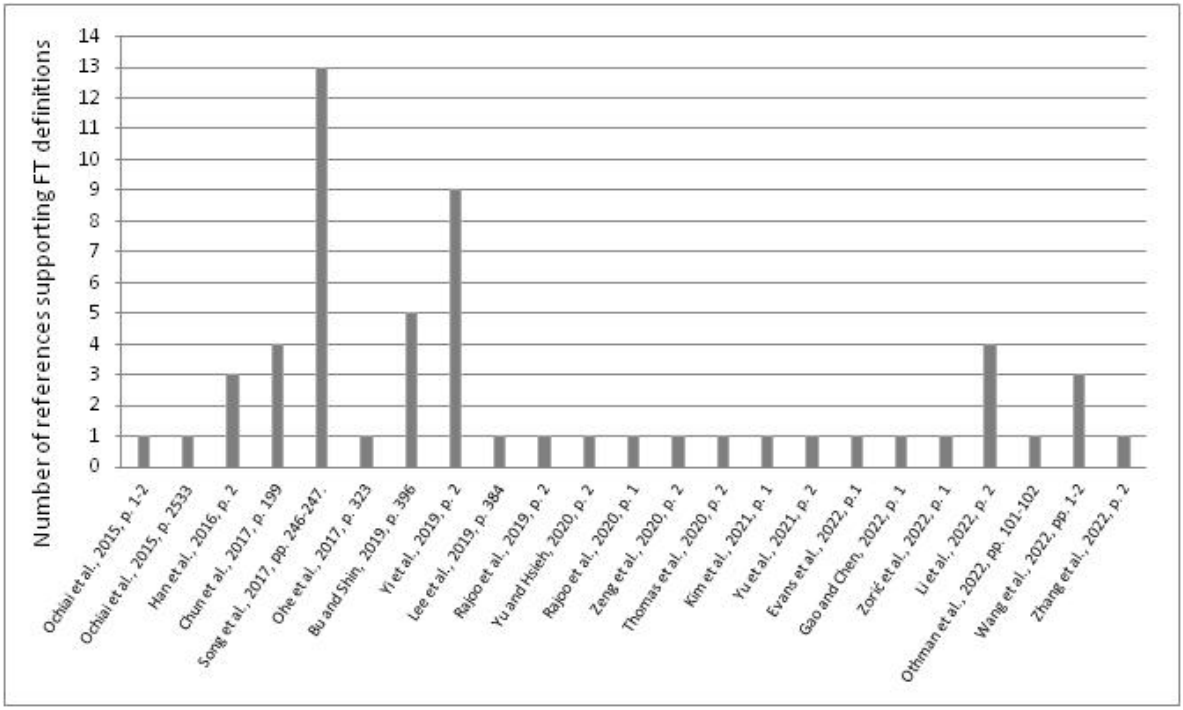

Fig. 5. Scientifically supported forest therapy definitions, by the number of references cited to support it, in chronological order. Source: authors.

APPROACH II. (V). Heterogeneity derived from evidence-based (Valuable) *and* non-evidence-based (non-valuable) FT definitions

Several definitions omit explicit reference to medical evidence. For example, FT has been described as a holistic social activity suitable for social prescribing (Thomas et al., 2020, p. 2) or as structured engagement with forest environments (Bassi, Carzedda & Iseppi, 2022, p. 4), without acknowledging its required evidence-based medical foundation. Others conceptualize FT as a nature-based intervention rather than an evidence-based medical treatment. For example, FT has been described as a manualised nature-based intervention integrating restorative forest elements with mindfulness techniques (Evans et al., 2023, p. 2), and as a therapeutic practice grounded in interaction with natural environments (Yi et al., 2019, p. 2), thereby substituting evidence-based framing with a nature-based perspective. In contrast, several studies underscore the evidence-based foundations of FT. For instance, in Korea FT is legally defined as an activity enhancing immunity and health through forest elements (Yu & Hsieh, 2020, p. 2). Other authors explicitly affirm its medically verified benefits (Kim & Shin, 2021) and preventive effects, particularly for relaxation and stress management (Ochiai et al., 2015a, pp. 1–2; Song et al., 2013, p. 1). Some studies proposed the collection of medical data outside rigorous peer-review frameworks, suggesting that FT, combined with favorable environmental conditions and appropriate medical equipment, can deliver healthcare services (Wang, Bai & Tian, 2019, p. 955). Others attempted to reconcile divergent positions, defining FT as the use of forest environments for healthcare practices (Cvikl, Avguštin & Kreft, 2022, p. 1), aligning with leading proponents in Forest Medicine and nature-based therapy.

3.3. APPROACH II. (R). Heterogeneity deriving from concentrated (Rare) *and* non-concentrated (non-rare) FT definitions

Some scholars affirm the evidence-based status of FT without clearly defining its targets (Han et al., 2016, p. 2), whereas others specify both the relevant quality attributes (Ochiai, et al, 2015b, p. 2533). Some definitions frame FT as promoting general comfort and well-being rather than specific medical outcomes, emphasizing connection with nature (Bu & Shin, 2019, p. 396; Kotte et al., 2019) or guided walks enhancing overall well-being (Rajoo, Karam & Wook, 2020). Some studies attribute broad public health benefits to FT without specifying targets (Park et al., 2022, p. 493) or frame it as an alternative medical approach harnessing forests' healing properties (Yu et al., 2016, p. 125).

Others highlight preventive and rehabilitative aims, particularly for stress-related and lifestyle conditions (Song, Ikei & Miyazaki, 2017, pp. 246–247). Only a limited number of FT definitions explicitly emphasize health enhancement. FT has been framed as a complementary preventive treatment rooted in forest environments and in South Korea is legally defined as immune-strengthening, health-promoting activity under the Forestry Culture and Recreation Act (FAOLEX Database, p. 274).

APPROACH II. (I). Heterogeneity deriving from Inimitable and Imitable FT definitions

Some authors used the terms FT and FB interchangeably. For example, (Othman, 2022, pp. 101–102) presented FT as a form of natural therapy involving practices aimed at attaining preventive medical effects through exposure to natural stimuli that induce a state of physiological relaxation and enhance weakened immune function to prevent diseases. Other authors explicitly indicated a distinction between FT and FB. Yu et al. (2021, p. 2) introduced the term FT to describe the medically established health effects of forest exposure. Some studies further emphasised this distinction. (Ohe et al., 2017, p. 323) underscored the clear differentiation between FB and FT, with the latter being supported by evidence-based effects, especially when gathered locally.

APPROACH II. (N). Heterogeneity deriving from Non-substitutable and substitutable FT definitions

Numerous FT definitions highlighted the strategic significance of the FT in shaping healthcare innovation. These definitions underscore the irreplaceability of FT for establishing an FTB within a specific research area. For example, (Gao & Chen, 2022, p.1) illustrated that FT has emerged as a prevalent health experience model, operating as a business that fuses forestry and wellness to yield favourable physiological and psychological relaxation effects. Similarly, [132[i], p. 2] emphasised the pivotal role of the FT in integrating mindful exercise, mental health, and the forest circular economy. Thus, both substitutable and non-substitutable FT definitions have been made available.

APPROACH III. Heterogeneity deriving from heterogeneous *and* consistent FT definitions

The aggregated scores derived from the definitions provide a quantitative assessment of their consistency when analyzed across rows and their heterogeneity when examined across columns. Tables 6a–c present forest therapy (FT) definitions in descending order based on their degree of alignment with the original control definition.

Only one definition (Huber et. al., 2023) fulfills all four quality attributes—value, rarity, inimitability, and non-substitutability—as articulated within the Resource-Based Theory (RBT) framework. Five definitions satisfy three of the four attributes, twenty meet two attributes, and two definitions do not fulfill any of the specified quality attributes.

Rank	Studies – Defjinitions		V	R	I	N	Consistency/ Heterogeneity
	Forest Therapy Society	Forest Therapy(R) represents the evidence-based approach aimed to support the healing of individuals through immersion in forests (https://www.fo-society.jp/en/)	1	1	1	1	**4**
1	Huber et al., 2023	The positive effect of nature and its specific elements on human health is the essential component of forest therapy: This approach of nature connection therapy, also known as “forest bathing”/”Shinrin-Yoku”, is a collective term for activities designed to improve human health or well-being in a forest environment. (p. 3)	1	1	1	1	**4**
2	Zorić et al., 2022	One such concept to which we pay particular attention in this study is forest therapy, which has become not only a health and wellness trend in recent years but also a much-desired activity in nature-based tourism destinations. (p. 1)	0	1	1	1	**3**
3	Bielinis et al., 2020	One type of forest recreation meant to improve human health is often called forest therapy, forest bathing or Shinrin-yoku, and is often used as an alternative method to treat many afflictictions. (p. 1-2)	1	1	1	0	**3**
4	Lee et al., 2019	This research usually focuses on the physical, psychological, and physiological impacts of forest therapy, which is a health promotion method that uses proven effects of a forest environment, such as relaxation. (p. 384)	1	1	0	1	**3**
5	Yu et al., 2021	The term 'forest therapy,' derived from shinrin-yoku, describes the medically proven health effects resulting from exposure to forests. (p. 2)	1	1	1	0	**3**
6	Wang, Bai and Tian, 2019	Forest Therapy, taking advantages of multiple favourable factors, like the moderate climate, the high-quality atmosphere, the rich water resource, the fragrance gas, the enriched anions, the phytoncide and so on, accompanied by some medical equipment and/or methods, provides human with forest medical service and health care to reach their requirement for a relaxing and healthy life. (p.955)	1	1	1	0	**3**
7	Kim et al., 2021	Forest therapy' is the medically proven health effects of exposure to forest environment. (p. 1)	1	1	0	0	**2**
8	Ochiai et al., 2015	Forest therapy is now increasingly recognized as an effective relaxation and stress management activity with demonstrated a preventive medical effect and increased	1	1	0	0	**2**

		healthy effect among healthy Japanese adults. (pp. 15222-15223)					
9	Yu and Hsieh, 2020	In Korea, forest therapy is defined by law as immune-strengthening and health-promoting activities utilizing various elements of the forest, such as fragrance and scenic view. (p. 2)	0	1	0	1	**2**
10	Bu and Shin, 2019	Forest therapy is a method of feeling physical and mental comfort in a stressful life through connections with the vitality of nature by utilizing factors of forest therapy. (p. 396)	1	1	0	0	**2**
11	Kim, Shin, and Jeon, 2020	Forest therapy represents a program operated in forests that can relax the body and mind and improve resilience provide activities that can improve the immunity of the body and restore physical and mental health by utilizing various environmental elements that exist in forests. (p. 487)	1	1	0	0	**2**
12	Song et al., 2013	Forest therapy is a health-promotion method and uses medically proven effects of forests, such as relaxation, that can improve the health of the body and mind." (p. 1)	1	1	0	0	**2**

Table 6a. Heterogeneity versus Consistency of FT definitions. (Source: Authors)

Rank	Studies – Defjinitions		V	R	I	N	Consistency/ Heterogeneity
	Forest Therapy Society	Forest Therapy(R) represents the evidence-based approach aimed to support the healing of individuals through immersion in forests (https://www.fo-society.jp/en/)	1	1	1	1	**4**
13	Rajoo et al., 2020	According to the International Handbook of Forest Therapy, forest therapy can be defined as an evidence-based public health practice, using guided forest therapy walks that combined physical and mental exercises to improve general wellbeing. (p. 1)	1	1	0	0	**2**
14	Yi et al., 2019	Studies show that interactingwith nature improves thephysical andmental health of people, and forest therapy is gaining more recognition as a nature-based therapy. (p. 2)	1	1	0	0	**2**
15	Lyu et al., 2019	An immersive forest experience known as ‘forest therapy’ has recently received widespread attention as a novel form of psychological therapy for reducing stress and providing a feeling of relaxation. (p. 2)	0	1	1	0	**2**
16	Park et al., 2022	Forest therapy refers to activities that use various environmental factors of forests to improve human health. (p. 493)	1	1	0	0	**2**
17	Jung et al., 2015	By law, the term forest therapy was defined as immune-strengthening and health-promoting activities utilizing various elements of theforest such as fragrance and scenic view’ according to the Forestry Culture and Recreation Act of Korea. (p. 274)	0	1	0	1	**2**
18	Yu et al., 2016	Forest therapy offers an alternative technique that takes advantage of the inherent curative factors found in forests. (p. 125)	1	1	0	0	**2**
19	Yeon et al., 2023	Forest therapy is an activity that utilizes the forest environment to improve human health. (p. 2)	1	1	0	0	**2**
20	Park et al., 2020	Forest therapy refers to activities using various environmental factors of the forest to promote the health of the human body. (p. 2)	1	1	0	0	**2**

21	autore	Professor Qing Li, of Department of Rehabilitation Medicine, Nippon Medical School Hospital, Japan, the world's foremost expert in forest medicine and immunology, and Amos Clifford, the founder of the US-based Association of Nature and Forest Therapy, the world-leading organization in the movement to integrate nature and forest therapies, recognize FT as a method in which the natural environment of the forest is used for health care practices. (p. 1)	0	1	1	0	**2**
22	Ohe, Ikei and Song, 2017	The difference between the two concepts (forest bathing and forest therapy) is quite clearly defined because the effects of forest therapy are evidence-based in contrast to those for forest bathing. (p. 323)	1	0	1	0	**2**
23	Othman et al., 2022	Forest therapy also known as Shinrin-Yoku by Japanese is considered nature therapy through a set of practices aimed at achieving 'preventive medical effects' through exposure to natural stimuli that render a state of physiological relaxation and boost the weakened immune functions to prevent diseases. (p. 101-102)	0	1	0	1	**2**
24	Kamioka et al., 2012	Over the years, recreation activity and relaxation in a forest environment called "forest therapy" or "shinrin-yoku" (forest-air bathing and forest-landscape watching/walking) have become a kind of climatherapy or nature therapy, and are popular methods for many urban people with mental stress conditions. (p. 85)	0	1	1	0	**2**

Table 6b. Heterogeneity versus Consistency of FT definitions. (Source: Authors)

Rank	Studies – Defjinitions		V	R	I	N	Consistency/ Heterogeneity
	Forest Therapy Society	Forest Therapy(R) represents the evidence-based approach aimed to support the healing of individuals through immersion in forests (https://www.fo-society.jp/en/)	1	1	1	1	**4**
25	Zhang et al., 2022	Forest therapy is an important way to bring together mindful exercise, mental health, and forest circular economy, as the idea of circular development has a very good historical and policy foundation in Japan, and it integrates comprehensive cognition of medicine, health science, economics, and public policy. (p. 2)	0	1	0	1	**2**
26	Song, Ikei and Miyazaki, 2017	Forest therapy is now increasingly recognized as an effective relaxation and stress management tool that has been demonstrated to be an effective preventive or alternative therapy, and its effects have been studied in elderly individuals and adults at risk of stress- and lifestyle-related diseases such as high blood pressure, diabetes, and depression. (pp. 246-247)	1	0	0	1	**2**
27	Han et al., 2016	With continued publications of such studies, forest therapy has gained increasing recognition as an intervention method based on scientific evidence. (p. 2)	1	0	0	0	**1**
28	Gao and Chen, 2022	Forest therapy has been a very popular health experience model in recent years, which is a business model for integrating forestry and wellness with good physiological and psychological relaxation effects. (p. 1)	0	1	0	0	**1**
29	Rajoo et al., 2019	"Forest therapy is now widely accepted as an effective relaxation and stress management tool that has been proven to be an effective preventive medicine for stress and stress related diseases, but it is still virtually non-existent in Southeast Asia" (p. 2)	1	0	0	0	**1**

30	autore	Forest therapy is a nature-based intervention that considers the specific needs of individuals and the natural and social environment in which they live which is now increasingly recognized as an effective relaxation and stress management tool. (p. 2)	0	0	1	0	**1**
31	Zeng et al., 2020	Forest therapy has been proposed as one of the solutions for stress recovery and health promotion and has recently received widespread attention as a novel approach to achieving physiological and psychological relaxation. (p. 2)	0	1	0	0	**1**
32	Ochiai et al., 2015	Forest Therapy is increasingly recognized as a relaxation and stress management activity with demonstrated clinical efficacy. (p. 2533)	1	0	0	0	**1**
33	Chun, Chang and Lee, 2017	Forest therapy is a promising alternative therapy for enhancing mental health (p. 199)	0	1	0	0	**1**
34	Thomas et al., 2020	"A social activity that may be appropriate in the context of SP due to its holistic approach to wellbeing is Forest Therapy (FT) (p. 2) [35].	0	1	0	0	**1**
35	Evans et al., 2022	Forest Therapy (FT) is a manualised nature-based intervention that combines the restorative elements of the forest with a mindfullness-based approach that appears suitable as an adjunctive intervention to existingh psychological treatment. (p. 1)	0	0	0	0	**0**
36	Wang et al., 2022	Forest therapy is a complementary and alternative treatment method, with the forest environment to be the foundation and the preventive medicine to be the core. (p. 1-2)	0	0	0	0	**0**
		TOTAL SCORE	**24**	**31**	**13**	**11**	**79**

Table 6c. Heterogeneity versus Consistency of FT definitions. (Socurce: Authors)

Discussion

Systematic analyses of FT definitions are still limited (Liu et al., 2023). This early systematic review was constrained in scope, focusing primarily on FT definitions. As a result, it did not examine FB and FM definitions, FT trails (Gobster et al., 2023), or other potential causes of VCD-VCC processes. Moreover, the review employed only basic statistical analyses, in line with its objective of examining FT scholars' understandings, perceptions, and views on the concept's strengths and limitations (Rahman, 2020), as well as generating insights to guide its design, implementation, and evaluation. At the same time, it systematically assessed and ranked FT definitions according to the strength of scientific evidence supporting each in the published literature.

This study included articles published up to 2023 and therefore does not account for more recent developments in FT definitions. Notwithstanding this limitation, it is reasonable to assume that subsequent publications are more likely to introduce additional definitional variations than to reduce the existing heterogeneity. Furthermore, as we only searched titles in the Scopus database for 'forest therapy', there may have been selection bias, resulting in the exclusion of potential papers included in other repositories. Despite this limitation, we elucidated the high heterogeneity of FT definitions and the consistently high risk of an information pandemic (infodemic) in the FT research field. Thus, the adoption of multiple, interdisciplinary repositories instead of one repository would have been redundant given the purpose of this early systematic review. Of note, we excluded 17 out of the 36 reviewed records,

which included 'forest therapy' in their title, because the article did not include an FT definition. We excluded grey literature and studies considering the markedly different peer-review processes. We devised a theoretically rooted methodology that could be adopted to position each FT definition. Finally, we call for additional reviews including those aimed at assessing the heterogeneity of FT definitions by adopting PubMed and other medical, thus monodisciplinary, databases.

Nevertheless, despite those limits, results here obtained suggest that FT definitions are both scientifically supported and not scientifically supported, thus confirm the RH 1. Similarly, they are both evidence-based and not evidence-based (RH 2), targeted and non-targeted to achieve any public health target (RH 3), FB centred and not FB centred (RH 4), and thus heterogeneous and somewhat contradictory. This study confirmed the high risk of confusing FB and FT definitions (Liu et al., 2023)

RH 6 posits that the VCC and VCD processes can be operationalised given the substantial heterogeneity of FT definitions. This hypothesis was confirmed by our review, which identified marked variability across definitions. The findings further indicate that greater conceptual clarity can be achieved by situating these definitions within their evidence-based foundations, public health objectives, forest immersion practices, and links to outdoor health institutions.

Non-targeted FT definitions, without specific integrative medical aims and rehabilitation targets, would be considered to represent a naive approach. Decisions enacted by health and tourism institutions would likely not be facilitated by non-accurate distinctions between FT as EB-MT and FT as forest tourism (Droli et al., 2022; Lunt et al., 2011). Health institutions accustomed to manage treatments based on clinical evidence may find additional difficulties to adopt FT when it is defined as a guided excursion based on environmental evidence and protocols (Meneguzzo & Zabini, 2021; Bassi, Carzedda & Iseppi, 2022).

FT practices may contribute significantly to sustainable socioeconomic development in both developed and developing countries (Joshi, Rana & Kharkwal, 2023).

Although rapidly expanding worldwide, the term remains relatively new and is often encompassed by broader concepts such as nature-based interventions, ecotherapy, or climatotherapy (Schuh & Immich, 2022). Conceptual heterogeneity, however, may hinder health institutions and professionals in engaging with new EB-MTs effectively. The need for standardization has been emphasized by international associations and institutions at multiple levels. Meanwhile, initiatives such as ParkRx (ParkRx, 2024), UK social prescribing [136[ii]], Australia's "Healthy Parks Healthy People" (VSG, 2019), and ISFT-supported European programs (Cvikl, Avguštin & Kreft, 2022) reflect growing global demand.

Conclusions

The transition from FB to FT and from FT to FM has required extensive labour and economic efforts over more than four decades. To the best of our knowledge, no other systematic review of FT definitions has been published. Thus, our results cannot be interpreted in the context of other reviews.

The findings of this study suggest that VCD processes triggered by such FT definitions—particularly when disseminated through social media platforms and adopted uncritically as axiomatic through Artificial Intelligence—may contribute to the generation of an *infodemic*. According to international institutions, an infodemic refers to an overabundance of information, some of which may be accurate, that makes it difficult for individuals to identify reliable sources and obtain appropriate guidance when needed (Briand et al., 2023).

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Given the above-mentioned definition of an 'information pandemic,' and considering the marked heterogeneity of definitions—namely, the coexistence of evidence-based and non–evidence-based variants—we identified a possible information pandemic, which merits further examination in future studies.

Highly heterogeneous and partially contradictory information is unlikely to support health institutions, research groups, and healthcare professionals in engaging with new EB-MTs through processes of information acquisition, critical appraisal, and knowledge sharing. Healthcare scholars and professionals should play a strategic role in facing such infodemic, as well as deciding which definition best fits their needs before planning any intervention. If so, it would be easier for healthcare institutions to assist them. This would help both scholars and institutions to promote the implementation of FT as an evidence-based intervention, which would be consistent with the original approach.

Non–evidence-based FT definitions appear particularly likely to trigger VCD processes. The adoption of refined and standardized FT definitions could reduce conceptual heterogeneity, establish a reference standard, harmonize terminology, and strengthen interdisciplinary value co-creation processes. In sum, greater conceptual consistency and standardization may enhance institutional efficiency in the implementation of ongoing initiatives.

This review calls for further research. The latter could investigate negative externalities derived from dissemination of uncertain information about FT, or caused by the sharing of unclear or incorrect definitions, making FT less attractive for public health. Stakeholders who recognize the risks of negative externalities and are able to manage infodemics arising from imbalanced VCC and VCD processes may enhance the productivity of research investments and FT interventions. Such efforts could also contribute to improving the environmental sustainability of health systems and advancing progress toward Sustainable Development Goals.

Finally, more comprehensive definitions may foster proactive environmental and conservation behaviours. Further refinement could also position FT within the planetary health framework, with the aim of enhancing mental resilience, improving overall well-being, fostering mutually beneficial human–nature relationships, strengthening connectedness to nature, and promoting environmentally sustainable behaviours.

Author contributions

All authors made substantial contributions to the conception and design of the work and the drafting and review of the manuscript. MD was responsible for most of the data acquisition and writing the manuscript. MD, QL, GI and VC are responsible for Section 1. and Section 2.1. MD and LB are responsible for Section 2.2. MD, VC, YO, and QL are responsible for Section 3. Finally, all authors have approved the final version to be published and agree to be accountable for all aspects of the work, including its accuracy and integrity.

Acknowledgements

The authors thank Professor Juuli Lumivalo at the University of Jyväskylä, Finland, and Dr Hiroko Ochiai Chief of the Department of Plastic and Reconstructive Surgery and Chief of the Laboratory of Regenerative Medicine at Tokyo Medical Center, Japan, for kindly providing comments on the early versions of this manuscript.

Funding

This study was partially funded by Kakenhi, Grant-In-Aid for Scientifc Research, No. 24K03189 and No. 25K15710 by Japan Scociety For The Promotion of Science (JSPS). The authors declare that they have no competing interests.

Data availability statement

The data associated with this study are publicly available at: Droli Maurizio, Harvard Dataverse, "Enlightening information pandemics in the 'Forest Therapy' research field", 2024, V1 (https://doi.org/10.7910/DVN/HKIMYN).

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