Department of General Practice and Primary Health Care
University of Helsinki, Finland

Dissertationes Universitatis Helsingiensis
143/2026

Supporting health and wellbeing through nature-based interventions in primary care

Annika Kolster

ACADEMIC DISSERTATION

To be presented, with the permission of the Faculty of Medicine of the University of Helsinki, for public examination in the University of Helsinki Language Centre Festive Hall,
on April 24th, 2026, at 13 o'clock.

Helsinki 2026

Supervisors

Research Professor Timo Partonen
Department of Healthcare and Social Welfare,
Finnish Institute for Health and Welfare,
Helsinki, Finland

Ulla Aalto, PhD, MD
Department of Geriatrics,
University of Helsinki and Helsinki University Hospital,
Finland

Reviewers

Associate Professor Kadri Suija
Institute of Public Health and Clinical Nutrition, School of Medicine, Faculty of Health Sciences, University of Eastern Finland and Institute of Family Medicine and Public Health, University of Tartu

Docent Erja Rappe
Ikäinstituutti/Age Institute Finland and
Faculty of Agriculture and Forestry, University of Helsinki

Opponent

Adjunct Professor Matilda van den Bosch
The School of Population and Public Health University of British Columbia, Canada, and
Senior Researcher at ISGlobal, Barcelona, Spain and European Forest Institute

Cover

Miikka Vaskola

Publisher: University of Helsinki
Series: Dissertationes Universitatis Helsingiensis 143/2026

ISBN 978-952-84-2157-3 (print)
ISBN 978-952-84-2156-6 (online)
ISSN 2954-2898 (print)
ISSN 2954-2952 (online)

PunaMusta Joensuu 2026

To the wild, beautiful and vulnerable Nature that we humans depend on.
Nature will live on without humans, but humanity will not survive without Nature.

Abstract

Contact with nature has a profound impact on human health. Nature-based prescribing applies nature-based interventions (NBIs) to promote wellbeing and thereby address the burden of disease, supporting both individual and public health. In chronic medical conditions, treatment goals shift from curation to disease management and retaining wellbeing, acknowledging the physical, mental, and social dimensions of health. Loneliness is a well-described risk factor for poor health outcomes. It is common among older adults residing in assisted living facilities (ALFs), a population with a high prevalence of multimorbidity, as well as functional and cognitive decline. The effects of NBIs depend on the environment, the activity, and the individual's wishes and perceived connection to nature.

This thesis, comprising four sub-studies, explores the impact of contact with nature on human health, with a focus on mental and social wellbeing among adults with an identified need for health improvement. The first aim was to explore how group-based NBIs have been used to alleviate loneliness and support wellbeing. Study I, a mixed methods systematic review, included 38 articles describing NBIs that build on 1) gardening, 2) physical activity, and 3) natural elements. The diverse populations challenged comparison of the effects. In the narrative analysis, qualitative studies demonstrated that NBIs may cultivate connectedness and belonging, while quantitative studies revealed clearer effects on general wellbeing.

The second aim was to investigate the meaning of nature among older adults residing in ALFs and, furthermore, to examine whether there is an association between nature connection and psychological wellbeing, and, if so, whether it is influenced by health status or disability. A cross-sectional mixed methods survey was conducted. It included 854 residents in 25 ALFs in the Helsinki area (Studies II and III). The average age of respondents was 83 years, 54% had dementia, and 55% suffered from loneliness. Although 96% considered nature important, only 51% had contact with nature as often as they desired. The wishes for activities were feasible, and 83% wanted to participate in NBIs. Nature connection associated with psychological wellbeing and happiness, and this association was accentuated when mobility was poor.

The final aim was to explore how an NBI affects mental wellbeing among primary care patients, and whether there are differences in the wellbeing outcomes compared to a sports intervention. Study IV is a clinical trial with participants (n = 79) being recruited from a social and health care center in the municipality of Sipoo. Following the eight-week intervention, self-reported wellbeing and functional ability improved in both the nature and sports groups, while mental wellbeing and self-reported sleep improved only in the nature group. Specifically, feeling relaxed, energetic, good about oneself, close to other people, and dealing well with problems improved in the nature group.

NBIs can readily be implemented in primary care. The studies of this thesis demonstrated positive outcomes, especially for mental wellbeing, and highlighted nature connection as a moderator of wellbeing outcomes. Nature-based prescribing requires person-centered approaches, referrals by trusted professionals, and tailored interventions. Safety considerations are essential for frail participants. NBIs may reduce symptoms and thereby the need for potentially harmful medications. While evidence supports mental health benefits, further high-quality research is needed to clarify the long-term effects and pathways to impact. Equitable access to natural environments necessitates addressing barriers such as poor self-efficacy, autonomy, and mobility limitations.

Sammanfattning
Hälsa genom naturbaserade interventioner i primärvården

Naturkontakt har stor betydelse för hälsa. Naturbaserad förskrivning tillämpar naturbaserade interventioner för att främja fysisk aktivitet, social samhörighet och välbefinnande. Inom hälsovården kan naturbaserade interventioner främja välmående särskilt hos personer med kronisk sjukdom. Vid långvarig sjukdom skiftar vårdens mål från kurering till stöd av välbefinnande och funktionsförmåga, med beaktande av hälsans fysiska, psykiska och sociala dimensioner. Ensamhet, en etablerad riskfaktor för sjukdom, är vanligt bland äldre personer i serviceboenden. Effekten av naturbaserade interventioner beror på miljön, aktiviteten och individen, inklusive hans eller hennes relation till naturen.

Denna avhandling omfattar fyra studier. Dess första syfte var att undersöka om och hur naturbaserade interventioner i grupp kan lindra ensamhet och stödja välbefinnande. Studie I, en systematisk litteraturöversikt av 38 artiklar, beskriver interventioner som bygger på 1) trädgårdsskötsel, 2) fysisk aktivitet och 3) naturliga element. De flesta studier utforskar hälsoeffekter på kroniskt sjuka eller segregerade grupper. Det stora spannet av deltagare, interventioner och mätare försvårade jämförelsen. I den narrativa analysen påvisade kvalitativa studier minskad ensamhet, medan de kvantitativa studierna visade en tydligare effekt på det allmänna välbefinnandet.

Det andra syftet var att undersöka naturens betydelse för äldre personer i serviceboenden, att analysera om det finns ett samband mellan naturrelation och psykiskt välmående samt huruvida detta samband påverkas av hälsotillstånd eller funktions-förmåga. Studie II och III bygger på en tvärsnittsundersökning. Totalt 854 äldre personer i 25 olika serviceboenden svarade på strukturerade frågor. Deltagarnas medelålder var 83 år, 54 % hade demens och 55 % led av ensamhet. Trots att 96 % ansåg att naturen är viktig, upplevde endast 51 % att de hade kontakt med naturen enligt önskan. Önskemålen för aktiviteter var tydliga och genomförbara, 83 % var intresserade att delta i naturbaserade interventioner. Naturrelationen hade ett samband med psykiskt välbefinnande och lycka och detta samband blev särskilt uttalat hos personer med dålig rörlighet.

Slutligen undersökte vi hur en naturbaserad intervention påverkar det psykiska välmåendet hos patienter inom primärvården samt om det finns skillnader i välbefinnande-utfall jämfört med en motionsintervention. Studie IV är en klinisk interventionsstudie där deltagarna (n = 79) rekryterades från en social- och hälsovårdscentral i Sibbo kommun. Efter den åtta veckor långa interventionen förbättrades självrapporterat välbefinnande och funktionsförmåga i både natur- och motionsgruppen, medan förbättringar i psykiskt välbefinnande och självrapporterad sömn endast observerades i naturgruppen. I naturgruppen förbättrades särskilt upplevelsen av att känna sig avslappnad, energisk, nöjd med sig själv, nära andra människor samt förmågan att hantera problem på ett bra sätt.

Naturbaserade hälsobefrämjande interventioner kan tillämpas i primärvården. Denna avhandling, som fokuserar på äldre vuxna och primärvårdspatienter med kroniska sjukdomar, konkluderar positiva resultat, särskilt för psykiskt välbefinnande. En framgångsrik implementering kräver personcentrerade tillvägagångssätt, stöd från betrodd vårdpersonal samt trygga och individanpassade program. Naturbaserade interventioner har potential att lindra symptom och att därmed minska behovet av läkemedel. Framtida forskning kan utreda naturinterventioners långtidseffekter och klargöra genom vilka mekanismer hälsoeffekter uppstår. Tillgång till naturmiljöer är en grundförutsättning för naturbaserade interventioner och för både individens och befolkningens hälsa.

Tiivistelmä
Terveyttä luontoperustaisin menetelmin perusterveydenhuollossa

Luontokontakteilla on syvällinen vaikutus ihmisten terveyteen. Osana sairaudenhoitoa luontoperustainen toiminta voi vähentää pitkäaikaissairauksien aiheuttamaa taakkaa. Pitkäaikaissairauksien hoidossa tavoitteet siirtyvät parantamisesta taudin etenemisen hidastamiseen ja oirehallintaan sekä toimintakyvyn tukemiseen huomioiden terveyden fyysiset, henkiset ja sosiaaliset ulottuvuudet. Yksinäisyys vaikuttaa negatiivisesti sekä hyvinvointiin että sairausennusteeseen. Luontokontaktin terveysvaikutukset riippuvat ympäristöstä ja toiminnasta sekä yksilön toiveista ja koetusta luontoyhteydestä.

Väitöskirjassani tarkastelen luontokontaktin vaikutusta ihmisen terveyteen keskittyen pitkäaikaissairaiden aikuisten psyykkiseen ja sosiaaliseen hyvinvointiin. Väitöskirja perustuu neljään osajulkaisuun. Ensimmäisenä tavoitteena oli selvittää, miten ryhmämuotoisia luontoperustaisia interventioita on hyödynnetty yksinäisyyden lievittämisessä. Tutkimus I on 38 artikkelia sisältävä systemaattinen kirjallisuuskatsaus. Kuvatut interventiot perustuivat 1) puutarhanhoitoon, 2) fyysiseen aktiivisuuteen ja 3) luontoelementteihin. Tutkimuspopulaatioiden moninaisuus vaikeutti vaikutusten vertailua. Narratiivisessa analyysissä laadulliset tutkimukset osoittivat, että luontoperustaiset interventiot voivat vahvistaa yhteenkuuluvuuden ja osallisuuden kokemuksia, kun taas kvantitatiiviset tutkimukset osoittivat selkeämpiä vaikutuksia yleiseen hyvinvointiin.

Toisena tavoitteena oli tarkastella luonnon merkitystä palveluasumisyksiköissä asuvien ikääntyneiden henkilöiden elämässä sekä selvittää, onko koetun luontoyhteyden ja psyykkisen hyvinvoinnin välillä yhteyttä ja vaikuttavatko terveydentila tai toimintarajoitteet tähän yhteyteen. Poikkileikkauskyselyyn (tutkimukset II ja III) osallistui 854 palvelutaloasukasta 25:stä yksiköstä Helsingin alueella. Vastaajien keski-ikä oli 83 vuotta, 54 % sairasti dementiaa ja 55 % koki yksinäisyyttä. Vaikka 96 % piti luontoa tärkeänä, vain 51 % raportoi pääsevänsä luontoon niin usein kuin olisi toivonut. Vastaajilla oli toteuttamiskelpoisia toiveita luontoperustaisesta toiminnasta, ja 83 % oli halukkaita osallistumaan luontoperustaiseen toimintaan. Koettu luontoyhteys oli yhteydessä psyykkiseen hyvinvointiin ja onnellisuuteen, ja tämä yhteys korostui erityisesti henkilöillä, joiden liikkumiskyky oli heikentynyt.

Viimeisenä tavoitteena oli selvittää, miten luontoperustainen ryhmätoiminta vaikuttaa perusterveydenhuollon potilaiden hyvinvointiin verraten sitä liikuntaryhmään. Kliiniseen interventiotutkimukseen (tutkimus IV) rekrytoitiin osallistujat (n = 79) Sipoon sosiaali- ja terveyskeskuksesta. Kahdeksan viikkoa kestäneen intervention jälkeen itsearvioitu hyvinvointi ja toimintakyky paranivat sekä luonto- että liikuntaryhmässä, mutta psyykkinen hyvinvointi ja itsearvioitu unen laatu paranivat ainoastaan luontoryhmässä. Luontoryhmässä parantuivat rentoutuneisuuden ja energisyyden kokemukset, tyytyväisyys itseen, läheisyyden tunne toisiin ihmisiin sekä kyky selviytyä ongelmista.

Luontoperustaiset menetelmät soveltuvat perusterveydenhuoltoon. Luontokontakti edistää etenkin mielenterveyttä. Henkilön koettu luontoyhteys näyttää moderoivan hyvinvointivaikutusta. Luontoperustaiset menetelmät osana sairaudenhoitoa edellyttävät potilaskeskeisiä lähestymistapoja ja luotetun ammattilaisen suositusta sekä räätälöityjä interventioita. Turvallisuusnäkökohtia huomioimalla mahdollistetaan kaikkien osallistumista. Luontomenetelmien pitkän aikavälin vaikutuksista sekä vaikutusmekanismeista tarvitaan lisäymmärrystä. Saavutettava, monimuotoinen luonto tukee sekä kansan että yksilön terveyttä ja on edellytys luontoperustaiselle toiminnalle.

List of abbreviations

ADL	Activity of daily living
ALF	Assisted living facility
ART	Attention restoration theory
CBT	Cognitive Behavioral Therapy
CCI	Charlson Comorbidity Index
CI	Confidence interval
COVID-19	Disease caused by the coronavirus SARS-CoV2
GNCS	Gerontological Nature Connection Scale
GP	General practitioner
IADL	Instrumental activity of daily living
ICOPE	Integrated care for older people
MMSE	Mini-Mental State Examination
NCDs	Noncommunicable diseases
NBI	Nature-based intervention
NBSP	Nature-based social prescribing
PWB	Psychological wellbeing
QA	Quality assessment
RECETAS	The research program “Re-imagining Environments for Connection and Engagement: Testing Actions for Social Prescribing in Natural Spaces”
SD	Standard deviation
SRT	Stress reduction theory
SP	Social prescribing
THL	Finnish Institute for Health and Welfare
WEMWBS	Warwick-Edinburgh Mental Well-being Scale
WHO	World Health Organization
WONCA	World Organization of Family Doctors

Table of Contents

Abstract **4**

Sammanfattning **5**

Tiivistelmä **6**

List of abbreviations **7**

Original publications **10**

1 Introduction **11**

2 Review of the literature **12**

2.1 Defining health and disease **12**

2.1.1 Physical health 12

2.1.2 Mental health 13

2.1.3 Social health 14

2.1.4 The levels of prevention 16

2.2 Defining nature and contact with nature **17**

2.2.1 Nature exposure 19

2.2.2 Nature connection 20

2.2.3 Theoretical research frameworks 22

2.2.4 The impact of nature contact through the lifespan 24

2.3 Supporting wellbeing as part of care **25**

2.3.1 Multimorbidity 25

2.3.2 Primary care: patient-centered and caring for the population 25

2.3.3 Targeted health promotion and social prescribing 27

2.4 Supporting health through nature-based interventions **30**

2.4.1 Nature-based solutions for health 30

2.4.2 Nature-based prescribing: an emerging process 31

3 Aims of the study **40**

4 Materials and methods **41**

4.1 Connecting through nature **42**

4.2 Importance of nature and Happy by nature **43**

4.3 The Health Forest intervention **47**

4.4 Ethical considerations **49**

5 Results 51
5.1 Nature-based interventions for social belonging and wellbeing 51
5.1.1 Participants and referral process 51
5.1.2 Intervention characteristics 52
5.1.3 Outcomes of group-based NBIs 53
5.2 Wishes for nature contact among older adults 56
5.2.1 Role of assisted living facilities in supporting nature contact 60
5.2.2 Nature connection and psychological wellbeing 61
5.3 The Health Forest intervention: a clinical trial in primary care 64
5.3.1 Effect on positive mental wellbeing 65
5.4 Results at a glance 68
6 Discussion 70
6.1 Main findings 70
6.2 Comparison with previous literature 71
6.2.1 Participants, recruitment, and interest in participating 71
6.2.2 Feasible nature-based interventions 73
6.2.3 The mediating role of nature connection 74
6.2.4 Health effects: from public health towards person-centered care 75
6.2.5 NBIs on the prevention ladder 79
6.2.6 Implementing nature-based prescribing in primary care 81
6.3 Strengths and limitations 83
6.4 Interpretation and significance of the results 85
7 Conclusion 87
8 Implications for clinics and future research 88
9 Acknowledgements 90
References 92
Appendices 112
Appendix 1: Developing the Gerontological Nature Connection Scale (GNCS) 112

Original publications

This thesis is based on the following publications:

I Sachs AL, Kolster A, Wrigley J, Papon V, Opacin N, Hill N, Howarth M, Rochau U, Hidalgo L, Casajuana C, Siebert U, Gerhard J, Daher C, & Litt J **Connecting through nature: A systematic review of the effectiveness of nature-based social prescribing practices to combat loneliness.** Landscape and Urban Planning. 2024;248:105071.

II Kolster A, Rautiainen LJ, Aalto UL, Jansson A, Partonen T, Sachs AL, Litt JS, Masó-Aguado M, Pitkälä KH. **The importance of nature and wishes for nature-based experiences among older adults in assisted living facilities.** Geriatric Nursing. 2025;63:300-6.

III Kolster A, Rautiainen LJ, Aalto UL, Kautiainen H, Jansson A, Partonen T, Litt JS, Masó-Aguado M, Pitkälä KH. **Happy by nature: Nature connection as a source of psychological wellbeing in assisted living facilities.** J Am Med Dir Assoc. 2025 Sep;26(9):105740.

IV Kolster A, Heikkinen M, Pajunen A, Mickos A, Wennman H, Partonen T. **Targeted health promotion with guided nature walks or group exercise: a controlled trial in primary care**. Front Public Health. 2023;11:1208858.

The publications are referred to in the text by their Roman numerals.
This thesis includes additional analyses and results from the material used in the articles.

1 Introduction

Health is more than the absence of disease; it is the possibility to fulfill one's potential and be active within the community [1]. Salutogenesis, i.e. circumstances that support wellbeing, is understudied compared to pathogenesis, i.e. factors causing disease. Physical, mental, and cognitive symptoms can either be caused or aggravated by social or behavioral factors such as sedentary living, chronic stress, loneliness, or sleep deprivation [2]. Achieving and retaining health is an individual and societal goal. Health care mostly focuses on the individual, while public health strategies target the population [3].

In the aging society, multimorbidity is increasing, and the goal of treatment will need to shift from curation to disease and symptom management [4]. Psychological wellbeing and the feeling of purpose are associated with reduced mortality, despite medical diagnoses [5-7]. Symptom management through non-pharmacological strategies potentially reduces polypharmacy and thereby adverse drug effects [8]. Therefore, supporting wellbeing and intrinsic capacity is an essential part of care [9].

Health has physical, mental, and social dimensions [1,10]. The understanding of health as a multi-dimensional entity, in which the importance of different domains may vary from person to person, is essential for this thesis. There is no consensus on how to best target health-promoting interventions [4]. Behavioral changes depend on social support, and local possibilities, in addition to the individual's medical state, motivation and functional ability. Social prescribing is a process supporting people with identified needs to engage in activities in the community, aiming to improve participants' capability and reduce health inequality [11]. As the number of people living with chronic disease is increasing, the need to develop effective and cost-efficient ways to support health and self-efficacy is urgent [9].

Contact with nature has a profound impact on human health. Evidence describes a wide range of positive health effects, including stress reduction, an increase in physical and social activity, and positive immune responses [12,13]. An individual's nature connection is instrumental for these outcomes [14]. Nature-based solutions enable human interaction with nature. Such advancement may either target the environment, e.g. by providing accessible natural spaces, or support individual behavior through nature-based interventions (NBIs). NBIs potentially improve health through multiple pathways simultaneously, given that the interventions meet the needs of the participants.

This thesis explores when and for whom NBIs are feasible in healthcare, focusing on mental wellbeing. It describes the process of nature-based prescribing. Furthermore, it investigates nature connection among older adults in assisted living facilities (ALFs), and how this connection is related to psychological wellbeing. Residents in ALFs have a high burden of disease. The thesis balances between public and person-centered healthcare.

2 Review of the literature

2.1 Defining health and disease

Good health is a universal wish, yet the meaning of health is broad and subjective. The World Health Organization (WHO) defines health as "*a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity*" [1]. Although the concepts of health and wellbeing are closely related, they are not interchangeable. Health is a more objective, measurable description than wellbeing, which is more subjective [15]. Health is not a static state [15,16], and intrinsic capacity and resilience enable persons to adapt and enjoy good wellbeing, despite diseases [17]. The physical, mental, and social dimensions of health overlap and depend on each other, as visualized in Figure 1 and explained in the following paragraph.

A medical disease is diagnosed through the evaluation of symptoms (i.e., the patient's subjective perception of illness) and signs (objective findings of physical impairment) [18], and established using the international classification of diseases, i.e. ICD-10 [19]. When possible, medical treatment targets the underlying reason for sickness. However, in chronic conditions, treatment aims to moderate disease progression, reduce symptoms and maintain functional ability. In the aged population, psychological wellbeing, including the feeling of purpose and positive life expectations, is associated with longevity and is a potentially protective factor for health [5-7,20,21].

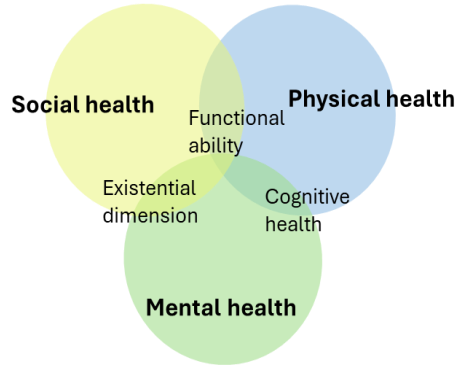

Figure 1 The dimensions of health overlap and depend on each other.

2.1.1 Physical health

Physical health refers to bodily function. A healthy organism can maintain allostasis, i.e. adapt to changing circumstances [12,16]. Allostasis relies on humoral, nervous, and immunological reactions. If adaption fails, allostatic load remains,

eventually causing illness [16]. Stress is a part of life to which the body adapts. Prolonged stress may, however, alter bodily function, cause prolonged symptoms, inflammation, and eventually disease [22-24]. Improvements in public health during the last century have been dramatic, resulting in a positive trend in life expectancy and a rapidly increasing population aged 65+ [25]. Furthermore, the disease burden has shifted. Infectious diseases are now mostly treatable, and noncommunicable diseases (NCDs) have become the leading cause of mortality[2]. In Finland, NCDs of particular importance to public health include: cardiovascular diseases, diabetes, asthma and allergies, chronic respiratory diseases, cancer, memory disorders, musculoskeletal diseases, and mental disorders [26]. Physical health is established through life, and some periods have a bigger impact than others. Genetic factors and the fetal period are estimated to determine 20% of an individual's health [27,28]. Lifestyle during the life course is the most important determinant, the approximated impact being 50% [2,27]. Lifestyle factors account for 60–80% of the origin of NCDs, which in turn cause 74% of deaths worldwide[2]. NCDs share five major risk factors: tobacco use, physical inactivity, harmful use of alcohol, unhealthy diets, and air pollution [2]. Insufficient sleep is also a major risk factor [29]. In addition to traditional risk factors, unknown common factors, i.e. environmental or stress-related factors, increase the burden of multimorbidity [30]. Chronic inflammation is part of the pathogenesis of NCDs [23]. The shift in disease burden has occurred simultaneously with a decline in contact with the natural environment, which raises the interesting question of whether biodiversity loss and inflammatory diseases are related [31].

2.1.2 Mental health

Mental health is not the absence of mental disorder but a state of self-awareness, autonomy, and capability. Good mental health is associated with reduced mortality [32], reduced mental illness, better physical health, and social functioning, as well as academic achievement [33 34]. As concepts, positive mental wellbeing, psychological wellbeing, intrinsic capacity, and resilience overlap and are used interchangeably, depending on the context. Positive mental wellbeing, also referred to as flourishing or thriving, includes six dimensions: 1) Autonomy, 2) Environmental Mastery, 3) Personal Growth, 4) Positive Relations with Others, 5) Purpose in Life, and 6) Self-Acceptance [35]. Intrinsic capacity is defined as the composite of the physical and mental capacities that an individual can draw on at a point in time [36]. Resilience is the ability to thrive in the face of adversity [37 12].

A psychiatric disorder changes a person's previous self. The prevalence of severe psychiatric disorders has been quite stable over time, and the lifetime prevalence of a psychotic disorders is 3% [38]. The annual prevalence of depression is 5–7 % [39]. In recent years, the use of anti-depressants and mental health services has increased

[40], although the prevalence of severe psychiatric disorders seems stable [41]. Anxiety and depressive disorders are now a leading cause of sickness benefit in Finland [42]. This raises the following questions: Are we facing a decline in mental health rather than a rise in mental disorders? Could a shift towards a more supportive approach help reduce both individual suffering and societal losses? The definition of mental health acknowledges the individual as part of a social construct, the community [43].

2.1.3 Social health

Social health refers to an adequate quantity and quality of relationships in a particular context to meet an individual's needs [44]. This definition embraces variation amid people, time, and situations. Social health includes the aspects identity, autonomy, social skills, and social connections [45], as presented in Figure 2. Societal norms, values, and culture can either support or weaken individual health [45]. Furthermore, the environment and public spaces highly impact how people live and interact [46]. Social participation is associated with better perceived health [47].

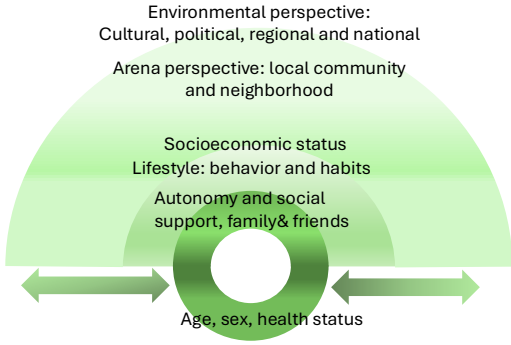

Figure 2 A visualization of the social dimensions of health. The individual's ability to be active in society varies. The factors closest to the individual matter most. An individual can act on several levels simultaneously. (Adapted from the generic dimensions of health model [48])

Loneliness is a negative experience of lacking meaningful relationships, whereas social isolation is a structural concept referring to few ties with others [49]. Social inactivity refers to a scarcity of participation in social activities [50]. Although the concepts overlap, they are distinct and appear to have different impacts on health [50,51]. Furthermore, loneliness has existential, social, and emotional dimensions [52]. Solitude is commonly considered a positive feeling and a chosen state, requiring autonomy [53].

Transient loneliness is common, but chronic or severe loneliness threatens health and wellbeing, and is a risk-factor as important as obesity, physical inactivity, and smoking [49,54]. Among older adults, loneliness and social isolation are associated with cognitive decline, poor wellbeing, and increased admissions to long-term care and mortality [55,56]. In younger populations, loneliness can determine health through the lifespan and increase the risk, for example, of mental disorders and cardiovascular disease [54,57]. Furthermore, loneliness is associated with lower

life satisfaction, negative perceptions related to care, a reduced effect of treatment, and increased use of healthcare resources [58,59].

The highest prevalences of loneliness and social isolation have been reported among people with poor physical and/or mental health, disabilities, in younger and older populations, those experiencing financial insecurity, living alone, and among single parents [49,53,54]. Life changes, such as falling ill, changes in family bonds, or unemployment, are risk factors for loneliness and social isolation. Professionals who meet people in these transitions have a key role in recognizing and addressing loneliness [59]. Supporting social connection on the individual and the community levels aids adaption and coping [60]. As loneliness is a subjective feeling, it is crucial to ask about perceived social health [52]. Although GPs and primary care workers are uniquely positioned to identify loneliness, health professionals often feel a lack of competence in addressing it [59]. Furthermore, the social dimension of health is the most difficult dimension to describe in research, as we lack validated measures [44,53 45]. Moreover, the process of building relationships is an outcome itself [45].

2.1.3.1 Functional ability

Functional ability refers to a person's capability to execute everyday tasks and activities. Basic needs, including mobility, personal hygiene, and eating, are referred to as activities of daily living (ADL) [61]. Instrumental activities of daily living (IADL) are more complex functions, such as performing and planning household work or caring for finances [62]. Functioning and disability associated with health conditions are classified using the International Classification of Functioning, Disability and Health (ICF), which is complementary to the ICD-10 classification [63]. Reduced functional ability becomes a disability if not compensated, but with aid, either physical or social, a person with disabilities can retain functional ability [64]. Frailty, an age-related clinical syndrome characterized by a decline in functional ability and vulnerability to stressors, is very common in the aged population, but under-detected [65 66]. An accessible environment corresponding to the individual's needs enables mobility and autonomy. However, actual physical activity also depends on the person's capacity and motivation [67]. Consequently, the environment can either support or reduce functional ability; moreover, supporting mobility treats disease and supports health [68].

The dimensions of health are intertwined and depend on each other. A physical disease reducing functional ability can cause social isolation, resulting in loneliness and poor mental wellbeing, loss of autonomy, and also cognitive decline [55]. Another person in the same situation receiving tailored support may adapt to the situation and regain wellbeing. However, both the individual's and the society's ability to adapt varies. Failure to respond in time may lead to poor outcomes; increasing health expenses, inequality, and a decline in population health [4,24,60,69].

2.1.4 The levels of prevention

Prevention refers to action aiming to avoid the occurrence or development of a health problem and/or its complications. The World Organization of Family Doctors (WONCA) describes four levels of prevention, as presented in Table 1 [70].

Table 1 The levels of prevention, as defined by WONCA [70]

PREVENTION: Action to avoid the occurrence or development of a health problem and/or its complications. Can be divided into four categories:
1**. Primary prevention**: Action taken to avoid or remove the cause of a health problem in an individual or a population before it arises. Includes health promotion and specific protection (e.g. immunization).
2. **Secondary prevention**: Action taken to detect a health problem at an early stage in an individual or a population, thereby facilitating cure, or reducing or preventing it spreading or its long-term effects (e.g. methods, screening, case finding, and early diagnosis).
3. **Tertiary prevention**: Action taken to reduce the chronic effects of a health problem in an individual or a population by minimizing the functional impairment consequent to the acute or chronic health problem (e.g. prevent complications of diabetes). Includes rehabilitation.
4. **Quaternary Prevention**: Action taken to identify a patient at risk of overmedicalization, to protect him or her from new medical invasion, and to suggest to him or her interventions that are ethically acceptable.

Health promotion primarily takes place in society [3]. Health care's role is accentuated in secondary and tertiary prevention [71]. Understanding whether an action is taken to prevent a disease, to target a prevailing risk factor, or to avoid impairment of an existing condition is crucial for setting relevant treatment goals, but also for using available resources wisely [3].

Up to 20% of all medical treatments may be of no use or even harmful [70,72,73]. Therefore, quaternary prevention, i.e. reducing low-value care, calls for attention. Low-value care is best targeted by increasing awareness among health professionals as well as the lay public [73]. The *Choosing wisely* (2012-2023) was a broad international initiative to promote quaternary-prevention, an aspect now increasingly considered in clinical care recommendations. Two examples are the Finnish *Vältä viisasti* recommendation to avoid benzodiazepine medication for common sleeping disorder [74], and the Swedish *Kloka Kliniska Val* campaign highlighting that medication should not be the first option for treating mild depression and mental illbeing [75]. The evidence supporting these recommendations refers to the side effects and harm that the medication can cause to the individual, further, low-value care poses unnecessary harm to the environment and excessive use of health care resources [76].

2.2 Defining nature and contact with nature

The complex relationship between human health and the environment has developed throughout evolution. When exploring the current understanding of this interconnection, we balance between public and individual health. The health effects of the surroundings depend on the behavior of the individual [77]; however, the individual can only act and possibly adapt within the given range of the surroundings. Although recognizing the intrinsic value of the natural world, in this thesis, nature and natural elements will be described in relation to human health. Nature concepts are presented in Table 2. These concepts are related to 1) the environment and its qualities and 2) the individual's perception of nature and the way in which a person interacts within the environment, and, specifically, how this resonates with values and needs.

Table 2 Explanations of the concepts relating nature to health.

Concept	Explanation
Nature	Physical features and processes of non-human origin that people can ordinarily perceive, including living nature, still and running water, qualities of air and weather, and the landscapes that comprise these and show the influence of geological processes. [78]
Climate	The average weather conditions for a particular location over a long period of time, ranging from months to thousands or millions of years [79]
Weather	The state of the atmosphere at a particular time, including temperature, precipitation, atmospheric pressure, wind, and humidity. [79]
Biodiversity	The variability among living organisms from all sources including, i.a., terrestrial and aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems. Biological resources include genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity. [80]
Microbiome	The human microbiome consists of all microbial organisms and their genetic content in the human body [81].
Living nature	Flora and fauna [78]
Natural environment	An environment with little or no human presence [78]
Greenspace	Land covered by vegetation of any kind. Includes vegetation on private and public grounds, irrespective of size and function. Greenspace is commonly measured through satellite images [82]. Definitions can be nuanced and context-specific and depend on the considered environment–health pathways. Therefore, we specify: **Accessible greenspace** – places that are available for the general public to use free of charge, mostly without time restrictions. **Natural greenspace** – places where human control and activities are not intensive, and a feeling of naturalness predominates. May exist as a distinct typology but also as discrete areas within other greenspace. [83] **Urban greenspace** (a.k.a. urban nature) - An environment with natural features, often planned and partly manmade, e.g. a park, trees in a city, or planted flowers.

Concept	Explanation
Bluespace	Outdoor environments that prominently feature water, such as oceans and coasts, rivers, lakes, and ponds. [84]
Other landscape	Research rarely focuses on health and whitespace, i.e. landscape with water in a solid state, e.g. snow, or brownspace, e.g. desert or rock. [85]
Urban greenspace interventions	Actions that significantly modify the quality, quantity, and accessibility of urban greenspace. This can be done by establishing new urban greenspaces or by changing the characteristics and functions of existing ones. [86]
Gardening	Gardens are spaces used to grow plants and flowers; they may be private or common. Gardening includes potting and caring for plants (indoor and outdoor). Activities offer possibilities to exercise, connect with others, and grow food. Examples: allotment gardening, guerrilla gardening (small gardens in urban spaces), and community gardening [87].
Horticultural therapy (HT)	Integrates structured gardening and qualified therapy [87]
Forest	Tree-covered land. Includes rural forests for wood production, managed woodland for recreation purpose (i.e. national parks), and untouched, natural forests. [88]
Forest therapy (FT)	Activities guiding participants to actively connect with nature, often by supporting mindfulness and activating senses. FT is not usually defined as containing qualified therapy [89]. However, therapeutical treatments in forests have also been developed [90].
Natural elements	Elements used to promote connection with nature in a restricted setting. These elements include pictures, sounds, smells, and objects.
Nature dose	Tools used to assess 1) objective time and types of activities pursued in nature, 2) subjective perceptions of nature, biodiversity, and experiences, and 3) actual biodiversity present at an intervention site. [91]
Nature experience	The subjective experience of nature as such [78]
Nature connection	No established definition of nature connection exists. In this thesis, the following definition is used: Nature connection is a relationship between the self and the natural world, a sense of personal identity, which includes cognition, emotions, and behavior.
Pro-environmental behavior	Actions, attitudes, and intentions that contribute to or promote the wellbeing of nature around us [92].
Eco-anxiety	A wide range of ecologically oriented affective experiences, including both negative emotions, i.e. sadness and distress, but also the will to act [93].
Biophobia	Aversion to nature [94]
Interaction with nature	Interaction may be intentional or unintentional [84]. Level of interaction: 1) viewing, 2) incidental presence of nature, and 3) active participation and involvement [95]
Nature deficiency	A term to describe a lack of contact with nature [96]

2.2.1 Nature exposure

Research on the interconnection of nature and human health has mostly been conducted in urban contexts, where the health effects of affinity to natural spaces are compared with built environments [97]. Some of the evidence has manifested after the loss of biotopes, biodiversity, and greenness [31,98,99]. An umbrella review by Yang et al. analyzed 40 systematic reviews and meta-analyses exploring the impact of urban nature on health [97]. The reviews primarily concluded cross-sectional material, the studies were conducted in high-income countries, and, furthermore, methodological limitations and risk of positive bias were noted. Drawing from this evidence, the review found beneficial associations of greenspace with all-cause and stroke-specific mortality, cardiovascular morbidity, cardiometabolic factors, mental health, low birth weight, physical activity, sleep quality, and urban crime rates. No consistent associations between greenspace and other health outcomes (e.g., cancers) were observed [97]. It is estimated that two-thirds of the global population will live in cities by 2050. Therefore, urban nature and greenspace has a crucial impact on public health [86,100].

Residential greenspace displays an inverse association with all-cause mortality, especially that caused by cardiovascular disease [82,101]. In urban settings, a distance of 300–500 m is commonly considered as living close to a natural environment, this distance has mostly been measured using satellite imaging [82]. Other applied measures include self-reported outdoor visits and greenspace exposure [102]. Future research may apply more sophisticated data from global positioning systems (GPS) to see where people spend their time [103,104].

Nature exposure may be intentional, i.e. the person chooses to spend time in a certain environment, or unintentional [84]. Interaction with natural spaces can be divided into three levels: 1) viewing nature (either real or reproduced), 2) incidental engagement with nature (exposure while engaged in some other activity), and 3) direct engagement (defined as implying an active decision to visit a natural surrounding) [95]. All three levels of interaction appear to influence human health, although differently [95]. In addition to psychological aspects, the type of nature exposure has an impact. Direct contact includes touch and microbe exposure; it also activates more senses than indirect contact [84,105].

Throughout history, nature has been a part of everyday life, providing unintentional direct contact. Recreational nature visits are a new phenomenon. Nature might even become a luxury, if encounters require resources, such as time, economic means, and land. Accessible natural surroundings in residential areas have a large potential impact on public health [106,107]. Urban planning may enable everyday activities, such as biking or walking to work. Increasing and managing greenspace is recommended as an approach to improve public health in urban settings [82,86,108].

2.2.1.1 Nature dose

Measuring the nature dose, i.e. the amount and type of interaction that modifies health outcomes, is challenging [109]. Research has often focused on time spent outdoors. However, the individual variance in interaction with the natural world makes time an insufficient measure [110]. Aspects such as temperature, air quality, and biodiversity should be assessed [91]. In addition, the aesthetics, enjoyability, and perceived safety of outdoor areas need consideration [14,88,111,112]. Direct contact with a biodiverse environment enriches the microbiome on the skin and in the gut [81]. Factors beyond human control, such as weather, have an impact not only on behavior but also on the physical response. For example, humidity and a stable temperature are often beneficial for a person with chronic cardiovascular disease, while hot or cold temperatures might cause harm, with extreme temperatures ultimately increasing mortality [113]. New tools for assessing the nature dose will help future research [91].

Primary prevention targets the whole population, but it is noteworthy that the importance of such actions is accentuated in vulnerable populations. Clean air is an example. In 2021, more than 90% of the urban population in the EU was exposed to harmful levels of air pollution, a well-described risk factor for several medical conditions [114]. The greatest burden of disease arises from ischemic heart disease and diabetes mellitus. Small children are especially sensitive to air pollution [114]. Reducing air pollution is beyond the scope of a single person, but through awareness, one can avoid or reduce harmful exposure.

2.2.2 Nature connection

The health outcomes greatly depend on the way an individual interacts in and with nature, including habits, preferences, and capability. Health effects appear to correlate more with the perceived nature connection and engagement than the actual time spent outdoors [110,115].

Nature connection is the relationship between the self and the natural world, a sense of personal identity, which includes cognition, emotions, and behavior. In this thesis, I use nature connection as a umbrella term, including the partly overlapping concepts of nature relatedness, connectedness with/to nature, emotional affinity toward nature, connectivity, and a feeling of being part of nature [39,92,110,116-118]. Several scales for assessing nature connection exist, three examples are presented in Table 3. It is recognized that the quality of the existing scales needs improvement, and that the age, culture, and needs of the target groups are not recognized [118]. In addition, the scales vary in whether they regard the dimensions of health and include functional ability.

A small but consistent association between nature connectedness and happiness is recognized. However, the concept has mostly been explored among young and

healthy individuals [116]. Nature connection is sometimes considered a personality-like trait that is stable over time, fluctuating only slightly, even though the amount of contact might vary substantially during different periods in life [92,116]. Other researchers argue that nature connection can be strengthened and improved through active actions, also being instrumental to wellbeing [119]. Qualitative research indicates that the connection changes during the life course, e.g. retirement can give more time for observation and activity. However, following physical decline, undemanding activities, including gardening, have been found to be preferred, and accessible greenspace becomes increasingly important [120]. The need to define whether nature connection is to be considered a trait or state is acknowledged [118]. Most researchers agree that the relation to nature is established during childhood, and that meaningful moments have an important impact in establishing connection [110,121,122]. Biophobia, aversion to nature, is rarely described, but might increase as nature becomes more distant [94].

Table 3 Examples of scales and measures used to assess nature connection.

Scale	Questions	Interpretation
Nature Connection Index (NCI) [123]	1. I always find beauty in nature 2. I always treat nature with respect 3. Being in nature makes me very happy 4. Spending time in nature is very important to me 5. I find being in nature really amazing 6. I feel part of nature	1–7: Completely agree – completely disagree NCI items and weighted points index for each point on the response scale. A conversion spreadsheet is available. QA: Doubtful/low quality [118]
Nature Relatedness Scale – Short Form (NR-6) [124]	1. My ideal vacation spot would be a remote wilderness area 2. I always think about how my actions affect the environment 3. My connection to nature and the environment is a part of my spirituality 4. I take notice of wildlife wherever I am 5. My relationship to nature is an important part of who I am 6. I feel very connected to all living things and the earth	Scale 1–5: Disagree strongly–Agree strongly In 7 surveys involving about 1,000 people, average scores ranged from ~3.0 to 3.5, with 70% scoring between ~2.2 and 4.3. Definition: "Individual levels of connectedness with the natural world" QA: Moderate/sufficient quality [118]
Extended Inclusion of Nature in Self scale (EINS) [125]	A visual scale with circles representing self and nature. Question: Please choose the picture below which best describes your relationship with the natural environment.	Scale 1–7, the circles move from being completely apart, to being one. QA: Moderate/sufficient quality [118]
QA = Quality assessment		

Social and cultural aspects impact the relationship with nature [92,118,122]. In Finland, nature is generally highly appreciated. In a cross-sectional internet survey, 84% of the more than two thousand respondents considered everyday contact with nature to be an important part of everyday life [126]. Respondents considered nature a source

of immaterial wellbeing, offering relaxation and restoration from everyday stress, and the appreciation of nature was highest among academically educated women older than 65 years [126]. Supporting the connection with nature requires understanding of individual preferences and needs[127].

2.2.3 Theoretical research frameworks

The health effects of nature depend on factors related to the individual, as well as the environment, as visualized in Figure 3.

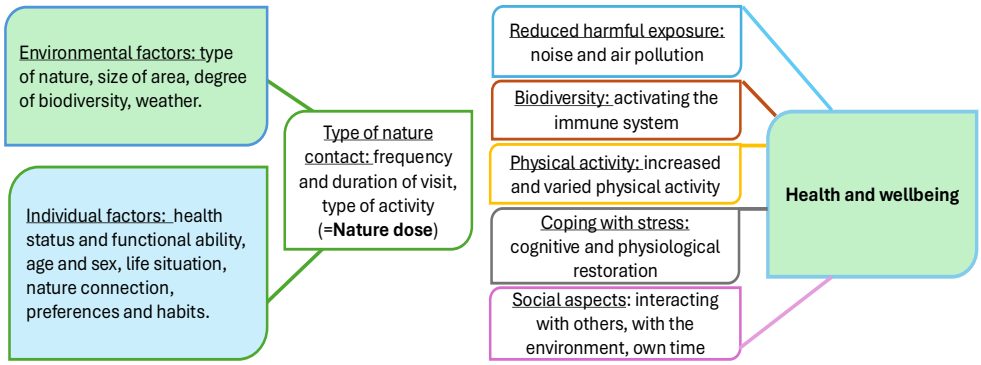

Figure 3 Health effects depend on the environment, the individual, and the activity. The figure is modified from Hartig et al. [78]

The theoretical guidance for research has evolved during the last decade. *"Nature and Health"* by Hartig et al. recognized the need to define and measure nature exposure and described mediating pathways through which nature impacts health [78]. A health impact was concluded to arise through 1) air quality, 2) physical activity, 3) social contacts, and 4) stress reduction. Hartig et al. acknowledged that these pathways are intertwined and co-existing. The authors discuss methodological challenges related to measuring nature exposure, selecting relevant outcomes and demonstrating causality at the population level.

The restorative capacity of nature has been rationalized by the stress recovery theory (SRT) and attention restoration theory (ART). The SRT underlines that contact with nature promotes a positively toned mental state, activates the parasympathetic nervous system, and reduces existing stress [128]. Stress recovery is not only a feeling, and exposure to natural environments also reduces physiological stress responses [128,129]. The ART emphasizes that nature restores the ability to direct attention [130]. Both healthy and vulnerable populations have displayed improved cognitive function during and after outdoor interventions [129,131,132]. Over time, a lack of restoration can lead to mental and physical illness [46].

Focusing on health and greenspace, an explanative framework, "*Exploring pathways linking greenspace to health: Theoretical and methodological guidance"* describes three domains: 1) reduced harmful exposure, 2) enhanced healthy behavior, and 3) activation of human restorative capacities [14]. The recommendations for future research include the use of spatial measures for greenspace, as well as utilizing individual behavioral or perceptual measures to further understand the impact and mediating role of the domains. Perceptual measures include perceived greenness, access and attractiveness, safety, perceived restorative quality, and social cohesion. In addition, the need for longitudinal and experimental studies is highlighted.

Further guidance builds on previous conceptualizations. "*Pathways linking biodiversity to human health: A conceptual framework"* adds the mediating role of both perceived and actual biodiversity [84]. Intentional vs unintentional contact with nature is discussed, as well as direct and indirect contact with biodiversity. This framework proposes that indirect intentional contact with high perceived biodiversity, such as looking at pictures, also has positive health outcomes. The dimensions of health are recommended to be assessed through both observation and self-reported measures.

Exploring physical health, the study *"Hunt for the origin of Allergy*" in Karelia is to be considered ground breaking [133]. Karelia was divided by the closed border between Finland and the Soviet Union from 1944 until 1991. In Finland, the incidence of allergies and asthma increased rapidly. However, this was not seen in Russia, as confirmed by blood tests [133]. Furthermore, the prevalence of allergies did not differ among adults born in the 1940s. In Russia, the traditional rural lifestyle retained close contact with a biodiverse environment, supporting a diverse microbiome on the human skin and gut, triggering a favorable immune response [81,84]. Moreover, type 1 diabetes, an autoinflammatory disease, was six times more common in Finland [134]. The findings in Karelia led to the *biodiversity hypothesis*, proposing that a loss of biodiversity leads to chronic inflammation and an unfavorable immune response [31,81]. Chronic inflammation and the auto-immune response play a crucial role in the pathogeneses of most NCDs [31,81].

The most recent framework, "*Nature-based biopsychosocial resilience: An integrative theoretical framework for research on nature on health,*" introduces the nature-based biopsychosocial resilience theory [12]. This includes the concepts of preventive resilience, response resilience, and recovery resilience. The article applies the levels of prevention to nature-based interventions, and through examples it illustrates how NBIs may support adaptation through different stages of a disease.

2.2.4 The impact of nature contact through the lifespan

The pathways through which nature contact influences health vary through life, as outlined in Figure 4. Biodiversity is crucial for the evolving immune system. Early direct contact with a diverse environment triggers healthy immune responses and is especially important during pregnancy and infancy [81,133]. Continuous diverse exposure is beneficial during childhood [81,135], and might also reduce symptoms of existing allergies for adolescents and adults [136]. There is ongoing research exploring whether exposure to natural microbes may enhance the effect of vaccinations by triggering the immune response [137].

For children, natural surroundings provide an activating playground. However, the amount of physical activity depends on the family [104,138]. Among adolescents, the role of hobbies, friends, and the place of residence increases [139]. Well planned greenspace may support physical activity among adults, potentially providing opportunities for everyday exercise [140]. For older adults, the mediating role of exercise decreases and health benefits appear to arise through other pathways [101]. Everyday chores may, however, provide a reason for activity.

The need of stress recovery is accentuated among adults, and nature is a source of resilience, especially during difficult times [112]. Nature supports self-regulation of emotions at all ages [25,118,122]. Nature connection is established during childhood and is enforced by joint experiences and by spending time in nature [121,122,139]. During youth and early adulthood, the quality of or, on the contrary, a lack of social bonds influences the time spent in and the subjective importance of nature [127,139]. Experiences during youth may be formative [131]. Nature connection has commonly been considered stable during adulthood. However, both qualitative findings [120] and population surveys [126] indicate that the importance of nature might be accentuated in difficult times, and in old age.

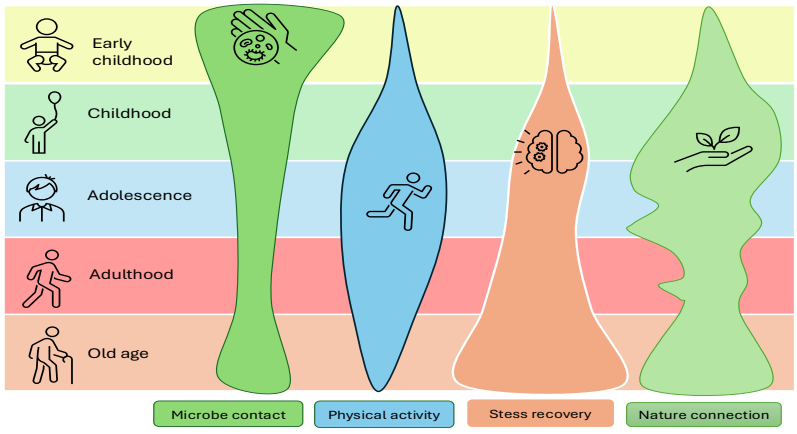

Figure 4 A visualization of the relative importance of the different pathways of contact with nature during successive stages of life

2.3 Supporting wellbeing as part of care

Traditionally, medical treatment has targeted disease. However, in chronic conditions, and especially in the aging population, supporting wellbeing and self-efficacy improves health at both the individual and population levels [36,141]. Salutogenesis, the origin of health, is a much less researched concept than pathogenesis, the origin of disease. The concepts are complementary, not opposite [46]. The importance of supporting intrinsic capacity and functional ability alongside disease management and pharmacological treatment is increasingly recognized as a path to healthy aging [5,9,17,142]. The Integrated Care for Older People (ICOPE) guidelines support integration of the clinical level and service/system level, thereby shifting care activities from the hospital towards the community [9].

2.3.1 Multimorbidity

Multimorbidity is defined as two or more coexisting chronic medical diseases or sensory impairments that are independent of each other [4]. In Finland, 31% of men and 44% of women in the age group 18–64 years have multimorbidity, while among 65–85-year-olds, the corresponding figures are 77% for men and 79% for women [66]. Multimorbidity increases the risk of poly-pharmacy, a poor quality of life, and reduced functional ability [66]. Multimorbidity is a heterogeneous concept. Some disease clusters, such as cardiovascular diseases, are best tackled by medication and the treatment of risk factors, while other clusters call for a more holistic approach [66]. Chronic pain, insomnia, and depressive symptoms are associated with multimorbidity. Furthermore, it is acknowledged that some conditions, including frailty and depressive symptoms, are under-detected [66]. Longevity has increased the number of people living with multimorbidity and the need of healthcare [4,143]. Health systems must develop and adapt new strategies to support and retain functional ability, targeting both individuals and the population [144].

2.3.2 Primary care: patient-centered and caring for the population

Primary care is often the first point of medical contact within the healthcare system, thereby caring for a wide range of health problems and people. Reasons for contact include medical problems, symptoms, and general illbeing [145]. Furthermore, in Finland, primary health care provides a wide range of health-promoting services. Primary care is a broad multi-professional field, and in addition to early disease diagnostics, it also handles the management of chronic conditions and long-term care. General practice is part of primary care, with a specific responsibility for the health of the community and, as recently acknowledged, the environment [146,147]. General practitioners (GPs) consider the dimensions of health and apply a person-

centered approach. This includes considering not only the individual, but also their family and the community [147]. Continuity of care, i.e. longitudinal follow-up, and the relationship between the patient and doctor increases trust and has repeatedly been shown to be instrumental to better care, patient safety, and the efficient use of healthcare resources [148]. Through patient empowerment, timely health promotion is integrated in care. However, general practice has a focus on secondary and tertiary prevention [71].

High perceived stress is known to increase the use of primary care services [24]. Moreover, symptoms secondary to stress, such as anxiety, insomnia, or physical symptoms, are a common cause of contact [69,149] Frequent attenders commonly suffer from symptoms that might not be due to a specific medical diagnosis but illbeing [150] [69]. Social isolation increases the use of primary healthcare services [151]. Health care must identify and address these non-medical needs to avoid medicalization and overtreatment, but first and foremost, to help the individual patient. Person-centered care, a core value in general practice, is an approach that acknowledges the link between life events and health and promotes the capacity of patients to draw on their individual and communal resources. [152]. Although GPs recognize loneliness and stress, addressing these issues is often considered challenging [24,59]

Finland is a high-income welfare country with a high life expectancy. However, health inequity, i.e. an unfair situation in society where some have more opportunities than others, is an acknowledged and persistent public health challenge [153] [154]. In 2022, 65% of the Finnish population reported their health to be good. However, in the highest income group, this figure was 75%, and in the lowest income group, only 53% [154]. Supposedly, a part of the population needs tailored support to retain health.

Strong primary health care is recognized as essential for coordinating care in the aging population [143]. In 2023, Finland underwent a health reform, aiming to integrate social and health services, reduce socioeconomic and geographic inequalities, ensure the quality of health, strengthen primary care, and control costs [155]. Following the reform, the responsibility of organizing primary health care was relocated from municipalities to wellbeing services counties. In addition, the management and responsibilities of health and wellbeing promotion have changed, and national projects aim to support health promotion on a national level [60].

Long-term care for the ageing population in Finland

The health policy in Finland supports aging in place, and older adults primarily live in their own homes. Long-term care becomes relevant when a person needs more care and assistance than can be provided at home [143]. In the population, of those older than 75 years, 8% live in long-term care, while for persons aged 85 years or

older, the corresponding figure is 17% [156]. Assisted living facilities (ALFs), the most common form of long-term care, offer a home-resembling environment, also providing end-of-life care. Facilities differ greatly; they do, however, commonly provide social and physical activities to complement care. Residents in ALFs commonly have either cognitive or functional decline and several comorbidities, limiting their independence [157]. Previous studies have revealed that 35% of the residents in ALFs suffer from loneliness [158]. Associated symptoms, such as anxiety, depression, and insomnia, lead to a risk of medications potentially causing harm [159]. The treatment goal shifts from prevention and curation to palliative care and maintaining quality of life. Psychological wellbeing and the will to live are independent prognostic health outcomes [64]. Interventions supporting psychological wellbeing and reducing loneliness not only improve quality of life, but may also reduce the need for medical care and even mortality [160]

2.3.3 Targeted health promotion and social prescribing

Targeted health promotion aims to achieve behavioral change, e.g. to increase physical activity, promote a healthy diet, or support social cohesion among individuals or groups with a defined need. Long-term outcomes and sustainable behavioral changes are difficult to achieve, and no clear consensus on the effectiveness of interventions exists [4,161,162]. Multidomain lifestyle interventions may slow disease progression in many medical conditions, including dementia [163] and cardiovascular disease [164]. By targeting several risk factors and diseases simultaneously, such interventions address multimorbidity. Among older adults, the best long-term impact has been demonstrated in interventions that support all dimensions of health [165]

Physical activity is a central part of targeted health promotion. Sedentary behavior is a well-described risk factor for poor health and disease [166]. The potential positive health impact is greatest if those with very low levels of physical activity can improve their activity levels [167,168]. Accessible outdoor areas provide opportunities for activity, but it is to be recognized that inactive individuals might experience psychological or social barriers to participation [169]. In the general population, long-lasting interventions have also failed to increase physical activity [161]. Among older adults, interventions succeeding in increasing physical activity have acknowledge the social dimension of health [170].

The health cross (Figure 5) visualizes the individual's medical health and perceived wellbeing as two different dimensions. Wellbeing includes mental and social wellbeing and health-literacy, capacities that support resilience and self-care. Distinguishing health and wellbeing helps professionals to estimate the need for support.

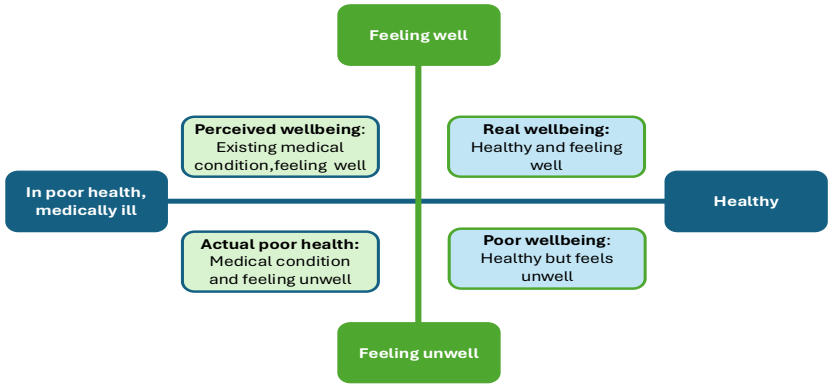

Figure 5 The health cross differentiates actual (medical) health (*blue line*) and perceived wellbeing (*green*). This visualization helps to distinguish medical needs and wellbeing as two parallel and complementary dimensions.
Adapted from Eriksson's theory of multidimensional health [171]

Although targeted health promotion is a central part of the work in primary care, the pathways and responsibilities vary highly within Finland [71]. Patients in need of intensified health guidance commonly have poorer health literacy and capability and need support beyond providing knowledge. Supporting healthy behavior could reduce health inequality [26]. As the disease burden caused by NCDs is rising and the population is aging, the need for effective interventions is urgent [2,168,172]. However, the effect and implementation of holistic strategies, such as supporting the intrinsic capacity of older adults, is not sufficiently established [173]. The discussion on who has the best expertise to support patients in need of health promotion is important, as the demands in general practice are high, and there is a lack of workforce [174].
Social prescribing (SP) is an emerging concept, a process through which trusted individuals in clinical and community settings refer persons with identified, non-medical needs to non-clinical support in the community [175] [11,176]. The process of social prescribing has recently been defined as presented in Table 4. The practice originated in the United Kingdom; however, similar systems have simultaneously emerged globally [177,178].

Table 4 The operational definitions of social prescribing [175]:

Social prescribing is "a holistic, person-centred and community--based approach to health and well-being that satisfies Condition 1 and either Condition 2 or Conditions 3 and 4:

► Condition 1: Identifier identifies that person has non-medical, health-related social needs (e.g., issues with housing, food, employment, income, social support)

► Condition 2: Identifier connects person to non-clinical supports and services within the community by co-producing a non-medical prescription

► Condition 3: Identifier refers person to connector

► Condition 4: Connector connects person to non-clinical supports and services within the community by co-producing a non-medical prescription"

Social prescribing is complementary to medical care and should have a clear aim. The process of referral within social prescribing varies, and existing praxis is visualized in Figure 6. [11,179]. Signposting, or unstructured referral, is a common recommendation of activities in the community. Information may be provided using printed or digital material. Through direct referral, the health professional enrolls the patient in an activity. In the link worker model, the health professional refers the patient to a connector, who supports the partaker in finding a suitable activity. The holistic models include feedback from the activity provider, allowing follow-up of the effects of the intervention. A holistic model can either be individual or group based. Such models are seldomly used in real life [11]. The social prescribing process depends on the healthcare system and the activities available in the community, and local solutions are therefore needed [178]. In Finland, the concept of social prescribing (Hyvinvointilähete) has been utilized in Lapland [180]. Although the approach is only emerging, recent development has provided a wide range of wellbeing services through digital signposting on a national level [60].

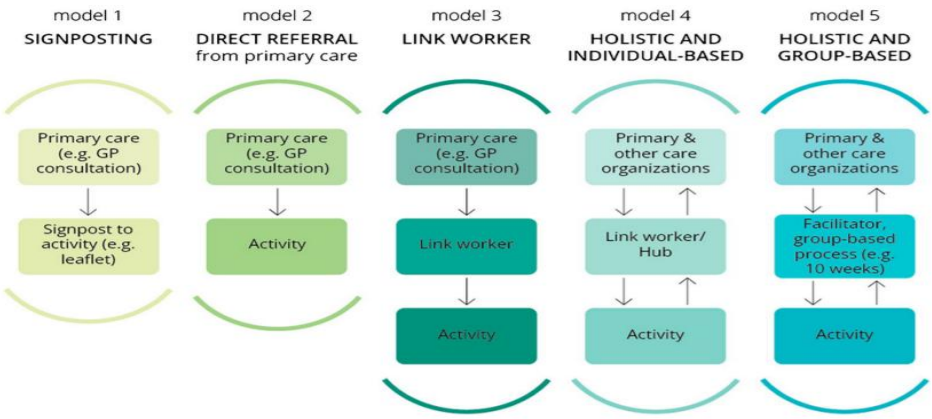

Figure 6 A visualization of the existing social prescribing processes, as presented by Litt et al. 2023 [179]

A systematic review focusing on older adults identified three critical components in social prescribing: 1) assessment before prescription, 2) matching participants with relevant activities, and 3) individualized support from a link worker. [181] The social prescribing movement aims to tackle several global sustainability challenges. By supporting health as a broad concept, SP may support self-efficiency [11] Furthermore, interventions aim to empower both the individual and the community, and thereby tackle segregation and health inequality [177]. By reducing the need for pharmaceutical treatments, SP may decrease the risks of overprescribing and the strain that pharmaceuticals pose on the environment [76]. A well-working process may reduce the need for healthcare, and thereby costs [182].

2.4 Supporting health through nature-based interventions

Nature-based solutions support public health by enabling access to natural habitats and greenspace, while nature-based interventions attempt to include people who do not engage by themselves [183]. Nature-based prescribing describes processes through which clients or patients are referred to NBIs.

2.4.1 Nature-based solutions for health

Most outdoor visits take place close to home, and residential greenspace therefore has special importance [106]. In urban surroundings, city planning enables nature-based solutions, and furthermore, community initiatives may improve the local environment. Greenery decreases air and noise pollution and may buffer temperature [82]. For the sustainable use of natural environments, the use of areas with sensitive biotopes needs consideration and planning. Natural environments serve several simultaneous functions: a park may provide protection against flooding and reduce heat islands, in addition to beauty and recreational use [107]. Urban nature in the vicinity of schools and kindergartens has not reduced obesity among children, while adults are more active if there is greenspace close by [13,140]. Safety and accessibility need consideration so that citizens of all ages can enjoy urban nature [46]. There has been little research on which qualities of greenspace reduce loneliness [111]. Frequent visits to local greenspace are associated with better mental health for both people living alone and those living with a partner, an effect that arises through relational and collective restoration [184].

For older adults, accessible areas close to home enable nature contact [185,186]. A global meta-analysis found that urban greenspaces, particularly those featuring community gardens, had a significant positive impact on the health of older adults, including those individuals with dementia [187]. This review reported effect sizes as follows: reduced incidence of dementia (-0.06), improved social participation (0.14), increased physical isolation= independent spaces (0.54), reduced anxiety (-0.28), relieved depression, relieved mental disorders (-0.32), calmed agitation (-0.06), increased positive emotions (0.10), reduced sadness and anger, improved quality of life, enhanced cognitive function (0.52), and improved sleep [187]. On a population level, small effect sizes are also meaningful. Preserving and increasing urban greenspace is recognized by WHO as a strategy to support public health [83].

Residents in rural areas face different challenges. Nature is present, but accessibility might be challenging. The impact of surrounding green or blue space on the amount and intensity of physical activity is debated. Some studies have reported an increased amount of moderate exercise while others have not, and this outcome probably varies with age and the social situation [188-190] As an example, in

a population study in northern Finland, residential greenness increased physical activity among men but not women [191]. In Finland, children and young adults living in rural areas are less physically active than those living in cities [192].

Although proximity to nature is beneficial, being outdoors and interacting with nature improves health further [13,102,133]. A Finnish cross-sectional population study demonstrated that those frequently spending time outdoors in natural environments used less psychotropic, antihypertensive, and asthma medication, while this association was not seen for people only viewing nature [102]. Outdoor exercise appears to have a more positive effect on psychological wellbeing than indoor exercise [193]. Moreover, the impact of surrounding greenness on mental health is accentuated for those who are physically active [194]. Understanding how, or whether, exercise in natural surroundings provides additional health benefits to physical activity is of importance for targeting preventive intervention [190]. Particularly among older adults, health outcomes of contact with nature might not be mediated by physical activity [195,196]. Nature's restorative potential may be activated by several triggers, such as smells and sounds, in addition to visual elements [105]. Understanding the needs of residents in long-term care is crucial to adapt nature-based solutions to their needs [197].

The potential of different types of natural habitats has been investigated. Generally appreciated qualities of woodland include fascination, an escape from routines, and the environment being compatible with personal needs [88]. However, not all qualities need to be met in order for a forest to be restorative [88]. Old forests are considered more restorative; however, people enjoy different qualities in the landscape [88]. The restorative potential of bluespace is increasingly acknowledged, and other types of nature have been investigated [85]. Restorative experiences using favorite places refers to an individual's active use of a valued place for self-regulating psychological strain [112]. Persons feeling stressed or perceiving physical symptoms are more likely to seek comfort in a natural environment, and report better outcomes from these visits, as compared to those feeling healthy [198]. The use of favorite places requires autonomy. Moreover, such self-regulation concerns poor mental health rather than psychiatric disorders. Severe depression or a psychosis may manifest as withdrawal from social contacts, and such conditions must be identified as for safe NBIs [183].

2.4.2 Nature-based prescribing: an emerging process

The novelty of nature-based interventions as part of care is demonstrated by the undefined labelling; the terms nature prescription, green prescription, nature-based prescribing, and nature-based social prescribing (NBSP) are used synonymously. Despite unclear nomenclature, the components are similar or even identical. Nature-based prescriptions aim to address the burden of chronic disease

and increase physical activity, social connectedness, and pro-environmental behavior; they can thereby be considered similar to, or a form of, social prescribing [175,199]. In this thesis, I use nature-based prescribing as an umbrella term, covering NBSP and also treatment for specific diseases, including nature therapy or rehabilitation. NBIs have been implemented in all age groups, from pregnant women, infants and toddlers, to adolescents and adults, to addressing the needs older adults in the community, as well as in long-term care. Furthermore, studies have included both clinical and non-clinical populations. Non-clinical populations include either the general population or defined groups, i.e. office workers, students, schoolchildren, families in deprived areas or older adults.

An example of a study with a clear preventive scope is a longitudinal cohort study that took place during the restrictions following the COVID-19 pandemic [200]. The study involved 35 301 adults aged >18 years, and the targeted recruitment focused on involving participants from low-income backgrounds, including unemployed or low educated participants, and vulnerable groups participating in third-sector organization activities. Therefore, the sample was not representative of the general population, and the study is to be considered as a form of NBSP applying signposting. The study excluded respondents employed in key professions working during the pandemic, i.e. participants were mostly at home during the COVID-19 lockdown. Participants were encouraged to go outdoors (i.e., the balcony), and the time spent outdoors was measured in relation to wellbeing. Spending more time outdoors was associated with a decrease in depressive and anxiety symptoms and an increase in life satisfaction, but no association with loneliness was detected.

Individual interventions aim to provide personal guidance and support behavioral change [200, 201]. Interventions may also support engagement with nature through guided tasks [132]. Unstructured prescriptions (signposting) include counseling for families or other groups [202]. Group-based interventions are complex, as they not only build on interaction with nature, but also within the group and with the facilitator or leader [183].

Several reviews on the effect of NBIs have been conducted in recent years, most of which have used a narrative approach to describe interventions, participants, and list assessed outcomes [183,202,203]. Only a minority of the interventions have self-identified as nature-based prescribing [199]. The evidence base is, however, rapidly increasing [204]. Furthermore, several nature-based programs that are not research projects are ongoing [176,199,202,205]. In reviews, the number of identified studies has varied greatly. For example, an American review on nature prescriptions in clinical out-patient settings identified only 11 studies, and although the search was not age restricted, ten of them included children and their caretakers and only one an adult population [202]. The largest review to date identified 92 studies [199].

NBIs include a diverse range of activities. Outdoor interventions can be classified into three broad categories: 1) gardening (including horticultural

therapy), 2) exercise-based activities, and 3) nature-based therapies (interventions that aim to support psychological wellbeing through nature connection) [89,199]. Natural elements and indoor activities are sometimes included [204].

2.4.2.1 Health outcomes of NBIs and effect of nature-based prescribing

The pathways through which NBIs impact health are wide ranging. For example, gardening provides physical activity, social company, a sense of purpose, and healthy food [206]. This challenges the choice of relevant outcomes and explains the diverse range of assessments used. Table 5 compiles systematic reviews exploring the effect of nature-based prescriptions. A selection of studies that applied nature-based prescribing, specifically some form of forest therapy, in the treatment of either a diagnosed disease or defined symptoms are presented in Table 6.

The systematic reviews included both healthy individuals and patients with chronic diseases. Although several positive health outcomes are reported, the different populations challenge comparation. Moreover, few studies have included information on the clinical importance of a given intervention. As an example, although reduced blood pressure is generally a positive outcome, the clinical significance depends on whether the person is hypertensive or not. The duration of the interventions and follow-up have varied substantially. The direct effects of nature contact might differ from more long-lasting outcomes, and the latter is to be considered more important in a care setting. Less than half of the studies in the review by Nguyen et al. included clinical populations [199]. Participants were referred to the intervention in 63% (n = 58) of studies, with an equal number referred by health and social professionals. The health effects were clearer for participants who were referred to the NBIs than for those who self-engaged. Adewuyi et al. included both structured and unstructured referral, and their study revealed that neither the prescription methods, i.e. written vs verbal, nor the form of intervention, i.e. individual vs group, influenced the health outcome [204]. Coventry et al. focused on mental health outcomes. In addition to the meta-analysis based on RCTs presented in Table 6, the review also includes controlled and single-arm studies[89]. The main finding was that NBIs improve mental health outcomes across all populations, including adults with chronic medical conditions or common mental disorders, and healthy people. The authors therefore conclude that NBIs can be effective both as part of care and in prevention. Although the number of studies was insufficient for sub-group comparison, nature-based therapies delivered in groups displayed the most consistent effects. In this review, forest and wilderness therapies had the best effect, followed by green exercise, while the reported effects of gardening were more mixed. The most effective interventions lasted 8–12 weeks, and each session lasted 20–90 minutes. All the reviews report a risk of positive bias, but the risk was smaller in RCTs and the quality of the studies was acceptable.

Table 5 Systematic reviews assessing the effects of nature-based prescriptions

Study	Included studies, participants	**Outcome**	Comments
Nguyen et al. 2023 [199] Effect of nature prescriptions on cardiometabolic and mental health, and physical activity: A systematic review	Nature prescription, controlled interventions (RCTs and non-randomized) Studies n = 92, of which 28 included in the meta-analysis Participants mostly adults (64%) or older adults (27%) Participants with underlying health problems n = 43. Socially deprived areas n = 11.	**Assessed outcomes**: Physical n = 39 (42% of studies); psychological and cognitive 62 (67%); behavioral 23 (25%); different biomarkers 20 (22%) Effect on **depression scores** (moderate) SMD compared to control: -0.50, (-0.84 to -0.16), I^2 83%, Change from baseline: -0.42 (-0.82 to -0-03), I^2 0% Effect on **anxiety** (moderate to large): SMD compared to control: -0.57 (-1.12 to -0.03), I^2 91%, Change from baseline: -1.27 (-2.20 to -0.30), I^2 0% **Blood pressure**: Systolic: -4.82 mmHg (-8.92 to -0.72), I^2 60% Diastolic: -3.82 mmHg (-6.47 to -1.16), I^2 59% **Physical activity** (small effect on steps, uncertain on activity): Daily steps: 900 steps (790 to 1010), I^2 0% Physical activity: 39.1 min (12.6 to 65.6), I^2 32%	Type of referral recorded (health or social service, general referral) and included in the analysis. Small and somewhat unclear differences, depending on the referring institution. Strong effects in reducing anxiety and depression scores were mainly observed in studies featuring social professionals, but not health professionals. For blood pressure, large variation in follow-up time: 1 day to 12 weeks
Coventry et al. 2021 [89] Nature-based outdoor activities for mental and physical health: Systematic review and meta-analysis	Nature-based interventions (RCTs, controlled trials, and before-and-after studies) Studies N = 50 Healthy adults n = 24, students n = 8, adults with health problem n = 16	Assessed outcomes, meta-analyses based on RCTs: **Depressive mood** (n = 9): NBIs vs C: -0.64 (-1.05 to -0.23), I^2 86% **Anxiety** (n = 5): NBIs vs C: -0.94 (-1.87 to -0.01,) I^2 94 % **Positive affect** (n = 6): NBIs vs C: 0.95 (0.59 to 1.31), I^2 46% **Negative affect** (n = 5): NBI vs C: -0.52 (-0.77 to -0.26), I^2 10%	Results are grouped by intervention type: **Nature-based therapy** (n = 8, average duration of intervention 5.2 weeks (SD 4.76)), **gardening** (n = 16, 11.6 weeks (SD 6.58)), **green exercise** (n = 25, 6 weeks (SD 6.92)). For anxiety, garden interventions (n = 2) favor control, SMD 0.43 (-0.02 to 0.89)
Adewuyi et al. 2023 [204] Health effects of green prescription: A systematic review of randomized controlled trials	Green prescriptions (RCTs) Studies n = 31, Healthy adults n = 15, adults with health problems n = 16	**Assessed outcome:** Intervention type (*number of studies reporting positive impact/total number of studies*) **Psychological health and wellbeing:** Green exercise (*4/7*), gardening (*4/6*), forest therapy (*7/8*), distraction therapy (*0/1*), park prescriptions (*1/2*) **Cardiometabolic health:** Green exercise (*3/6*), gardening (*4/6*), forest therapy (*2/2*), park prescriptions (*0/1*) **Physical activity:** Green exercise (*5/6*), gardening (*1/1*), park prescriptions (*2/2*) **Other:** Relieving pain (*2/4*), orthopedic outcomes (*0/2*) Inflammation (*2/2*), exhaustion (*0/1*), social cohesion (*0/1*), use of healthcare (*1/1;* however, control group not comparable)	Most studies had a broad scope. In addition, the interventions of the control groups often included some nature aspect. 87% of the studies were published in the years 2011–2022 Prescription method, i.e. written vs verbal, did not impact the health outcome; neither did the form of intervention, i.e. individual vs group
Abbreviations;	RCT= randomized controlled trial, SD Standard deviation, SMD = standardized mean difference, I^2= measure for heterogeneity		

Table 6 presents controlled intervention studies applying NBIs as a part of care, excluding gardening. The eight studies described involved clinical populations and the interventions were all forest-based in some way. Studies exploring only the immediate effect of nature exposure are excluded. The studies fulfilling these criteria included participants with either diagnosed depression or long-lasting stress-related health problems, with two articles describing the same population. The participants are to be considered chronically ill, and especially those with stress-related health problems had a long history of absence from work before entering the program. All interventions appealed more to female participants, the exception being the "Wilderman" program, which only recruited men. Several studies noted challenges in recruitment from health care, since NBIs are not an established form of care.

In an RCT targeting patients with diagnosed depression, Hyvönen et al. compared a group participating in an NBI in addition to treatment as usual (TAU), to a control group only receiving TAU [207]. Both groups had similar uses of medication and therapy. The researchers had hypothesized a better effect in the nature group, but they recorded significant superiority only for the domain workability. Restoration increased and distress decreased in the nature group but not the control group. However, pairwise comparison revealed no difference between the groups. The COVID-19 restrictions impacted the study, as some meetings were arranged so that participants were in nature alone, although in contact with the group and facilitator through a remote connection.

Sleep was assessed in two studies, both of which found positive effects of the NBI. Yeon et al. included participants with diagnosed depression and found that depressive and somatic symptoms decreased whilst subjective sleep improved in the intervention group [208]. Self-reported depressive symptoms decreased among adults with severe alcohol abuse taking part in a 9-day camp, and sleep improved sleep following the NBI [209].

Two studies analyzed the use of health-care services and found a reduced need for GP services following the intervention[210,211]. However, this outcome remains somewhat unclear, since the control group was not completely comparable.

Considering the long-lasting symptoms of the participants, the effect of the interventions is to be considered good. Most of the studies described had a long follow-up. In the interventions targeting depression, the effect of the NBIs was equivalent to cognitive behavioral therapy (CBT) [212].

Table 6 Controlled NBI studies including elements of forest therapy as part of medical care

Interventions targeting: **Depression**			
Effects of nature-based intervention in the treatment of depression: A multi-center, randomized controlled trial Hyvönen et al. 2023 (Finland) [207]			
Participants + referral: Adults diagnosed with depression. Severe disease excluded. Recruitment in outpatient healthcare. Screening by phone. NBI n = 59 Control (C) n = 77 82% female, age 45.2 (19–64 y)	**Study + intervention** RCT I: Forest therapy – Flow with nature program. 12 weekly outdoor group meetings á 90 min + TAU C: Treatment as usual (TAU) Follow-up 3 months, those in control group were offered participation in the intervention after this	**Outcome (measure) + results:** Depression (BDI): significant improvement in both groups. Distress (CORE-10): reduced in NBI, no change in C, pairwise diff. not significant Restorative experiences (ROS) increased in NBI, no change in C, pairwise diff. not significant Self-reported ability to work: improved in NBI	**Interpretation and comment:** No difference between groups in depressive symptoms. In the NBI group, participants without medication displayed a greater reduction in depressive symptoms. NBI reduced psychological distress, increased restorative experiences and workability. The NBI program is described, and each meeting had an aim. During COVID, NBI was organized online or as hybrid meetings.
Effects of Urban Forest Therapy Program on Depression Patients Yeon et al. 2022 (Korea) [208]			
Adults with mild depression, diagnosis by a psychiatrist. Participants with severe disease and mobility problems excluded. NBI: n = 22; C = 25 85% female, age 37.31 ± 10.27 y	RCT; I: FT in urban forest, 2 h/week for 6 weeks. C: TAU, follow-up by a GP. The urban forest was chosen for easy accessibility. Structured program included: recognition (session 1+2), action (3+4), and change (5+6). Participants were together, but group interaction was not emphasized.	Depression (BDI and HRSD): BDI improvement in I (t = 2.605, p = 0.017), no change in C. HRSD improvement in both groups, post-intervention score lower in NBI Sleep quality (PSQI): Improvement in NBI (t = 4.395, p < 0.001), no change in C Somatic symptoms: Improvement in NBI (t = 3.919, p < 0.001), no change in C (PHQ-15)	The authors state that the effects of the NBI were similar to cognitive behavioral therapy (CBT). BDI decreased by 34% when comparing baseline and post-intervention. Self-reported sleep quality improved, and the degree of somatic disease also decreased from high to medium following the NBI.
The influence of forest therapy camp on depression in alcoholics Shin et al. 2012 (Korea) [209]			
Adults with chronic alcohol abuse, recruitment in inpatient care, after detoxification, before the start of other treatment. N = 92, I = 47, C = 45	RCT I: 9 days (d) of FT in a natural forest, goal-oriented (3 d nature interaction, 3 d challenge, 3 d self-introspection) C: TAU, unspecified. Measures before and after.	Depression (BDI): Moderate at start, significant reduction following the NBI (t = -6.27; p < 0.001), no change in C. NBI: fewer self-reported sleeping problems post-intervention	Participants in their 40s with severe depression at the beginning of the program showed the most significant improvement following the NBI. Short follow-up.

Interventions targeting: **Stress-related health problems**			
Efficacy of nature-based therapy for individuals with stress-related illnesses: randomised controlled trial Stigsdotter et al. 2018 (Denmark) [213]			
Adults (age 20–60 y) with diagnosed psychiatric stress disorder (ICD F43), incapable of working >3 months (M), unemployment common. Exclusion: Severe psychiatric disorders and substance abuse. N = 84, I = 43, C = 41 82% women. Referral from municipalities, healthcare, insurance companies + self-referral.	RCT: Both interventions lasted 10 weeks. Both groups received support to return to work. I: NBI in Nacadia ® therapy garden, mindfulness, stress reduction, group and individual tasks. 3 h x 3 days/week. Structured program + homework C: Cognitive Behavioral Therapy STreSS, 20 indoor sessions for 10 weeks. Recruitment 2 M before intervention, follow-up 12 M.	Psychological General Well-Being Index (PGWBI) NBI: medium to large effect; StreSS: medium effect of treatment. Both groups improved, no difference. Burnout Questionnaire (SMBQ): Significant effect in both groups. No significant pairwise difference between any of the time points.	Both groups improved significantly, no difference between groups observed. The STreSS program has previously been established in RCT. The authors note that the NNBT is a structured program. Although participants are in groups (median 6 pers.), the intervention is individual. Recruitment was challenging through health care, as this is a novel intervention; many participants were recruited though newspapers and then checked for eligibility.
A Long-Term Follow-Up of the Efficacy of Nature-Based Therapy for Adults Suffering from Stress-Related Illnesses on Levels of Healthcare Consumption and Sick-Leave Absence: A Randomized Controlled Trial Corazon et al. 2018 (Denmark) [210]			
Same as above Long-term follow-up, 12 months after intervention I: n = 37 C: n = 35	Same as above	Sick leave: A significant decrease 12 months after intervention (both groups) Healthcare consumption: A significant decrease in the number of GP contacts 12 months after intervention vs 12 months before.	Similar positive outcomes in both groups. Healthcare consumption remained higher than in the general population. The authors highlight the need for early interventions; participants were chronically ill.
Stress recovery in forest or handicraft environments – An intervention study, Dolling et al. 2017 (Sweden) [214]			
Adults (18–65 y, M = 48) with high stress and stress-related health problems. Recruitment through newspapers and employers. Many were on sick leave or unemployed. I: n = 27 C: n = 19	RCT, group based, instructors did not aim to build social relations. 3-month intervention, 3 h twice/week Forest therapy, same group, same area. Handicraft: same frequency, guided and free activities. Possibility to relax	Fatigue (CIS): improved Stress (PSQ): improved Self-esteem (SCQ): no change Burnout (SMBQ): improved Self-reported health (SF-36): Self-reported symptoms: improved general health, less limitation in daily life, happier, calmer, less tired. Number of medications: reduced. Sleep monitored by actigraphy: sleep latency – 9 min in C group	The outcomes did not differ between groups; both interventions improved self-reported health. The researchers considered the change in sleep minor. Intervention relied on the environment and activity, also supporting autonomy (possibility to withdraw) Facilitator specifically did not support social cohesion. Recruitment challenges noted.

Using Nature-Based Rehabilitation to Restart Process of Rehabilitation in Individuals with Stress-Related Mental Illness Sahlin et al. 2015 (Sweden) [211]			
Participants + referral: Employers with prolonged sick-leave (>3 months) due to stress-related mental illness. Participants were diagnosed in health care; all worked for a regional employer in Sweden N = 57, 92% women, age 45 y (26–63). The majority had medication and psychotherapy outside the program. C = 45, all women, age 49 y (32–61), sick-leave > 14 X	**Study + intervention** Explorative intervention study I: Wide range of NB activities; gardening, walks. 16 weeks, 3 h on 4 days/week; after 12 weeks, return to work and reduced NBI C: Occupational health service group, multi-professional rehabilitation including PA. C in different phase of rehabilitation, participants chosen to match NBI. 12-month follow-up	**Outcome (measure) + results:** **Outcomes reported only for NBI!** Burnout (SMBQ): Reduced, a significant number recovered. Depression (BDI): improved: 88% had lower post-intervention depression score Anxiety (BAI) improved: 63–71% favorable effect. Wellbeing (PGWB): improvement from start, highest at 12 M Sick leave (Both groups, register, 6+12 M after program): Decreased in NBI, no change in C Use of healthcare (register, 6 +12 M follow-up): Reduced use	**Interpretation and comment:** NBI: Reduced scores for self-assessed burnout, depression, and anxiety, increased wellbeing and reduced healthcare utilization. In addition, sick leave reduced, supporting the benefit of rehabilitation. The control group was only described as a reference group; health-outcomes were not reported. In addition, the control group had an earlier stage of illness. Participants in the NBI may be considered as chronically ill: the sick-leave duration was 3 M to 12 years (mean 19 m SD 24)
The Wildman Programme—Rehabilitation and Reconnection with Nature for Men with Mental or Physical Health Problems—A Matched-Control Study Hoegmark et al. 2021 (Denmark) [215]			
Men in poor health. Mental health problems were common; many were unemployed. I: n = 114 C: n = 39 Referral from healthcare centers, GPs and job centers. The majority had other treatment and medication. Average age 55 years.	Intervention study with matched control I: 3 h weekly meetings for 9 weeks; NBIs build on nature connection, exercises for body and mind, and building community spirit. C: TAU: not specified Follow-up: baseline, 9 weeks and 6 months.	Quality of life (WHOQOL-BREF which includes 4 domains): Physical and psychological health improved following intervention; social relationships: weak improvement at 6 months; environment: no change; perceived stress (PSS): significant improvement; perceived restorative scale (PRS): improvement. A significant difference between groups only detected for physical health at 6 months	The intervention and control groups differed: the intervention included more men with a psychiatric diagnosis and referred from job centers (unemployed) The study was not randomized. Recruitment was initially difficult; word of mouth then helped with recruitment. The study partly took place during COVID restrictions.
NBI = Nature-based intervention, FT = forest therapy, TAU = treatment as usual, CBT = Cognitive behavioral therapy, I = Intervention, C = control, d = days, M = months			

Summarizing the literature review, nature-based solutions potentially support the resilience and intrinsic capacity of people living with chronic disease and multimorbidity. As discussed, NBIs may target comprehensive wellbeing. Deeper understanding of the mediating pathways is still evolving. To date, most evidence concerns mental wellbeing, but the pathways to impact are not well understood on the individual level.

The realistic review "Greenspace interventions for mental health in clinical and non-clinical populations: What works, for whom, and in what circumstances?" by Masterton et al. provides a framework for assessing not only the impact but also the mechanisms through which NBIs act [183]. Older adults with dementia were excluded from this study. The in-depth analysis of 49 studies identified three broader themes (nature, individual self, and social self) and seven program theories, as presented in Table 7.

Table 7 The three program themes (A-C) and the seven program theories as described by Masterton et al.

A. Nature
1. Escape / Getting away
2. Space to reflect
B. Individual Self
3. Physical activity
4. Self-efficacy
5. Having a purpose
C. Social Self
6. Relationship with facilitator
7. Shared experiences

A recent review focusing on NBIs for older adults highlighted the spiritual dimensions of contact, nature as a place for peace, personal growth, and being part of something bigger, in addition to previously described indicators for wellbeing and physical health [25]. This review also underscored behavioral opportunities, mainly physical activity [25].

The thesis integrates two concepts: 1) nature and health and 2) the process of supporting wellbeing as part of care (through social prescribing), both of which are still evolving. Nature-based prescribing as part of health care is a new research area, and the literature review identified several knowledge gaps that can be considered critical. We need further understanding of when and for whom NBIs should be recommended, as well as clear descriptions of what interventions should contain and how the effects should be followed up. It is also questionable whether the health outcomes of the general population and chronically ill patients are directly comparable. Better descriptions of key concepts, i.e. nature connection and nature dose, will advance development in this multiprofessional research field [84]. This thesis addresses these knowledge gaps.

3 Aims of the study

This thesis aims to explore how contact with nature supports human health, focusing on mental and social wellbeing among adults identified to be in poor general health. Furthermore, it examines how nature-based interventions can be integrated into care, describing existing praxis and discussing the feasibility and implementation of NBIs in primary care.

The specific research questions for this thesis with the corresponding studies I–IV were:

1. How have nature-based interventions been used to alleviate loneliness, and what is their effect on wellbeing? (I)

2. What is the meaning of nature among older adults residing in ALFs, and how can facilities support interaction with nature? (II)

3. Is there an association between nature connection and psychological wellbeing among older adults living in ALFs, and how is this influenced by health status, mobility, or disability? (III)

4. How does a nature-based intervention affect mental wellbeing among health center patients, and are there differences in wellbeing outcomes compared to a sports intervention? (IV)

4 Materials and methods

The material presented in this thesis is derived from a systematic review (Study I) and two populations: older adults living in ALFs (Studies II and III) and adult utilizers of primary health care (Study IV). Both populations represent target groups identified to potentially benefit from nature-based prescribing [11]. The study design, populations, and methods of the included studies are summarized in Table 8.

Table 8 Overview of study methods

Article Name	Study design and assessment	Participants	Outcome
Study I Connecting through nature: A systematic review of the effectiveness of nature-based social prescribing practices to combat loneliness.	Systematic review of controlled and non-controlled studies. PRISMA checklist, mixed-methods appraisal tool, narrative analysis	Populations of all ages and backgrounds participating in group-based NBIs. Included studies n = 38, participants n = 1191	Effect on loneliness, social cohesion, and belonging. Thesis additionally describes wellbeing outcomes.
Study II The importance of nature and wishes for nature-based experiences among older adults in assisted living facilities.	Cross-sectional survey Mixed methods: Quantitative + thematic analysis of open-ended answers.	Older adults N = 845 permanently living in 25 ALFs in the Helsinki Metropolitan Area	Willingness to participate in a NBI, importance of nature, and wishes for nature-based activities.
Study III Happy by Nature: Nature Connection as a Source of Psychological Well-Being in Assisted Living Facilities.	Cross-sectional survey Quantitative: including development of the Gerontological Nature Connection Scale (GNCS) through factor analyses.	Same as study II	Relationship between nature connection and psychological wellbeing (PWB).
Study IV Targeted health promotion with guided nature walks or group exercise: a controlled trial in primary care	Clinical pilot study: Health forest vs Sports group Quantitative: pre-post questionnaire and sleep monitored using an accelerometer.	Primary care utilizers of a social and health care center in Sipoo. Participants were identified by a doctor, nurse, or social worker. N = 79	Positive mental health, self-assessed wellbeing, and device-measured sleep.

4.1 Connecting through nature

Study I was a systematic review and narrative analysis describing the current evidence base for the effect of NBSP on loneliness. The study explored whether group-based interventions in nature enhance social connections and social cohesion and facilitate belonging.

The review had a wide scope, including populations of all ages and backgrounds. Studies were eligible if they specifically integrated nature into their intervention, while also being group-based. The definition of NBIs was broad, including nature exposure, outdoor activities, and indoor activities with nature elements. Furthermore, studies had to meet the criteria of NBSP, rehabilitation, or therapy. According to the aim of the review, studies were included that measured or examined experiences or perceptions of loneliness, social isolation, alienation, or connectedness.

Any intervention study design that met the eligibility criteria was entered, i.e. randomized controlled trials, controlled trials, and uncontrolled studies. The mixed methods approach incorporated both quantitative and qualitative primary research. Qualitative studies were eligible if the results described outcomes related to loneliness or social connectedness. Quantitative studies were eligible if they included measurable loneliness-related outcomes in relation to nature-based group interventions. The quality of the included studies was assessed using the Mixed Methods Appraisal Tool (MMAT) Version 2018 [216]. A detailed description of the search strategy, including the PRISMA flowchart, and results from the quality assessments are presented in article I. (Link to flowchart). Of the 6475 studies identified in the initial screening of titles and abstracts, 144 full-text articles were assessed, and 38 studies were included in the review.

In the identified studies, loneliness was mostly assessed alongside other measures of wellbeing, a list of which is published as a supplementary table in the original article. In this thesis, I further evaluate these results, including studies that: 1) yield > 3 quality points [216], 2) fit the description of nature-based social prescribing [175], and 3) include wellbeing measures alongside loneliness.

4.2 Importance of nature and Happy by nature

Studies II and III were based on a cross-sectional survey with 854 respondents. The participants were older adults permanently living in assisted living facilities (ALFs) in the metropolitan area of Helsinki, Finland. The 25 ALFs included in the studies took part in the international RECETAS study (Re-imagining Environments for Connection and Engagement: Testing Actions for Social Prescribing in Natural Spaces), a research project aiming to develop and assess NBIs as a way to support health and reduce loneliness [119]. Within the ALFs, staff identified potential voluntary participants fulfilling the inclusion criteria: age ≥55 years with a Cognitive Performance Scale (CPS) score of <4 [217]. In addition to exploring the research questions described, we recruited participants to the RECETAS intervention study through this survey, identifying residents suffering from loneliness and interested in taking part in NBIs [218]. Through the survey, we checked for eligibility for the intervention study, the criteria of which were MMSE ≥ 15 [219] and a life-expectancy over 6 months, while bedbound residents and those unable to communicate were excluded [218].

Background data, including age, sex, and information on medical conditions and regularly used medications, were retrieved from medical records. Multimorbidity was assessed using the Charlson Comorbidity Index (CCI) [220]. The number of medications (active agents) in daily use was counted, and everyday use of antidepressants, neuroleptic medication, and benzodiazepines was noted.

The applied questionnaire was developed by the research team. It included measures for health and self-rated wellbeing previously used and validated in the target group, as summarized in Table 9. Additionally, for background data, we inquired about the marital status (married/widowed/single or divorced). Education was categorized as <8 years (primary school or less) or ≥8 years of education. We asked about satisfaction with and the feeling of safety in current living. Respondents also reported an approximate number of close persons in their lives.

The nature questions were developed by the research team and are presented in Table 10. To explore how nature connection was related to health and psychological wellbeing, we developed the Gerontological Nature Connection Scale (GNCS) through factor analysis, as described in section 4.2.1.3.

Participants were interviewed by a trained research nurse or researcher, and the duration of the conversation varied from 15 to 60 minutes. The survey took place between September 2022 and August 2023.

Table 9 Measures and scales applied in Studies II and III

Measure/tool (study)	Description or question (answer options)	Interpretation
	From health records	
Charlson Comorbidity Index (CCI) (II, III)	Prevalence of the following medical diseases: dementia, stroke, diabetes, cancer (any), asthma/COPD, myocardial insufficiency, myocardial infarction (also previous), rheumatoid arthritis, gastric ulcer	Multimorbidity is defined as more than 2 co-existing diagnoses. However, psychiatric diagnoses are not included in this index. [220]
Medication (II)	Number of prescribed medications in regular use.	Number of medications gives an indication of the disease burden. Polypharmacy defined as ≥5 medications [8]
	Self-reported parameters	
Pain	"Do you suffer from daily pain?" (Yes/No)	Easy to answer
Sleep	"Do you sleep enough?" (Yes/No)	Question used in previous studies; easy to answer [221]
Functional ability	"Does your general health allow you to walk easily outdoors?" (Yes/No, I need an assistive device/No, I need help from others/No, I cannot go outside)	Answers *Yes* and *I need an assistive device* were pooled as "Good functional ability", as this is the context of assisted living facilities.
Self-rated health (SRH)	Single question: "In general, how would you rate your health today" (Very good/Good/Fair/Poor)	Self-rated health is divided into good (very good or good) or poor (fair or poor).
Psychological wellbeing PWB (II, III)	(1) "Are you satisfied with your life?" (Yes/No) (2) "Do you have zest for life?" (Yes/No) (3) "Do you feel needed?" (Yes/No) (4) "Do you have plans for the future?" (Yes/No) (5) "Do you suffer from loneliness?" (Seldom or never/Sometimes/often or always) (6) "Do you feel depressed?" (Seldom or never/Sometimes/Often or always)	PWB is calculated as follows: 0 points are assigned for the answer "no" in questions 1–4, "often or always" in questions 5–6. 0.5 points are assigned for "sometimes" in questions 5–6. 1 point is assigned for the response "yes" in questions 1–4 and "never or seldom" in questions 5–6. The total number of points is then divided by the number of questions answered. The PWB score ranges from 0 to 1, with higher numbers indicating better wellbeing [222]
Happiness	Single question: "How happy or unhappy do you feel at the moment?" (Very happy/Quite happy/Quite unhappy/Very unhappy/Can't say)	Options "very happy" and "quite happy" are pooled as "happy"
Attitude to life	"How would you describe your current general attitude to life? (Positive/Negative/Can't say).	Easy to answer; a previously used question.

4.2.1.1 Constructing the nature questionnaire

To explore the current meaning of nature, we included two sets of questions focusing on a) views regarding nature experiences and b) the current subjective importance of named examples of nature-based activities. Considering the target group, the nature questions were planned to be easy to answer with the response options Yes/No/Can't say. The questions, as presented in Table 10, were planned to capture themes previously recognized as central for nature connection [84,131].

Table 10 The theme and aim of the nature questions and statements used in Studies II and III.

Theme and aim	Question / Statement
General importance of nature	"*Nature is important to me";* "*It is important to protect nature"*
To address biological and physiological benefits	"*Nature helps me relax"; "It is easier to breathe outdoors"; "I feel less pain when in nature";* and *"It is easy to move outdoors"*
Dependent on assistance, and might rely on the opinions of others	"*I have access to nature as often as I desire"; "My relatives think I should go outdoors"; "It is difficult to go outdoors"; and "It is possible to experience nature indoors"*
Social and emotional meaning of nature	*"I get topics for discussion from nature"; "My relationship with nature is an important part of who I am"; "Nature brings back good memories";* and "*I feel part of something bigger in nature"*
Potential negative perceptions or harms of NBIs we inquired	*"I am afraid of getting hurt outdoors"; "I am afraid of falling or slipping outdoors"; "Insects and ticks are a danger to me"; "Nature brings back bad memories";* and "*Nature is boring".*
To explore the perceived importance of commonly used NBIs.	"Are the following activities important to you?" (Yes /No/Can't say) 1) Being outdoors, 2) Gardening/caring for flowers, 3) Looking at pictures or paintings with nature themes, 4) Nature's sounds (e.g., birdsong), 5) Fresh air, 6) Nature-related TV programs, 7) The view from the window, 8) Contact with animals
Open-ended questions:	1) "Has the meaning of nature changed with age?" (Yes /No), followed by the open-ended question "If so, how?" 2) "Has the meaning of nature changed during the COVID-19 pandemic?" 3) "Does the assisted living facility and its surroundings support nature contact and physical activity in nature?" (Yes/No) "How/how not?" 4) "What kind of nature experiences do you wish for?"
Respondents' willingness to participate in future nature-based interventions	"Are you willing to take part in a nature-based intervention?" (Yes/No)

4.2.1.2 Qualitative analysis

The responses to the open-ended questions were mostly brief and sometimes single-worded. For the thematic analysis, we applied systematic text condensations, and to estimate the frequency of relevant topics, we documented the numbers of statements for each of the identified themes and categories throughout the coding process [223]. When respondents gave multiple answers to one question, for example describing several favorite nature locations, responses were included in several categories. Two authors (AK and LJR) independently read the qualitative responses to form an overall picture of emerging themes. In the second stage of the analysis, the data were systematically reviewed. The coding process included identifying, classifying, and sorting out the meaning units related to the research questions. Meaningful expressions found in the text were reduced to codes and individual expressions. This process was flexible, as we added and changed the codes along the way. As some meaning units were coded under several code labels, we reconsidered the sub-groups in a consensus discussion (AK, LJR, UA, KHP). During the third step, we reviewed the meaning units and sorted them into larger themes and subgroup categories. In the final stage of the process, we selected and synthesized quotes representative of the findings [223]. Systematic text condensation is a thematic process that has evolved in general practice [224]. The process is very similar to other described steps for thematic analysis [225].

The results for questions 1) and 4) presented in Table 10 are included in article II. In this thesis, I additionally include analyses for open-ended questions 2) and 3)

4.2.1.3 Statistical analysis

The data are presented as means with standard deviations (SD) for continuous variables or as counts (n) with percentages (%) for categorical variables. Data were tested for normality, and an appropriate statistical method was used depending on the distribution.

The variance in responses was smaller than we predicted. Therefore, to statistically interpret the meaning of nature, we applied explorative factor analysis. This is a data-driven method used to identify underlying correlations within a broad range of variables and thereby group the responses into factors that not only form a statistical but also a theoretically logical model [226,227]. Explorative factor analysis is a tool to build scales, but it is not a rigid method and should be supported by expert discussion [227]. It is also noteworthy that the method looks for correlations among responses, not among respondents.

The 27 quantitative nature questions included in the survey were re-evaluated during a series of consensus meetings (AK, TP, KP, HK). We included questions showing variance in answers and addressing nature. We individually assessed the uncertain answers ("Can't say") to form two categories (Yes/No). The responses for

statements presenting a negative outlook, e.g. “Insects and tics are a threat to me”, were inverted before they were included in the model. This process is described in the Appendix.

Exploratory factor analysis was performed using the iterative principal factor method for factoring and promax-rotated factor loadings on the polychoric correlation matrix to identify related items among the nature questions. The strategies used to extract the number of factors were the Kaiser criteria, which determine that components with eigenvalues lower than one should be excluded, and the scree test of Cattell criteria. Internal consistency was estimated by calculating Cronbach’s alpha with a bias corrected bootstrap and 95% CI.

With the team, we evaluated several models to identify unique variables that related strongly to only one factor and also provided a reasonable theoretical connection [227]. Correlation coefficients less than 0.20 were considered very weak, those between 0.20 and 0.39 weak, between 0.40 and 0.59 moderate, between 0.60 and 0.79 strong, and above 0.79 very strong. Statements with weak correlations were excluded.

The final model included three factors and 12 questions, which formed the *Gerontological Nature Connection Scale (GNCS)*. The GNCS score is the sum of the included nature questions, and it follows a normal distribution. The score was divided into tertiles, with a corresponding number of participants in each group.

The relationship between the GNCS (including quadratic terms) and PWB values was evaluated using two-way analysis of covariance with age and sex as covariates. Correlation coefficients with 95% CI were calculated by using the Pearson method.

Statistical analyses in article III were carried out by HK using Stata, version 18.0 (StataCorp, College Station, TX, USA). The statistical analyses in study II and this thesis were performed by AK using IBM SPSS Statistics, version 27, software.

4.3 The Health Forest intervention

The participants in Study IV (Health Forest) were recruited among patients and clients utilizing the Health and Social Service Centre of Sipoo. The participants lived in the municipality of Sipoo, a rural area in southern Finland with abundant accessible natural environments.

The adapted intervention was developed during the national Terveysmetsä (transl. Health Forest) project beginning in 2015 [228,229]. The positive response gave rise to a need for a more systematic evaluation of the program, resulting in this clinical trial. The controlled pilot study on parallel groups in an intention-to-treat setting was planned without expected superiority for either group. Rather, the aim was to compare two interventions, neither of which is to be considered a control

group. The project was described in the local media, but participation required direct referral by a care professional.

The Health Forest study started in 2018 and was planned to continue until 2020, aiming to include 160 participants equally distributed between the groups. A 25% drop-out rate was predicted, and power estimate measures were based on this figure. Unfortunately, the COVID pandemic in 2020 hindered group interventions, reducing the total number of participants. The intervention was completed twice a year (spring and autumn) during the years 2018 and 2019.

Enrolment was not based on a diagnosis, but instead the personnel at the health center (nurses, medical doctors, and social workers) were instructed to involve adults in poor general health. The physical requirement was the ability to walk approximately 3 km at a slow pace. Participants received information on the intervention and study before choosing between either the Nature group or the Sports group. Both interventions consisted of 7 sessions within 8 weeks, as described in supplementary material in article IV. Although the reason for referral was not reported in the study, enrolment was a part of real-life treatment, and we know that many participants had either diabetes or depressive symptoms. In addition, multimorbidity was established in the sample.

Self-assessed mental wellbeing measured with the 14-item Warwick-Edinburgh Mental Well-being Scale (WEMWBS) was the first outcome in study IV. Secondarily, we analyzed self-reported health and sleep and device-based sleep, as presented in Table 11. The questionnaire included background information (gender, age). Responses were collected before the intervention and at end of study.

Table 11 Measures, scales, and questions applied in Study IV

Measure / tool	Scale / tool	Interpretation, strengths and limitations
Is nature important to you?	1 (not at all) to 5 (very)	A general question, easy to answer. The question is not validated.
Is physical exercise important to you?	1 (not at all) to 5 (very)	
How is your health at the moment? *How is your mental health at the moment*? *How is your ability to function at the moment*? *How do you sleep at the moment*?	1 (poor) to 5 (good)	The health questions have been used in the FinHealth population survey [230]
Mental wellbeing: Warwick-Edinburgh Mental Well-being Scale (WEMWBS)	14-item tool; questions presented in Table 18	Developed to assess positive mental wellbeing [231,232]; has shown consistency with scales assessing depression and anxiety disorders [233,234].
Device-based sleep and physical activity	ActiGraph GT9X Link, Actigraph LLC	Data shows the number of active days with a minimum of 10 hours of wear time from midnight to midnight.

The amount and quality of activity and sleep were measured using a wrist-worn accelerometer. As we were interested in the effects on everyday life, accelerometer data were collected before and after the intervention. The physical activity data have not yet been analyzed. Sleep is reported as the total sleep time, time in bed, and sleep efficiency. After sleep onset, the number and length of awakenings is also reported.

In this thesis, I further search for factors predicting a positive or negative change in the WEMWBS score, and focus on the participants with a WEMWBS score below 45, a cut-off known to be associated with a risk of depression [232].

4.3.1.1 Statistical analysis

Data were tested for normality, and differences between the groups were assessed using the independent t-test for normally distributed variables and the Mann–Whitney U-test for non-normally distributed variables. The change measures were analyzed using either the dependent t-test or Wilcoxon signed-rank test, depending on the distribution of data.

We created groups for self-reported health outcomes, where scores of 1 to 3 were regarded as poor health and scores of 4 and 5 as good health. Participants were regarded to have fulfilled the program if attending 5 or more sessions. These categorial groups were compared using cross-tabling and the chi-squared test.

Binary regression analysis was applied to search for factors predicting a change in the WEMWBS score. Health status, gender, age, group, and season were further used as covariates in regression models. The statistical analyses were performed using the software IBM SPSS Statistics, version 27.

4.4 Ethical considerations

The strategy used in the literature review "Connecting through nature" (Study I) was registered in the International Prospective Register of Systematic Reviews in March 2023, ID CRD42023407011. The review followed the Adapted PRISMA recommendations for reporting systematic reviews of qualitative and quantitative evidence [235]. All studies were reviewed by two independent researchers using COVIDENCE software.

Research including participants with cognitive decline requires special consideration. However, it is also an ethical concern that people diagnosed with dementia might be excluded from studies. These issues were considered when planning the RECETAS study, of which Studies II and III were a part. Ethical approval was granted by the ethical committee of the Helsinki and Uusimaa Hospital District (HUS/119/2022) and study permission was granted by the City of

Helsinki (HEL 2022-004436 T 13 02 01). Respondents received oral and written information about the study and its aims and signed informed consent allowing use of data and later contact. In case of a reduced judgment capacity (MMSE score < 18), the closest proxy provided consent. Participants were free to withdraw from the study at any time. Data were anonymized using REDCap software and thereafter stored and analyzed in the secure platform of the University of Helsinki. The randomized controlled trial, to which the current study recruited participants, is registered at ClinicalTrials.gov, ID: NCT05507684.

The Health Forest study was approved by the ethical committee of the Helsinki and Uusimaa Hospital District (HUS/3520/2017), and study permission was granted by the municipality (7.2.2018). The study did not interfere with the participants' health care, as it was possible to take part in the intervention without participating in the study. Participants provided informed consent, allowing the use of data and later contact. Anonymized data are stored at the Finnish Institute for Health and Welfare (THL).

5 Results

5.1 Nature-based interventions for social belonging and wellbeing

We identified and systematically reviewed a wide range of studies (n = 6475), as presented in the PRISMA flowchart in article I. In the 38 included studies, loneliness was mostly assessed alongside other health outcomes. Of the included studies, 18 used a quantitative approach, 12 were qualitative studies, and 5 applied mixed methods. The mixed methods studies are integrated in the results and analyses as quantitative or/and qualitative, as appropriate. Only one study was a randomized controlled trial, and this was also the only study to specifically target loneliness [236]. Six trials included a control group [237-241], and these were mostly non-randomized experimental studies. Nine studies explored the use of nature-based social prescribing without a control group [200,242-249]. We considered four of these to be field studies, aiming to evaluate ongoing programs or the impact of real-life events [200,243,244,250].

In the result section of this thesis, I concentrate on the quantitative results.

5.1.1 Participants and referral process

We identified three distinct groups of participants: 1) adolescents, 2) adults in poor mental health, and 3) older adults.

The adolescents were identified to be at risk of social exclusion or stress, and included a) Japanese university students without diagnosed mental disorder, among whom loneliness levels were high [245]. The other youth studies were from the US, involving b) teen parents in a multiethnic, deprived area [247] and c) teenage students at an alternative school, recognized to be at high risk of social segregation [238].

Five studies involved middle-aged participants, and in this age group, all were either suffering from or recovering from mental disorders. All participants in these studies can be considered chronically ill, as the populations comprised veterans with a suicidal history [242], institutionalized adults [239], and participants referred to community projects by health professionals [243,244,248]. One study included participants with learning disabilities and autism [244].

Six studies involved geriatric participants, including both home-dwelling [236,237,246] and institutionalized [240,241,249] older adults. Although participation was not based on a diagnosis, the studies commonly reported medical conditions and the degree of multimorbidity. Notably, participants with severe disease were excluded in all six studies, and none of the studies involved participants diagnosed with dementia.

We did not include recruitment strategies in the original extraction form when planning Study I. However, during the review process, we noted a variety of ways to enroll participants. Larger studies used fliers and social media, and also contacted potential participants through trusted partners, mostly third sector organizations [200]. Recruitment was supposedly easier in institutions, in which posters and personal contact were used [240,241]. Adherence in these studies was also very good. Two studies included participants referred to the project by health professionals [243,244]. No studies reported reasons for refusing participation.

5.1.2 Intervention characteristics

The nature-based activities applied in the studies were categorized as follows:

Nature-based physical activities: Exercise or physical activity in a natural environment. Many of these activities included interacting with natural landscapes, including forests, parks, beaches, or mountains. Both exercise and leisure activities that make use of and engage with nature were eligible. The activities in the interventions were both adventurous, including mountain biking and rock climbing, and tranquil, such as an outdoor gym for older adults. Of all studies, 8/38 applied nature-based physical activities.

Natural element: A particular context or activity can incorporate elements of the natural world. To foster a sense of connection, it entails incorporating natural components into a setting, an experience, or a design. Examples of interventions include meditative forest therapy, mindfulness exercises, and nature restoration in wetlands. Interaction with natural elements was the main intervention in 5/38 studies.

Gardening-based interventions: Therapeutic horticulture or rehabilitative gardening activities where people work in a garden to improve social, emotional, mental, and physical health. The interventions included both group-based and individual gardening. The most common type of intervention, 17/38 studies included gardening. Of the studies with older adults, 11/13 were garden-based.

The duration of the interventions described in the quantitative studies varied from 3 days to 3.27 years. The shortest programs lasted 5 days including pre-and post-assessments [238], and 3 days with a two-week follow-up [245]. Both interventions were camps for students. Middle-duration interventions lasted 4–8 weeks [240 237 247 242 200]. The follow-up was longer than 4 months in six studies [241,246]. The longest follow-up was possible in ongoing projects [243 248 244 246].

5.1.3 Outcomes of group-based NBIs

Social constructs were assessed in parallel with other health outcomes, and few studies included in the review primarily targeted loneliness. Only one study specifically aimed to recruit participants identified as lonely [236]. The measures used to assess loneliness and social interaction were diverse. In all, six validated scales were applied, in addition to non-validated measures. Therefore, meta-analysis was not feasible, and the effects of the interventions were challenging to compare. Self-reported scales were most common, an exception being a study including participants with autism and learning disabilities, in which professionals assessed social interaction using a self-constructed scale meeting the needs of the target group [244]. Most studies used a combination of outcomes, including measures for quality of life, anxiety, depressive symptoms, and wellbeing, as well as measuring physical outcomes (for details, see Supplementary table in Study I).

Within the quantitative results, a stronger reduction in loneliness was found in studies with a middle to longer duration. In the qualitative results, themes related to increased social connectedness were identified: the development of social networks, making friends, and feeling accepted and respected by peers (Table 3 in article). The qualitative studies were mostly exploratory, although evaluative approaches to examine the subjective effects of NBSP on social isolation and loneliness did occur. Side effects were not reported to occur during the studies. Three studies [241,246,251] reported how they assessed harm and adverse outcomes. Generally, the referral process and the reasons for not attending or dropping out were poorly presented in the studies. In Table 4, the seven studies further analyzed are summarized. In the search strategy, we also included therapeutic programs; here, I include only NBSP studies.

The 3-day forest-bathing intervention involving students did not impact mental wellbeing or loneliness [245]. Two studies investigated the impact of ongoing garden interventions for mental health [243,244]. The long follow-up (1 to 3.3 years) enabled the recognition of different patterns. Mental wellbeing improved, but differences between genders and different participants were noted. The three NBIs involving older adults mainly took place indoors [240,241, 237]. Improvement was seen in life satisfaction and perceived mattering. Tse et al. included a qualitative follow-up for the intervention group, and participants reported increased feelings of pleasure, happiness, and responsibility, as well as an increased level of physical activity [240'].

Table 12 Description of quantitative studies applying social prescribing and reporting wellbeing outcomes.

Author, year, country and *Title*	**Study aims, design, and quality**	**Population characteristics and number of participants**	**Description of the intervention and length of intervention and follow-up**	***Reported outcomes (loneliness measures reported in article I)***	**Description of main findings Own remarks**
Kotera & Fido, 2021, Japan *Effects of Shinrin-Yoku Retreat on Mental Health: a Pilot Study* [245]	Forest bathing's effect on mental health. Pre–post-pilot study 4 ****	Undergraduate students, no psychiatric diagnosis. n = 25, mean age: 20.4, range 18–28, 60% women	Three-day forest bathing facilitated by experienced trainer. Follow-up 2 weeks	*Mental wellbeing: WEMWBS-J, Self-compassion SCS-J*	No significant changes were observed in mental wellbeing or loneliness
Wood et al., 2022, UK *The Impact of Therapeutic Community Gardening on the Wellbeing, Loneliness, and Life Satisfaction of Individuals with Mental Illness.*[243]	HT impact on wellbeing, loneliness and life satisfaction before and after COVID-19 pandemic Cross-sectional study 4****	Participants had mental health problems. Referral and self-referral. N = 53 Mean age: 47.4 (SD 13.1), 32% women	HT gardening once a week for 1–3 years supported by horticultural project workers, mental health staff, and volunteers. Average tracking of wellbeing 3.3 years	*Mental wellbeing: SWEMWBS. Life satisfaction: VAS 1–10*	Improved wellbeing. Earlier for men; female scores fluctuated more. Social interaction the most important element of HT. Emotional loneliness: declined in women, increased in men. Social loneliness: stable among women, declined among men.
Sempik et al., 2014, UK *The effects of social and therapeutic horticulture on aspects of social behaviour* [244]	HT effect on 1) social interaction, 2) communication, 3) motivation, and 4) task engagement. Cross-sectional study 4 ****	Participants in a HT program, referral + self-referral. n = 143, 76% men, 24% women, 18% under 18 years. Mental health problems (43%), learning disability (39%), and autism (7%)	Garden activities. Approx 25 participants/group, individual + group tasks. I: 5.5 h once a week. Assessments at start (day 0) and 30,60, 90, 180, and 365 days.	*Social interaction and communication, Likert 0–9 (*cooperation, sociability, attempts to gain, retain, or give attention). *Motivation, and task engagement: Likert 0–5.*	All participants: Increased scores for social interaction after 90, 180, and 365 days. Motivation improved at 90 days. Learning disability group: Social interaction and motivation at 90 and 180 days. Mental health group: Social interaction at 365 days.

Author, year, country and *Title*	**Study aims, design, and quality**	**Population characteristics and number of participants**	**Description of the intervention and length of intervention and follow-up**	***Reported outcomes (loneliness measures reported in article I)***	**Description of main findings Own remarks**
Lin et al., 2020, Taiwan *Effects of a combination of three-dimensional virtual reality and hands-on horticultural therapy on institutionalized older adults' physical and mental health: Quasi-experimental design* [241]	To examine health outcomes associated with horticulture therapy. Non-randomized study 5 *****	Residents > 65 years. Exclusion if dementia or severe illness. N = 106 Mean age: 77.41 (SD 7.49), 81% men I and C groups lived in similar nursing homes. *I: n = 59*	I: 18 x1 h twice a week for 9 weeks + 2-month follow-up. HT Mostly inside, voluntary use of VR equipment + caring for plants in between meetings. *C: Normal activities in institution B.*	*Health, meaning of life, perceived mattering, loneliness, and depression using the 12-item Chinese Health Questionnaire (CHQ-12)*	A significant group×time interaction was noted. The intervention group displayed improvement in health status, meaning in life, perceived mattering, loneliness, and depressive symptoms. Good commitment, no side-effects.
Tse, 2010, China *Therapeutic effects of an indoor gardening programme for older people living in nursing homes* [240]	Effect on socialization, life satisfaction, and ADL. Non-randomized study *4* ****	Older adults in assisted care, cognitively intact. median age 80–89 years n = 53, *I: n = 26*	I: Indoor gardening once a week for 8 weeks. *C: Regular care; no gardening program.*	*Life satisfaction, ADL.* *For one group: qualitative interview.*	ADL unchanged. I: improved life satisfaction and social network. Decrease loneliness. Qualitative follow-up: feeling of happiness, responsibility, engaging in social and physical activities
Fan et al., 2022, Taiwan *The effects of a combination of 3D virtual reality and hands-on horticultural activities on mastery, achievement motives, self-esteem, isolation and depression: a quasi-experimental study.*[237]	To explore the effects on mastery, achievement motives, self-esteem, isolation, and depression. Non-randomized experimental study 4 ****	Community-dwelling cognitively intact older adults. Exclusion if allergies, current illness, or hearing/visual impairment. n = 62 *I: n = 32* Mean age: 70.94 (SD 5.0), 75% female, 72% chronic disease.	I: VR and a horticultural activity on theme. 2 h once a week for 8 weeks. Eight persons/group *C: Scheduled activities, physical fitness, paper cutting etc. - NO gardening*	*Self-esteem, depression (GDS-15), Perceived mastery, Achievement motives and horticultural knowledge* *Generalized estimating equation was used to compare groups*	The intervention improved self-esteem and mastery but did not reduce isolation, depression, or achievement motives compared to control.

Modified from Supplementary table 2 in study I, Connecting through nature This table includes: Quantitative studies with a quality score ≥ 4 ****

There were no mixed methods studies > 3 *** HT: horticultural therapy; ADL: Activities of daily living I: intervention; C: Control

5.2 Wishes for nature contact among older adults

A total of 854 older adults permanently residing in 25 ALFs across the Helsinki region responded to the survey on which Studies II and III were based. The average age of respondents was 83 years (SD 8.7) and 73% were women. The characteristics of the participants are presented in Table 13.

Multimorbidity was common. The prevalence of the diagnosis composing the CCI was as follows: dementia 54%, stroke 23%, diabetes 24%, cancer (any, also previous) 17%, asthma or COPD 16%, cardiac insufficiency 15%, myocardial infarction 6%, rheumatoid arthritis 4%, and gastric ulcer 0.5%

Polypharmacy, another measure of disease burden, was widespread; participants had an average of 9.4 medications in daily use. Antidepressive medication was used by 26% (203/780 individual lists of medication). In addition, use of potentially harmful drugs was high: 30% (234/780) used neuroleptic medication, while 11% (84/780) used benzodiazepines daily.

The functional ability of the participants was generally poor: only 32% considered their mobility good, while 63% could walk either with a walking device or unaided and 37% either used a wheelchair or needed personal assistance. Gender differences occurred regarding functional ability: 28% of women considered their functioning to be good, whereas the corresponding figure for men was 40% ($p < 0.001$)

One in three respondents reported suffering from daily pain. Nevertheless, 82% of the respondents rated their general health as good, and 82% reported that they slept sufficiently. In addition, 73% stated that they were generally either happy or very happy and 83 % regarded their life attitude as positive. The average PWB score was 0.64 (0.23), indicating moderate psychological wellbeing. Generally, a PWB score of <0.4 is considered poor and a score of >0.8 indicates good psychological wellbeing [252].

Loneliness was common, as 40% felt lonely sometimes and 15% were often lonely. The respective figures for feeling depressed were 34% and 10%. Depressive symptoms were more common among women. Although the majority (90%) were satisfied with their social relationships, 8.5% had no close person in their life.

The majority (86%) reported that they were happy with their current living conditions and felt safe, although only 55% stating that moving to this ALF was their own choice.

Table 13 Characteristics of the participants in Studies II and III (n = 854).

Variable	Men (n = 233)	Women (n = 617)
Age, mean (SD)	80 (9.2)	84 (8.2)
Marital status, n (%)		
Married	80 (34)	113 (19)
Widowed	63 (27)	252 (42)
Unmarried or divorced	90 (40)	238 (40)
Education < 8 years, n (%)	117 (51)	306 (50)
Childhood in rural area, n (%)	102 (43)	339 (55)
Health, medical diagnosis, functional ability and wellbeing		
CCI, mean (SD)	2.0 (1.6)	2.0 (1.4)
Dementia diagnosis, n (%)	121 (53)	326 (55)
Number of medicines in daily use, mean (SD)	8.9 (3.7)	9.4 (4.1)
Subjective health good or very good	196 (82.1)	504 (82.1)
Reporting daily pain	52 (22.1)	199 (32.4)
Sleep subjectively sufficient	500 (81.6)	188 (81.7)
Functional ability, n (%)		
Good	94 (40)	173 (28)
In between	89 (38)	312 (51)
Poor	50 (22)	130 (21)
Fear of falling outdoors, n (%)	104 (45)	379 (62)
PWB score (SD)	0.67 (0.22)	0.63 (0.23)
Feeling satisfied with life, n (%)	485 (79.2)	196 (84.1)
Feeling needed, n (%)	319 (52.6)	132 (58.4)
Having plans for future, n (%)	133 (21.6)	57 (24.6)
Having zest for life, n (%)	538 (87.8)	208 (90.4)
Depressive symptoms, total n (%) No 478 (56.1) Sometimes 293 (34.4) Often 81 (9.5)	86 (37)	284 (46)
Lonely, n (%) No 386 (45.1) Sometimes 345 (40.3) Often 125 (14.6)	124 (53)	343 (56)
Life satisfaction and social connection		
Generally happy or very happy, n (%)	454 (73.3)	165 (70.2)
Satisfied with social connections, n (%)	202 (87)	556 (91)
Feeling safe or very safe, n (%)	548 (88.5)	214 (91.1)

PWB: Psychological wellbeing CCI: Charlson Comorbidity Index SD: Standard deviation

The perceived importance of nature was generally high, as 96% regarded nature important and 98% found nature protection important. Furthermore, 51% felt that the meaning of nature had changed with increasing age, and 291 respondents elaborated on this change. The increased importance of nature was rationalized through increased awareness and feeling closer to nature. Loss of connection was reported due to loss of mobility and autonomy because of poor health. Loss of important places, hobbies, and friends was mentioned when inquiring about the importance of nature. Only 15 respondents felt nature itself had become unimportant. The final themes regarding the perceived change in the meaning of nature with aging, as described in article 2, and presented in Table 14 were: *Valuing nature, Limited access, Increased awareness*, and *Letting go of nature*.

Table 14 Responses *(n = 291)* to the open question exploring how the meaning of nature changed with ageing, coded by *Theme* and *Category*.

Theme	*Category*	*Example*
Valuing nature (n = 141)	Meaningful nature (n = 113)	"I have missed nature; I wish it was summertime so that I could be sitting there."
	Spirituality and feeling close to nature (n = 28)	"I have spent a lot of time in nature. Now I experience more of a sense of sacredness; nature has enormous importance."
Limited access (n = 73)	Restriction due to poor health and disabilities (n = 35)	"I used to go picking mushrooms and berries and now I cannot do that anymore; I miss that."; "You can no longer access nature in the same way. With this illness, it is not possible."
	Nature is inaccessible (n = 38)	"But you can't get there. I like and I have always spent time in nature."; "It has just fallen away, only memories remain."
Increasing awareness (n = 47)	Paying attention to nature (n = 33)	"When I was young, I didn't think so much about nature. As you get older, you have more time to think."
	Nature protection, Environmental and climate change (n = 14)	"Nature is not valued as it used to be. It is not protected enough." and "The winters are warmer."
Letting go of nature (n = 29)	Reduced desire for nature (n = 18)	"It kind of goes out of your mind when you are in bad shape."; "Fears have increased, as I am afraid of falling and ticks, et cetera."
	Loss of autonomy (n = 11)	"Now you cannot do what you want."

This survey took place shortly after the social restrictions caused by the COVID-19 pandemic. Even so, the question "Has the COVID-19 pandemic changed the meaning of nature" was commonly considered difficult to answer, and only 110 participants responded. The impact was mostly negative. No access to the outdoors was the most common theme (n = 43): *"You couldn't go outdoors"*. However, increased importance was also mentioned (n = 37), and the moments outdoors

were significant: "*Valuable experience, when possible*". Moreover, participants found new ways of interacting: *"I enjoy the view when I can't go out"*. Fear (n = 17) was a theme that included mentions not only of the infection, e.g. "*Corona is a dangerous disease*", but also of the social climate: *"People behave differently, angrier*". Finally, a health decline and loss of functional abilities were reported (n = 7): "*I lost my functional ability*". As a conclusion, although the pandemic was distant for many at the time of the survey, individual impacts might have been significant, and nature was recognized as a source of resilience.

The question "*What kind of nature experiences do you wish for?"* was interpreted in two ways. Of all responses (n = 805), most were pragmatic requests considering the current living conditions, while a minority were escapist wishes for traveling and adventures. Open-ended responses were short. Only 48 respondents had no wish for contact with nature, 123 answered "cannot say", and 15 stated "anything". Figure 7 illustrates the distributions of wishes for nature experiences, including uncertain responses.

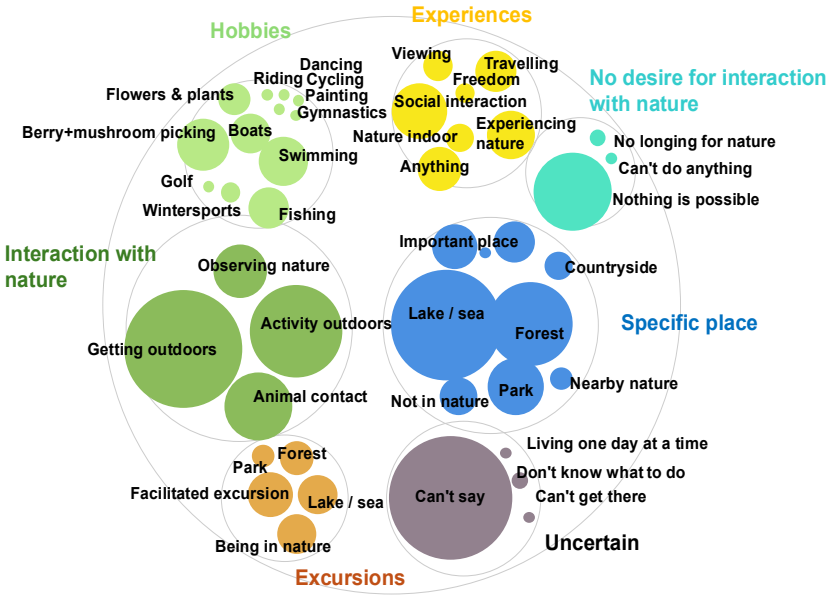

Figure 7 Older adults' responses (n=805) to the open question: "What kind of nature experiences do you wish for?" The size of the circles denotes the number of responses. A more detailed thematic analysis is published in article II, Table 3.

If the response clearly referred to contact with nature, e.g., "I would like to wander in the forest and listen to the sounds of nature", this was themed as *interaction with nature*. Just *being outdoors* was a common wish. Many responses emphasized *physical activity*, most commonly walking and swimming. A *specific place* was regularly the waterfront or forest landscape, as well as important places, often the respondent's previous home. Wishes for *experiences* included trips nearby, and picking berries, mushrooms, and fishing were also commonly

mentioned. Finally, *social interaction* brought up wishes for common activities, contacts with animals, and a call for assistance and support. Autonomy emerged under the theme of physical activity, exhibiting a wish to move at one's own pace and having access to aid, while wishes for solitude and personal space were mentioned as examples of social autonomy. Notably, not everyone longed for nature interaction, or could express a wish. The qualitative analysis presented in article II built on the 755 responses with content. The final themes were: interacting with natural elements (n = 233), important places (n = 224), resignation and hesitation (n = 172), longing for experiences (n = 140), and revisiting former hobbies (n = 82).

Altogether, 83% of respondents were interested in participating in future nature-based interventions.

5.2.1 Role of assisted living facilities in supporting nature contact

Of all respondents, 62% felt the ALF supported outdoor activities and 490 respondents elaborated on how the facility either encouraged or did not support contact with nature. The results are presented in Table 15.

Table 15 Responses *(n = 490)* to the open question exploring how ALFs either encourage or do not support contact with nature; responses coded by *Theme* and *Category*.

Theme	*Category*	*Example*
Environment (n = 216)	The ALF as an environment (n = 200)	"Nice yard; birds come to sit on the windowsill." "This place is lovely as an environment; it is easy to go"
	Urban surrounding (n = 9)	"I'm happy to go out, but I don't see it as nature."
	Poor accessibility (n = 7)	"Difficult to get around in a wheelchair due to the thresholds."
Atmosphere of the ALF (n = 201)	Staff enables outdoor activity (n = 72)	"A carer comes with you if you wish to go outdoors."
	Dependence on others (n = 70)	"No, because you depend on someone to take you there." "You don't get to go out much from here."
	Facilitated activities (n = 44)	"Especially in the summer, we are outdoors. Events, e.g. domestic animals."
	Requires own activity (n = 15)	"Not much is invested. If I ask nicely, I may get out."
Lacking something (n = 73)	Lack of staff, time, and support (n = 27)	"They won't take us out because there are not enough carers." "No one talks about nature or about going out."
	Lack of activities (n = 22)	"People who move here are in such bad shape that nothing happens, not even excursions."
	No experience yet (n = 15)	"Just haven't had a chance to try it yet, as my hip is still sore."
	Poor health (n = 9)	"All I can do is watch TV and listen to the radio."

A nice surrounding, assistance, and accessibility were frequently mentioned and appreciated. They form the theme environment (n = 216), in which the biggest category, the ALF as an environment, includes descriptions of the immediate surroundings and yard. Respondents also commented on the urban surroundings, and 7 respondents mentioned that the ALF had poor accessibility.

Under the theme atmosphere of the ALF (n = 201), respondents highlighted that contact with nature is enabled by the staff. This might require individual initiative: *"If I ask nicely, I may get out*". Responses highlighting company were often phrased expressing community: "*We do trips*". The attitude of the personnel was mentioned with appreciation, sometimes naming a single employee, or nurses' pets; 5% answered: *"They do their best"*. Planned activities, including discussions and indoor activities, were mentioned by 32 respondents, while 17 stated that nothing happens

Obstacles primarily consisted of barriers to going outdoors and limited time outside. A shortage of staff, lack of assistance, and poor accessibility, especially during winter, were commonly reported reasons. In addition, new residents were unfamiliar with the possibilities, and some could not participate due to poor health. These experiences compose the theme of lacking something (n = 73).

5.2.2 Nature connection and psychological wellbeing

During the interviews and when coding the open-ended questions, we noted a subtle, yet clear difference in wording, indicating individual variance in nature connection. For some, nature was a background setting for activity, while others described a profound connection with nature itself. To explore this matter further, we applied exploratory factor analysis to the responses to the nature questions. We identified three dimensions, and the included statements explained 71% of the total variance. These statements form the Gerontological Nature Connection Scale (GNCS) and are presented in Table 16.

The responses were distributed within the factors as follows: Factor 1 *Nature in mind* describes appreciation of and social bonding through nature (nature is a source of discussion, appreciation of gardening, contact with animals and pictures of nature, valuing being outside, and less perceived pain in nature). Factor 2 describes *Outdoor activity* (Having access to nature and finding it easy to move outdoors). Factor 3 *Nature apprehension* describes hesitation (nature brings back bad memories, and insects are dangerous).

Table 16 The three factors identified through exploratory factor analysis and the associated statements and correlation coefficient. Coefficients with values <0.40 are not shown.

FACTOR	STATEMENTS AND LOADING
NATURE IN MIND	I get topics for discussion from nature (0.628) Gardening and caring for plants is important (0.544) Looking at pictures of nature is important (0.502) In nature, I feel I am part of something bigger (0.485) I feel less pain when in nature (0.458) It is also possible to experience nature indoors (0.425) Contact with animals is important (0.420) Being outdoors is important (0.407)
OUTDOOR ACTIVITY	I have access to nature (0.733) It is easy to move outdoors (0.661)
NATURE APPREHENSION	Insects and tics are a threat to me (0.533) Nature brings back bad memories (0.513)

The nature scores followed a normal distribution; the average total was 7.74 (SD 2.21). Cronbach's alpha for internal validity was 0.56. Women appreciated nature somewhat more than men (nature score 7.84 (SD 2.12) vs. 7.46 (SD 2.42), $p = 0.022$). Question-specific differences between genders are presented in Table 17. Living in a rural area during childhood was associated with a higher nature connection, as explored by GNCS.

Table 17 Gender differences in responses to GNCS statements. The results are presented as number of persons agreeing with the statement

	Women N = 617 *n (%)*	*Men N = 235* *n (%)*	*P*
I have access to nature	300 (49)	135 (57)	0.021
I feel less pain in a natural environment	306 (50)	101 (43)	0.084
I get topics for conversation from nature	502 (81)	172 (73)	0.009
It is easy to be physically active in nature	346 (56)	156 (66)	0.006
It is also possible to experience nature indoors	430 (70)	153 (65)	0.20
Nature does not bring back bad memories	491 (80)	186 (79)	0.89
In nature I feel part of something bigger	302 (49)	110 (47)	0.58
Insects and ticks are not a danger to me	306 (50)	160 (68)	<0.001
Being outdoors is important to me	535 (87)	192 (82)	0.065
Gardening is important to me	384 (62)	70 (30)	<0.001
Pictures of nature are important to me	482 (78)	155 (66)	<0.001
Contact with animals is important to me	456 (74)	162 (69)	0.15

A high GNCS score was associated with happiness, a positive attitude, and subjective wellbeing. In addition, better mobility was associated with a higher importance of nature. Age, marital status, and disease burden were not associated with the nature score.

As illustrated in Figure 8a, a high nature score was associated with better psychological wellbeing. This association depended on the ability to independently mobile outdoors (Figure 8b). For participants with a low nature score, not being able to be independently active outdoors was related to a lower PWB score, while the PWB index did not vary with functional ability for persons with high nature scores.

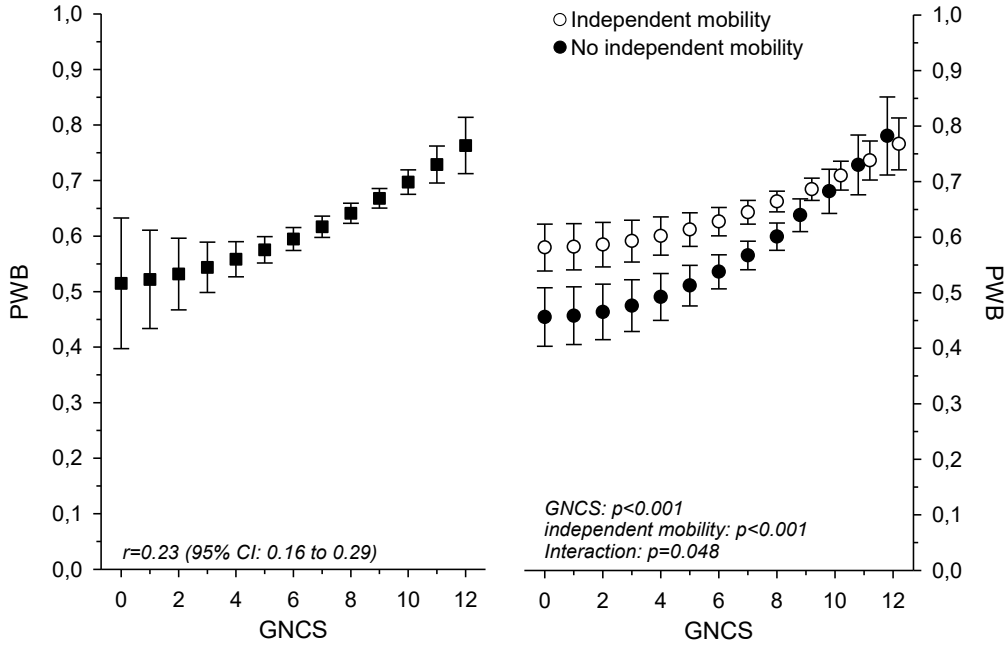

Figure 8 a) The relationship between psychological wellbeing (PWB) and the Gerontological Nature Connection score (GNCS), and b) the impact of independent mobility on this relationship. The model includes quadratic terms for GNCS. Analyses are adjusted for age and gender.

5.3 The Health Forest intervention: a clinical trial in primary care

The study included 79 participants with an average age of 58 years (range 29–81), and 79% were female. The nature group had 46 participants, while 33 persons took part of the sports group. The groups did not differ at baseline, and the commitment to the intervention was also similar. Participants took part in 5.3 sessions on average, and 72% attended 5 or more sessions, and were thereby considered as fulfilling the program. Baseline characteristics are presented in Study IV Table 1.

At baseline, only 26% of the participants considered themselves to be in good general health. The corresponding figures in the Finnish population are 62% for men and 63% for women [230]. On the 1-to-5 Likert scale, our participants' average self-rated general health was 2.97 (SD 0.93). Following the intervention, self-rated health improved in both groups (mean change 0.4, 95% CI 0.21 to 0.59, $p < 0.001$). The effects of the intervention are presented in Study IV Table 2

Average self-reported functional ability was 2.77 (SD 0.92) on the 1–5 scale, and considered good by only 20%. In both groups, functional ability improved following the intervention (mean change 0.45, 95% CI 0.28 to 0.62, $p < 0.001$).

Self-rated mental health was considered good by 44% of the respondents (mean 3.31, SD 0.94). Here, improvement occurred in the nature group (mean change 0.39, 95% CI 0.16 to 0.62, $p = 0.002$) but not in the sports group (mean change 0.04 95% CI -0.25 to 0.33, $p = 0.77$)

Sleep quality and sleep duration were generally low, and only 31% reported sleeping well. As measured by accelerometers and confirmed by diaries, the mean sleep time was 4.8 h (SD 1.2), and 81% slept less than 6 h per night, which is usually considered as an insufficient amount of sleep. The accelerometer-based number of awakenings after sleep onset was 14 on average (SD 5), and mean time awake after sleep onset was 34 min (SD 13). Sleep efficiency was 89% on average. Following the intervention, 61% (22 out of 36) of the participants in the nature group experienced a positive change in perceived sleep ($z = -3.78$, $p < 0.001$). In the sports group, 33% (8 out of 24) reported improved sleep quality ($z = -1.81$, $p = 0.07$). This is contradictory to the observed accelerometer measures, for which total sleep time decreased (-15 min) in the nature group but increased (+14 min) in the sports group.

In the nature group, the change in total sleep time depended on perceived health. The mean change in sleep time was -48 min (SD 64 min) if health was rated as good (n = 9), but -4 min (SD 52 min) if health was rated poor at baseline (n = 26). The independent t-test indicated a difference between the groups ($p = 0.047$). This pattern was not seen in the sports group. In the nature group, the number of awakenings decreased by 1.4 on average (95% CI 2.8 to zero, $p = 0.05$) and mean time awake after sleep onset decreased by 2.9 min on average (-6.1 to 0.3 min, $p = 0.08$), whereas no change occurred in the Sports group. Sleep efficiency did not change in either group.

Before the start of the study, 88% of all participants found nature important or very important (mean 4.35, SD 0.7). Even though the perceived importance of nature was so high, a further significant improvement (mean change 0.17, 95% CI 0.04 to 0.29, $p = 0.012$) was observed in the nature group. Exercise was important to 58% of the participants, and at the end of the study, the importance of exercise had increased in the sports group (mean change 0.28, 95% CI 0.12 to 0.44, $p < 0.001$).

5.3.1 Effect on positive mental wellbeing

The change in positive mental wellbeing as assessed with the WEMWBS score was our primary outcome. We analyzed the impact of participation in the interventions on the whole group, as well as considering the nature and sports groups separately, as presented in Table 18. The participants fulfilling the interventions (n = 54) displayed a significant improvement in the total WEMWBS score, with a mean change of 2.2 points ($p = 0.01$). However, the change observed in the whole group was mainly due to the good effect of the nature group (n = 33), in which a mean change of 3.5 points ($p = 0.008$) was observed, compared to a mean change of 0.4 points ($p = 0.75$) in the sports group (n = 21).

For the nature group, participation in the intervention improved the following aspects: feeling relaxed, the feeling of having energy to spare, the feeling of dealing well with problems, feeling good about oneself, the feeling of being close to other people, and the feeling of being cheerful.

In the whole group, the range of the WEMWBS change following the intervention was wide, from -12 to 19 points, the median difference being 1.5 points. Altogether, 61% experienced a positive outcome of the intervention (≥1 point), while the positive mental wellbeing score either did not change or decreased for 39% of the participants. The groups did not differ.

Using binary regression analysis, no factors emerged as clear predictors of a positive WEMWBS outcome. Better self-rated health at the beginning displayed a weak association (OR 1.93, 95% CI 1.01 to 3.67, $p = 0.047$). The impacts of self-rated health and mental health were nonsignificant when the model was adjusted for gender, age, and attendance. The group was not associated with an improved WEMWBS score.

Table 18 Change in positive mental wellbeing measured using the Warwick-Edinburgh Mental Well-being Scale (WEMWBS)

QUESTION Score 1–5		ALL PARTICPANTS n = 59–60			NATURE GROUP N = 34–35		SPORTS GROUP N = 23–24	
		Mean (SD)	Mean change (95% CI)	*P*	Mean change (95% CI)	*P*	Mean change (95% CI)	*P*
1	I've been feeling optimistic about the future	3.5 (0.8)	0.14 (-0.05 - 0.33)	0.159	0.23 (-0.02 - 0.48)	0.073	0 (-0.31 - 0.31)	1
2	I've been feeling useful	3.5 (0.8)	0.07 (-0.13 - 0.26)	0.497	0.08 (-0.16 - 0.33)	0.499	0.04 (-0.3 - 0.38)	0.802
3	**I've been feeling relaxed**	3.1 (0.8)	**0.27 (0.06 - 0.49)**	**0.015**	**0.31 (0.02 - 0.6)**	**0.039**	0.22 (-0.13 - 0.56)	0.203
4	I've been feeling interested in other people	3.7 (0.8)	0.13 (-0.07 - 0.34)	0.197	0.14 (-0.08 - 0.36)	0.201	0.13 (-0.29 - 0.54)	0.543
5	**I've had energy to spare**	3.0 (0.8)	**0.35 (0.13 - 0.57)**	**0.002**	**0.42 (0.11 - 0.72)**	**0.009**	0.25 (-0.06 - 0.56)	0.11
6	**I've been dealing with problems well**	3.2 (0.8)	0.18 (-0.04 - 0.41)	0.109	**0.31 (0.02 - 0.6)**	**0.039**	0 (-0.37- 0.37)	1
7	I've been thinking clearly	3.6 (0.7)	-0.07 (-0.27 - 0.13)	0.497	0.06 (-0.18 - 0.29)	0.624	-0.25 (-0.61 - 0.11)	0.162
8	**I've been feeling good about myself**	3.2 (0.7)	0.14 (-0.05 - 0.33)	0.159	**0.31 (0.07 - 0.55)**	**0.014**	-0.13 (-0.43 - 0.17)	0.377
9	**I've been feeling close to other people**	3.4 (1)	**0.3 (0.05 - 0.55)**	**0.019**	**0.39 (0.08 - 0.69)**	**0.014**	0.17 (-0.28 - 0.61)	0.445
10	I've been feeling confident	3.4 (0.9)	0.1 (-0.12 - 0.32)	0.359	0.26 (-0.02 - 0.54)	0.071	-0.13 (-0.48 - 0.23)	0.479
11	I've been able to make up my own mind about things	4 (0.8)	0.02 (-0.14 - 0.17)	0.829	0.03 (-0.19 - 0.25)	0.8	0 (-0.23 - 0.23)	1
12	I've been feeling loved	3.6 (1)	0.07 (-0.12 - 0.26)	0.484	0.19 (-0.06 - 0.45)	0.128	-0.13 (-0.43 - 0.17)	0.377
13	I've been interested in new things	3.8 (0.8)	0.17 (-0.02 - 0.36)	0.077	0.22 (-0.05 - 0.49)	0.103	0.09 (-0.17- 0.34)	0.492
14	I've been feeling cheerful	3.6 (0.8)	0.19 (-0.03 - 0.4)	0.086	0.39 (0.08 - 0.69)	0.014	-0.13 (-0.37- 0.11)	0.266
	Total WEMWBS score	48.3 (7.9)	**2.22 (0.53 - 3.92)**	**0.011**	**3.15 (0.87 - 5.43)**	**0.008**	0.76 (-1.82 - 3.34)	0.545

An important, although only indicative finding is that the participants with poor perceived health might have experience a smaller improvement in mental wellbeing compared to those considering their health good. The results are presented in Figure 9. In the nature group, participants with poor perceived health (n = 26) displayed an improvement in the WEMWBS scores, the mean change being 3.12 (95% CI 0.77 to 5.46). If health was rated good (n = 7), the mean change was 3.29 (95% CI -4.98 to 11.55), and the difference depending on the self-rated health status was nonsignificant (p = 0.95). However, in the sports group, those in poor health (n = 15) had a mean WEMWBS change of -0.93 (95% CI -4.10 to 2.24), whereas those in good health (n = 6) had the best response to the intervention, their mean change being 5 (95% CI 2.26 to 7.74). The difference depending on the self-rated health status was statistically significant (p = 0.004), but the cohort was small.

A similar pattern was observed for perceived mental health, and here, there was a difference depending on perceived health in both groups. In the nature group, those with poor mental health (n = 20) displayed a nonsignificant mean change of 1.15 (95% CI -1.23 to 3.53) in their WEMWBS scores, but those initially rating their mental health as good (n = 13) improved more (mean 6.23, 95% CI 1.87 to 10.6, p = 0.039). In the sports group, if mental health was poor (n = 12), the average WEMWBS change was -1.17 (95% CI -1.99 to 2.65), but when initial self-rated mental health was good (n = 9), the WEMWBS scores improved (mean 3.33, 95% CI 0.09 to 6.57, p = 0.071). Concluding these results, the response in positive mental wellbeing varied depending on perceived health, and individual variation was quite high, as demonstrated by the confidence intervals. It is to be noted that although the average change in the WEMWBS score was positive, several participants displayed a reduction in mental wellbeing.

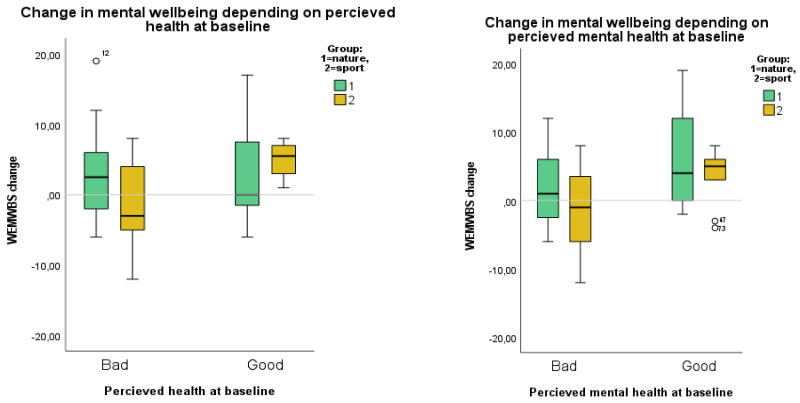

Figure 9 The change in the WEMWBS score depending on a) self-rated general health and b) self-rated mental health

5.4 Results at a glance

In response to the initial research questions, the results are as follows:

1. How have nature-based interventions been used to alleviate loneliness, and what is their effect on wellbeing? (I)

The NBIs targeting loneliness could be grouped into three categories: 1) nature-based physical activity, 2) interventions including natural elements, and 3) gardening. We identified three distinct groups of participants: 1) adolescents, 2) adults with chronic health impairment, primarily mental health problems, and 3) older adults. Participants were either chronically ill, suffered from long-lasting stress, or identified to be at risk of poor wellbeing or segregation. None of the group interventions had a primarily preventive scope. In the studies including older adults, those diagnosed with memory impairment were mostly excluded. Although positive effects were reported, due to the wide range of assessed outcomes, we could not conclude effects on loneliness on a general level.

The NBIs had greater effects on general wellbeing than on loneliness. Mental wellbeing, life satisfaction, and perceived mattering were the outcomes that most often improved following the intervention. None of the studies in our review followed up the use of health care services, medication, or mortality.

2. What is the meaning of nature among older adults residing in ALFs and how can facilities support interaction with nature? (II)

Nature was extremely important to the respondents in our study. The psychological dimensions of nature contact were clearer among women, while men found it easier to go outdoors. A deeper understanding of the dimensions of nature connection can help in the development of future NBIs for older adults in ALFs, a cohort in which autonomy needs special consideration.

The interest in taking part in NBIs was very high, with 83% being interested in participating. Older adults, including those with cognitive decline, had feasible wishes for activities, and the wishes were mostly pragmatic, e.g., visiting a favorite place. The possibility to go outdoors was strongly emphasized, and respondents who felt they could go outdoors as often as they wished reported better psychological wellbeing.

The atmosphere and personnel in the ALFs were often mentioned as instrumental to enabling nature connection, and respondents described ways in which nature is or is not present in their current life. Access to the outdoors was restricted by loss of functional ability and autonomy. Accessible areas, such as a yard or park close by, were often mentioned. However, indoor activities and the

view were also commonly considered important. Although 96% considered nature important, only 51% could visit nature as often as desired.

3. Is there an association between nature connection and psychological wellbeing among older adults living in ALFs, and how is this influenced by health status, mobility, or disability? (III)

A higher nature connection, as assessed with the score on the developed Gerontological Nature Connection Scale (GNCS), was associated with psychological wellbeing and happiness. This connection potentially buffers psychological wellbeing when functional ability is poor.

4. How does a nature-based intervention affect mental wellbeing among primary care patients, and are there differences in the wellbeing outcomes compared to a sports intervention? (IV)

Perceived general health and physical ability improved in both groups. Perceived mental health and the positive mental health score measured on the WEMWBS improved only in the nature group. Specifically, a positive change was noted for the statements: “I’ve been feeling relaxed”, “I’ve had energy to spare”, “I’ve been dealing with problems well”, “I’ve been feeling good about myself”, and “I’ve been feeling close to other people”. Attendance was good in both groups, and professionals identified suitable participants. We did not identify factors predicting a positive response in mental wellbeing.

Poor sleep surfaced as a clear finding among participants. Perceived sleep quality improved in the nature group, although the time asleep actually reduced, albeit not statistically significantly.

The results demonstrate that NBIs can improve wellbeing among people living in an area with accessible greenspace.

6 Discussion

6.1 Main findings

Nature-based interventions may support wellbeing and reduce loneliness. The nature-based group interventions identified in our mixed methods systematic review targeted participants in poor health. The reviewed qualitative studies described how NBIs potentially cultivate connectedness and belonging. The quantitative studies mostly reported small or modest effects on loneliness; the positive effects on general wellbeing were clearer.

Nature is highly appreciated among older adults residing in ALFs in Finland. Nature connection is associated with psychological wellbeing and happiness. The level of interest in taking part in NBIs is high, and older adults with cognitive decline also have clear and feasible wishes for nature activities. Participants having access to the outdoors reported better wellbeing. Our results revealed individual variance in how people build a connection with nature. A psychological connection, for instance, included perceiving less pain when outdoors, providing an example of how nature connection can potentially reduce symptoms. Other respondents emphasized physical activity. Understanding this personal variance, including hesitation towards nature, will help in developing and targeting future NBIs for older adults.

The Health Forest clinical trial, comparing a group-based NBI with a sports-based intervention, was feasible in primary care, and professionals identified suitable participants through social prescribing. The NBI demonstrated superiority in supporting self-reported mental wellbeing. There was large individual variation in the effect of the intervention, however, and we did not identify factors predicting a good or poor effect, although tentative findings suggest that the NBI could support those experiencing poor mental wellbeing.

6.2 Comparison with previous literature

As described in the literature review, much is to be clarified when exploring how nature-based solutions and interventions impact human health. Notably, most of the population enjoys the outdoors on their own, and the majority of those experiencing a health decline can make use of nature-based solutions without external support.

This discussion concentrates on NBIs as part of care. First, I focus on for whom NBIs could be recommended. Then, I discuss key elements of interventions and the role of nature connection as a mediator of wellbeing. The health effects, feasibility, and implementation of NBIs are discussed, with a focus on the context of primary care in Finland.

6.2.1 Participants, recruitment, and interest in participating

According to the systematic literature review of Study I, nature-based prescribing targeting loneliness has mostly been explored among participants in poor health. Considering the commonness of loneliness, we expected more studies with a preventive scope [253-255]. Recruitment strategies were generally poorly described. The focus groups corresponded to previous descriptions of potential participants in SP and nature-based prescribing [176]. Many studies investigated persons already taking part in nature-based activities, and these participants might be self-selected or have a more positive attitude towards NBIs than the general population.

The key steps of social prescribing have been described as follows [11]: 1) **Enrolment**: Identifying participants and referring them in such a way that they believe the activity is beneficial; 2) **Engagement**: Acceptance of the activity is more likely if it is accessible, and if the participant is supported, especially during the first meeting; 3) **Adherence**: Long-term commitment and completion of the program depends on the leader or facilitator, who also needs to acknowledge changes in the participant's situation. These steps also appear applicable to nature-based prescribing. However, no specific models or approaches were identified as effective in the realistic review by Husk et al [11].

The cross-sectional material on which Studies II and III built is to be considered unique, as it aimed to include all potential participants, including those who might have negative assumptions regarding NBIs. The high interest in taking part in NBIs (83% interested) was noteworthy, considering the frailty, burden of disease, and prevalence of dementia of the cohort. The residents in ALFs appeared to be in poorer health compared to previous studies [21]. Approximately 15% were often lonely and 10% often felt depressed. Nearly one in three used anti-psychotic medication daily, and these medications are known to be potentially harmful in the aged

population [8]. Loneliness has increased [158], which might partly be explained by the fact that the current study took place after the COVID-19 pandemic.

The self-rated health of the participants in the Health Forest intervention was considerably lower than in the general population [230]. Although the WEMWBS is not a diagnostic scale, respondents with a total score of ≤40 ought to be considered to have a high risk of major depression, while scores between 41 and 45 indicate a high risk of psychological distress and an increased risk of depression [232]. The average WEMWBS score was 48 in this cohort, while in the FinHealth 2017 population survey, the corresponding score in southern Finland was 52.8 (95% CI 52.3 to 53.3) [256] [230]. Health professionals identified and involved suitable participants. However, the intervention mainly appealed to women. Involving men in health-promoting activities is challenging, and the nature-based activity was no exception [257]. The challenge of recruiting men is recognized, as described in the literature review. For those participating in study IV, adherence to the intervention was good and did not differ between seasons. Based on this finding, nature-based interventions can be organized around the year, including in countries with seasonal changes, such as Finland.

In a follow-up study, 23 participants from the Health Forest group took part in semi-structured interviews 2–4 years after the intervention [258]. The majority reported that they would not have had the strength to engage in the activity themselves. Although some initially thought the suggestion of an NBI odd, they eventually considered it a person-centered form of care. The qualitative results highlight the importance of social and health care in conveying knowledge about nature's health-promoting effects. Furthermore, the importance of understanding the aim of the program and having an information meeting was emphasized [258]. These findings are in line with the literature, according to which previous relationships with healthcare providers support both engagement in and trust in greenspace programs and facilitators [183]. Realistic anticipations are crucial, as if the scope is too broad or if participants have inaccurate expectations, this will not only diminish the effects of the activity but might cause disappointment and thereby harm [183]. Knowing the expectations regarding an activity is central. For some, strenuous physical activity supports wellbeing and the feeling of achievement, while for others, this might be a negative experience, reducing the will to participate [183].

This variation might not only be dependent on age or physical function, but also on the way in which a person builds a connection with nature. Therefore, although health professionals do not carry out NBIs, they need to understand and support the methodology when referring patients or rely on a connector acquainted with the patient's needs [181]. The crucial role of clinicians, often GPs, has been highlighted in the literature [183,204]. In a multi-professional care setting, nurses and trusted care providers are equally important, as highlighted in our results. In ALFs, nurses and therapists are key actors. Interestingly, in their review, Adewuyi et al. found no differences in prescription methods when comparing written vs. verbal and

individual vs. group referral [204]. Contradictory, Nguyen et al. observed a better effect of interventions when participants were referred; specifically, the effect was better for participants referred from social services [199]. The participants in the Health Forest follow-up emphasized the importance of support from trusted health care [258]. The form of referral is probably secondary to the trust between the person in need and the care provider [183,258].

Participants suffering from loneliness and poor health might have a higher threshold to participation and need support to enroll. In addition, the first meeting with the facilitator and group is crucial [11,258]. Identifying and addressing loneliness is a central part of this thesis. Although Study I explored published studies addressing social constructs, the dimensions of loneliness were often not described. Moreover, several mixed methods studies did not initially consider loneliness, but the topic arose in the qualitative material. This was also a finding in the Health Forest study. In the qualitative follow-up, the subtheme *safely together in nature* was recognized [258]. The natural setting helped participants to relax and reduced social anxiety, while being part of a group and meeting the participants beforehand lowered the threshold to taking part in the activity [258].

Experiencing loneliness impacts behavior. Following up the general recommendation of spending 2 h/week in nature, an Australian study demonstrated that those experiencing loneliness were less likely to meet this recommendation [259]. Applying adjusted odds ratios (AOR), the study found that people who were lonely had a 24% lower probability of achieving this recommendation. Compared to non-lonely persons, the AOR for visiting favorite places at least once a week was 35% lower for those experiencing overall loneliness, 30% for those suffering from social loneliness, and 40% lower if loneliness was emotional [259].

6.2.2 Feasible nature-based interventions

The systematic review revealed that the interventions used to alleviate loneliness were very similar to NBIs addressing other health issues [199 89].

The wishes expressed by the older adults in ALFs were mostly clear, feasible and practical. Wishes often reflected the life lived and included common activities such as picking berries or mushrooms. Gardening, on the other hand, was not very popular, especially among men. The psychological support nature may provide was very similar to themes described in younger populations [183]. Reduced autonomy needs consideration, as older adults with physical and cognitive decline need support and guidance for safe nature contact.

Although a specific place was one of the most frequently mentioned wishes for nature interaction in our study, loss of autonomy greatly prevents the use of favorite places for emotional self-regulation: 51% of study participants did not have access

to nature according to their wishes. The potential and importance of greenspace in the close surroundings has previously been highlighted in studies including ALF management [186]. Natural elements could also support mental restoration when outdoor visits are not possible [260]. Digitals solutions, including virtual reality, could be a feasible way to enjoy nature [261]. Sounds, visual elements, scents, and interactive digital programs are interesting future solutions. In our study, lakes and the sea, i.e. blue space, were preferred surroundings, adding understanding to the increasing research on the mental benefits from affinity to water [262]. Winter was mentioned both in positive and negative terms. Respondents referred to climate change and warmer winters, and some respondents mentioned that winter sports such as skiing had previously been important for them. Slippery and cold winter conditions commonly restrict going outdoors, an everyday experience also previously recognized in the literature [263]. Although NBIs have been implemented in long-term care, residents' views and wishes are understudied. [264] Our results highlight the importance of including a focus group, and that people with dementia can also express clear and feasible wishes.

6.2.3 The mediating role of nature connection

We found that nature connection, as explored using the GNCS, was associated with happiness and psychological wellbeing among older adults. Similar results have manifested in younger populations [116]. A person with a strong nature connection might find nature settling and engage with it [183]. This capability may bridge poor functional capacity and declining health, as nature may remain a source of resilience [12,120].

Nature was highly valued by the older adults in ALFs, with 96% regarding nature important and 98% considering the protection of nature important. This appreciation was higher than in the general population, as in a recent Finnish population study, 87% considered nature important in their current lives [126]. In this survey, respondents stated that contact with nature gave them peace of mind (65%), vitality and energy (62%), mental wellbeing (59%), relaxation and restoration (56%), and they mentioned nature's gifts (56%) and health and wellbeing (55%). Of the more than 2000 respondents, 74% considered everyday outdoor physical activity as a way to stay healthy. Nature connection can also be achieved by looking at photographs and pictures. Respondents valued facts about nature, as well as nature encounters when traveling. These themes are very similar to those that arose among older adults, and self-efficacy was also pronounced in the follow-up of the Health Forest intervention [258]. Women over 65 years of age had the highest appreciation of nature [126]. Previous studies have indicated that the importance of nature might increase with age [120,185]. In our cross-sectional data (Study II), a

majority felt that the meaning of nature had changed with age, and many reported that it had increased value and importance.

Study III identified dimensions that potentially help to understand personal variance in how people build a connection with nature and thereby help in tailoring NBIs to achieve the best effect. Very similar dimensions, including psychological connection, physical capability, but also worries and fears, have previously been described in younger populations [265]. Functional disability is accentuated among older adults. Our finding that nature connection potentially supports psychological wellbeing is important. This connection can be supported by natural elements, and indoor gardening has also been shown to be beneficial if outdoor visits are not possible [241].

None of the intervention studies identified in Study I included the concept of nature connection. Nature connectedness/connection is not an established concept; the existing measures have dissimilar definitions and include different dimensions [118,266]. We have not identified previous studies on nature connection among older adults; on the contrary, older adults have often been excluded from such studies [116,183]. To our knowledge, the GNCS is the first gerontological nature connection scale [118]. Based on our findings, there is a need to develop scales that account for respondents' cognition, autonomy, and functional ability. However, such issues do not always depend on age.

Following the Health Forest intervention, the importance of nature to the participants increased. This demonstrates that a green, accessible environment is not enough, that persons in poor health need support to reconnect with nature, and that the intervention might have long-lasting effects, as presented in the qualitative follow-up [258]. The theme "*Seeing nature through new glasses*" included the subthemes: *Experiencing nature contact* and *Shared responsibility for nature, Tools for self-regulation* and *Social connection, shared joy, and knowledge*. Participants reported they had used nature connection broadly, sharing their new skills with family and at work [258]. Building a connection with nature may support a broader sense of belonging [131].

6.2.4 Health effects: from public health towards person-centered care

Nature and health research has evolved in the field of public health, focusing on prevention and health promotion on the societal level [183]. Transforming evidence from public health to individualized care can be challenging. Notably, the concepts of nature-based solutions, social prescribing, and nature-based prescribing are evolving, and all can be considered complex. Therefore, it is essential to explore these entities. A useful analytical framework for quality assessment describes the following six dimensions for assessing interventions [267]. An intervention should be:

Safe: Avoiding harm to patients from the care that is intended to help them;
Effective: Providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and misuse, respectively);
Patient-centered: Providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions;
Timely: Reducing waits and sometimes harmful delays for both those who receive and those who give care;
Efficient: Avoiding waste, including waste of equipment, supplies, ideas, and energy;
Equitable: Providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status.

In Study I, the diverse range of applied measures did not allow conclusions regarding effects on a broader level. Given the wide range of participants, this is understandable, as the effectiveness of interventions should be assessed using measures that focus on what matters to the focus groups, including quality of life, functional ability, and capability [9,142,268]. What matters varies with age, health status, and life situation. Furthermore, the effects on wellbeing were clearer than that on loneliness.

6.2.4.1 Safety

NBIs are generally considered safe [199,269]. However, when interventions developed for healthy and active people are implemented among participants living with frailty, safety needs further consideration. Safety aspects were poorly discussed in the articles included in Study I. Feeling insecure is a potential barrier to participating in NBIs. In Study III, 45% reported fear of falling. However, as this fear did not differ between indoors or outdoors, we excluded the question from the factor analysis, arguing that in this focus group, prevention of falls should always be considered. Interventions applying adventurous activities have mostly enlisted adolescents and young adults [89]. Some of the older adults responding to our survey recalled adventurous contact with nature in their youth, as these had provided meaningful moments. Very few, however, expressed such wishes in their current situation. Rather, they expressed feasible hopes for activities and considered safety. In the Health Forest interventions, no harm was reported, but we did not conduct a structured assessment of events.

Physical safety includes protection against harmful pathogens, including vaccination against tetanus and tick-borne encephalitis, and applying more careful hygiene if participants have suppressed immunity [270]. Avoiding direct contact with

microbes, however, may also have adverse effects in the long term, as described by the biodiversity hypotheses [81]. Furthermore, outdoor activities need to be adapted according to the weather. Risk assessment and careful planning enables frail participants to enjoy the outdoors, while overemphasizing risks might cause anxiety and reduce participation.

Psychological and social safety are intertwined, but neither was assessed in the studies included in our review. However, they probably impact outcomes and attendance. NBIs often include elements supporting personal growth and the learning of new skills, providing a sense of purpose [131,183]. If these needs are not met, NBIs might fail. Trained and confident facilitators are enablers of interventions supporting self-efficacy and self-esteem [183]. The facilitators need to acknowledge hesitation and biophobia. The outcomes of group interventions not only depend on the individual, the environment, and the facilitator, but to a high degree on the other participants. Therefore, a skilled leader not only knows about nature but also supports the group dynamics [258].

Experiencing ecological distress when observing the loss of natural habitats and the consequences of climate change, e.g. increased urbanization and snow-free winters, were themes that arose in our qualitative material. Eco-anxiety has mostly been described in young populations [93], but according to our findings, the topic is also relevant among the aged. Considering feelings of loss supports psychological safety [271]. Nature connection is a strong predictor of pro-environmental behavior, which in turn is positively associated with subjective wellbeing [121].

6.2.4.2 Effective, person-centered, and timely

Assessing the effects of treatment is essential for safe, efficient, and timely care. The intervention needs to match the needs of a participant at that moment. In the Health Forest study, the range of the change in WEMWBS scores was wide. No factors emerged as predictors of the outcome, although analysis suggested that the change depended on perceived health. Some participants might have had an undiagnosed major depressive disorder. Study IV did not, however, include information on the diagnosis or use of healthcare services. Compared to physical activity, the Health Forest study suggests superiority in supporting mental wellbeing and coping. Effects on mental health are the best described outcomes of NBIs, and the effects have been similar to cognitive behavioral therapy for mild-moderate depression [201]. Controlled trials are crucial when exploring the effects of NBIs, and when compared to established treatment, a similar effect is to be considered meaningful.

Person-centered care supports individualized solutions, while public health research relies on average scores and trends. For example, if there is an instant reduction in blood pressure, it is not to be assumed that nature is a treatment for hypertension. Although contact with nature may reduce stress, the long-term

effects remain unclear [129,272]. Overemphasizing effects noted on the population level or in large studies may jeopardize effective treatment on the individual level [2]. Social prescribing and nature-based prescribing should complement other care and include follow-up [11,179].

In Study I, the effects on loneliness and mental wellbeing were clearer in longer studies. This is logical, as trust and connections take time to build [183]. However, due to the diverse populations, interventions, and reported outcomes, we were unable to draw conclusions on the general effects or the mediating pathways. Understanding these pathways will help in the interpretation of effects in the future [25]. Previous reviews have also acknowledged that the characteristics of participants are commonly poorly described. [89,183,199,204]. Diverse populations have been compared in meta-analyses [89,199,273]. Comparing populations with very different characteristics may jeopardize knowledge [274]. Although some of the mechanisms by which nature impacts health probably are general, many of these pathways depend on the participants' capability, health, and motivation. Masterton et al. observed that NBSP might be especially effective for participants with trauma, anxiety, depression, suppressed anger, conflicts in relationships, and those who explicitly state that they need help [183]. Furthermore, greenspace interventions were noted to particularly help those who had undergone previous treatments, and the nature-based therapies were suggested to be used for those who previously attended traditional therapies but received insufficient help [183]. In addition, gender variance occurs. Masterton et al. suggested that men and women may respond differently to interventions, and a faster decrease in stress has been reported among women. We noted gender differences among the aged respondents in Study III. Women more often built a nature connection based on psychological aspects, while men generally found outdoor activities in nature to be possible. This may, however, depend on culture and traditional gender roles. In the Health Forest study, due to the small number of participating men, we did not explore gender differences.

A deeper understanding of what predicts good outcomes will help focus interventions, thereby making them patient centered. Concluding current knowledge, neither NBIs nor interventions reducing loneliness have proven effective enough to be a recommended form of treatment for major depressive disorders [275]. This is mostly because of a lack of high-quality evidence, but as an additional treatment, NBIs might be beneficial [275]. The broad potential wellbeing outcomes of NBIs are not only good. As recognized by Masterton et al., an unfocused scope is a major risk, as this reduces trust among both participants and referring health personal [183]. Realistic expectations are essential for good effects [183]. Furthermore, although referrals increase the amount of time spent outdoors, they might reduce the intrinsic enjoyment of visiting nature, as recognized among participants with depressive symptoms [276]. The spiritual aspects of nature contact are underscored among older adults [25].

6.2.4.3 Efficient and equitable

NBIs are potentially efficient, equitable, and timely. This, however, requires that nature-based solutions are available in the community, and that the referral process works [77]. NBSP may have favorable economic outcomes when considering social return on investment, evidence is however limited [277]. When evaluating efficiency, the use of health professionals' time should be considered in addition to the use of money. There is a concern that time spent by general practitioners in health-promoting work reduces their time spent on treating disease [174].

Study IV demonstrated that active interventions can also improve health among people living in an area with accessible nature. Concerning nature exposure, study II revealed that approximately half of the ALF residents cannot access the outdoors as they desire. Nature and health research has long relied on population data, such as the area of residence. However, this method lacks information on individual characteristics and behavior [196]. When data are collected using surveys, their validity depends on who has responded [102]. Our findings provide insights into how to promote equitability in accessing natural environments, highlighting the need for social support and assistance.

The use of resources, from the point of view of both providers and participants, was poorly discussed in the intervention studies included in Study I. Participation might depend on factors such as transport, clothing, and other resources, and participants with a poor socio-economic status might therefore reject enrolment. Social prescribing aims to be equitable, and through personal contact prior to participation, such barriers can be identified and addressed.

6.2.5 NBIs on the prevention ladder

Our findings provide tentative evidence that NBIs could be considered a form of quaternary prevention, as visualized in Figure 10. Although NBIs have previously been applied in relation to the pyramid of prevention, as described by Frieden, quaternary prevention has not been included [3,12]. Overtreatment means diagnosing and treating a disease that would not have impacted a person's life or life expectations [72]. Up to 20% of medical treatments and investigations can be defined as overtreatment [72,73]. This is not only a waste of resources but causes harm to patients. Side-effects of medication for symptoms that could have been relieved in other ways sometimes cause more harm than the symptoms themselves. Older adults are especially vulnerable to the risks of overtreatment and closely related polypharmacy [157]. It is estimated that one in five geriatric hospitalizations is partly due to overmedication, with sleep and pain medication being among the most common causes of medication harm [278]. Supporting wellbeing may reduce illness and the need for medication [76].

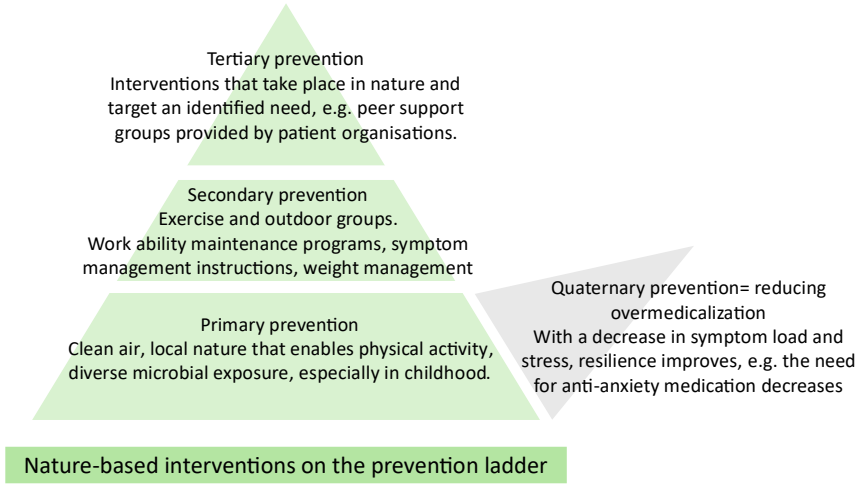

Figure 10 The effects of nature-based solutions and NBIs presented on the pyramid of prevention. The dimension of quaternary prevention is depicted as the shadow of the pyramid. Original publication: Yleislääkärilehti 04/25 [279]

Sleeping problems are a common cause of contact in primary care. The perceived quality of sleep was poor among the participants in Study IV, and most slept insufficiently, reporting less than 6 h/night of sleep. The effect of the intervention was paradoxical: although the time spent asleep was reduced in the nature group, participants reported better sleep. This is probably explained by fewer awakenings after sleep onset, which might have been due to reduced stress. The score for feeling relaxed improved among all participants and significantly in the nature group. Previous findings have indicated that improved sleep associated with contact with nature is mediated by improved mental health rather than physical activity [280]. Supporting intrinsic capacity and reducing stress could potentially reduce the need for medication.

Among the older adults, nearly half of the respondents recognized that they felt less pain when in nature. Natural elements have been used for pain reduction in experimental settings, but few studies have explored the long-term effects[204]. A population study revealed that those living in a green environment recovered faster after hip arthroplasty and needed less strong pain medication. However, this effect was not seen after knee surgery [281].

According to our findings, older adults recognize that contact with nature may reduce pain, and that a nature-based intervention can improve self-reported sleep. NBIs may reduce symptoms and thereby decrease the need for potentially harmful medications. Nature connection supports mental wellbeing and may help build resilience.

6.2.6 Implementing nature-based prescribing in primary care

Based on current knowledge, NBIs can readily be implemented in several domains in primary care, including general practice, occupational health, rehabilitation, mental healthcare, care of older adults, and in preventive strategies. The referral process, however, needs clarification to enable follow-up of the efficacy of nature-based prescribing strategies. Implementing nature prescribing in care involves a wide range of professionals. Nature-based solutions, mainly accessible natural spaces, are essential, and furthermore, NBIs need to be well described, including aims and target groups [201]. Since 1.9.2025, the national THL follow-up register of health-promoting work in Finland has included a code for recommending nature-based activities [282]. This will help in the follow-up of nature-based prescribing. As previously discussed, nature prescribing is complementary to other forms of medical care. In general practice, it is best applied in the context of continuity of care, which also allows evaluation of its effects. Social prescribing has been developed to meet the needs of frequent attenders in general practice [177].

The challenge of the definitions and overlapping processes related to nature-based and social prescribing are described in section 2.3.3. A clarification of the concepts is needed. Broadly, as visualized in Figure 11, nature-based prescribing can be divided into 1) general health-improving strategies, allowing citizens, patients, or clients to sign up through self-referral, targeted recruitment, or recommendation by health or social workers, and 2) strategies including referral. Holistic models including feedback to care providers are rare [11]. The NBIs applied as part of care described in Table 6 and the Health Forest intervention (Study IV) were well-described processes with a defined duration, a form of nature-based therapy or rehabilitation, and therefore very different from general nature-based solutions and common advice. It is arguable whether such defined interventions are to be considered nature-based therapy, or if they fit in the recent definition of SP, as a form of non-clinical support and services within the community [175].

Recommending activity in nature is considered a form of social prescribing. Nature-based solutions targeting the whole population are generally not included in nature-based prescribing descriptions. However, they should be acknowledged, since nature-based solutions and available information support public health and allow unstructured referral and personalized recommendations. Signposting is suitable for people with good health literacy, capability, or social support. Signposting does, however, require knowledge of nature-based solutions and activities in the area. In Finland, this information has since 2025 been available online, provided by the wellbeing services counties [26]. In the future, digital solutions may improve the follow-up of outcomes [179].

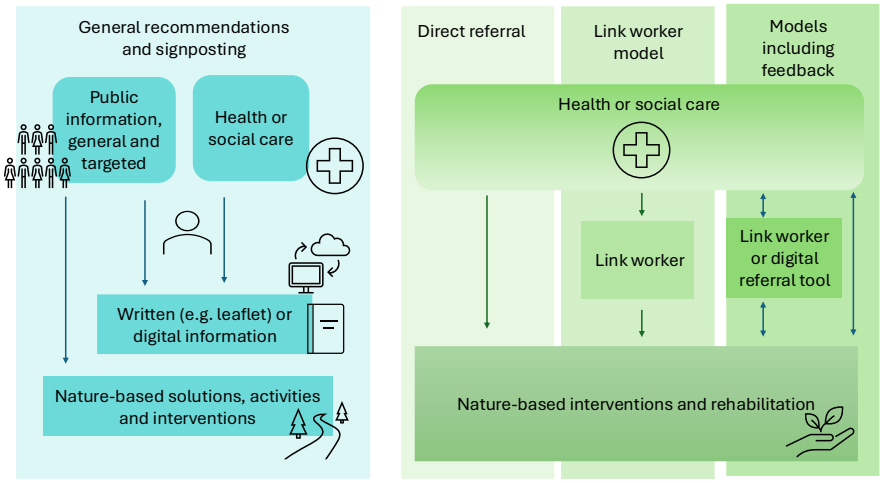

Figure 11 The models of nature-based prescribing include broad public health strategies, with information and signposting through leaflets or digital tools, as presented on the left. On the right, actual referral, which may take place through direct referral or include a connector, i.e. link worker. Holistic models provide feedback on progression and outcomes to the referring professional.

Direct referral requires that health professionals have profound knowledge of ongoing interventions. The Health Forest intervention applied direct referral, which was appreciated by the participants [258]. This model does, however, take away focus and time from other clinical work, and should not therefore be the primary strategy in general practice. It is to be acknowledged that engaging participants with poor wellbeing in health-promoting activities requires special competences. The role of the link worker is widely acknowledged [12,179,181 283].

Digital search engines and hubs can be a feasible way to support referrals. To date, very little research has been conducted on digital solutions [26,60]. It is to be acknowledged that not everyone can utilize digital tools. Digital resources may, however, aid health professionals, relatives, and volunteers, thereby supporting the implementation of NBIs. Online resources make information widely available, but reducing personal contact may increase loneliness. Solutions providing feedback and personal contact are a way to circumvent this adverse effect. Such interactive digital solutions potentially follow up the effect of social prescribing. Although the need to establish adherence and effects by follow-up is widely recognized, very few holistic models have been described outside research projects [11]. Although digital solutions may improve the follow-up of interventions, digital tasks may take the focus away from nature, thereby reducing the effects [132].

Recommendations should consider the context of the health system and the use of health professionals' time, so that health prevention is not overemphasized in

comparison to other duties [174,176] Primary care, especially general practice, has a central role in identifying people for whom NBIs could be beneficial [76]. Study IV demonstrated that professionals in the health center identified and involved participants suitable for the intervention. International studies emphasize the role of the GP [11,179]. Based on our findings, nature-based prescribing strategies may also be applied by other health professionals, e.g. nurses [258]. In Finland, nurses specialized in mental health care have a central role in the treatment of common mental disorders, e.g. depression and anxiety, and nature-based prescribing is a feasible tool in this work. Examples of social rehabilitation include NBSP for prisoners [284] and the unemployed [285]. Nature-based prescribing has also been used by physiotherapists [286]. In ALFs, nurses and therapists are key professionals in implementing NBIs in care, as well as in supporting autonomy and contact with nature, as described in the results.

The studies described in Table 6 in section 2.4.2.1 provided evidence that NBIs also had positive effects for patients with chronic symptoms and health problems. Stigsdotter and Corazon recruited participants with long-lasting sick leave, and reported recruitment challenges due to nature-based prescribing not being supported by healthcare and health insurance [210,213]. Hyvönen et al. found that compared to established CBT-based care, the Flow with Nature intervention improved self-reported workability among patients with clinical depression [207]. Occupational health care is a field in which nature prescriptions and NBIs could be implemented.

Prevention and health literacy are important and potentially cost-effective; this public health work is, however, best planned and executed through national campaigns, targeted information, and collaboration with patient organizations [27,136]. The need for a national nature program has been discussed in Finland [13 287]. Broad regional collaborations have been established, with the "Nature Step to Health" in the Lahti region being the most ambitious example [77].

6.3 Strengths and limitations

This thesis has several strengths. The included studies provide novel results and the theme is also timely, as both the field of social prescribing and nature-based solutions are rapidly evolving.

"Connecting through nature" (Study I) is the first systematic review exploring the effect of NBSP on loneliness. We followed the PRISMA guidelines for systematic reviews and, accordingly, the studies were evaluated by several authors. In addition, the work was supported by a steering group of experts to ensure both rigor and relevance of the review process and findings. By including quantitative, qualitative, and mixed methods studies, Study I presents a comprehensive insight into how NBIs may alleviate loneliness.

Nature connection has not previously been investigated among older adults in ALFs. The high number of respondents, including those who might be hesitant to participate in interventions, provides understanding that will help in developing solutions suitable for the focus group. In addition to the research questions, the study provided valuable knowledge of the wellbeing of older adults in ALFs. By applying methods that allowed the voices of the older adults to be heard, we supported person-centered care, and our study highlights that despite cognitive decline and poor functional ability, older adults can express their needs and desires. The development of the GNCS built on the qualitative findings and followed the recommended steps for measure development: 1) expert discussion, 2) exploratory factor analysis, and 3) validation through comparison of the results with previous measures [226]. The novel GNCS was tested in relation to established scales, primarily the PWB scale [252]. The wide range of measures, including the Comorbidity Index, medication, and social relations, thoroughly described the cohort.

Study IV was a pilot study in a real-life primary care setting, and the findings provide a realistic insight into how social prescribing can be implemented. The sports group was carefully planned to represent the current best practice and provides a meaningful reference to the nature group. Sleep was assessed objectively using wrist-worn accelerometers, and the measures applied have been used in previous studies, providing a meaningful reference. The qualitative interviews 2–4 years after the intervention added valuable understanding of the long-term effects [258]

This thesis also has limitations. The systematic review had a risk of positive bias, as studies with positive outcomes are more likely to be published. In addition, participants experiencing benefits are more likely to complete the follow-up, and we noted that none of the studies reported reasons for drop-out. Although the findings supported the ability of NBSPs to reduce loneliness, the diverse populations, interventions, and outcome measures made it difficult to conclude on the effects. None of the included studies reported the cost-effectiveness of the interventions; such analyses are critical to scaling up and funding NBSP.

Studies II and III were cross-sectional, and they do not therefore allow conclusions on causalities. A methodological limitation is that due to the short responses provided by participants, our qualitative evaluation may be considered a content analysis rather than an in-depth thematic analysis. The survey explored the perception of change in the meaning of nature at only one time point, making responses more subjected to the ambiance of that particular moment. In addition, as many respondents had cognitive decline, a risk of recall bias is to be noted. Furthermore, the cohort reflected the Finnish context and to some degree, this specific age group.

Study IV was not a randomized study. By choosing an approach aiming to improve health without addressing a medical problem, we lost an opportunity to

examine how nature can be used as a treatment for a specific disease. The Health Forest project had attracted public interest before the study, and the positive perception may have impacted the results in favor of the nature group, including among the referring health professionals. As 78% of the participants were female, the influence of gender cannot be determined from the study. The outbreak of the COVID-19 pandemic ended this study early, and approximately half of the planned number of participants took part in the trial, which especially affected the analysis of individual variance in effect of the intervention. In addition, the initially planned 6-month follow-up could not be completed, and moreover, we were unable to analyze how participation in the intervention affected the use of health care services.

6.4 Interpretation and significance of the results

This thesis synthesizes knowledge that will help in implementing nature-based solutions in person-centered health care. By acknowledging the gap between public health strategies and health care targeting individuals, it provides suggestions on how to best apply current understanding to improve wellbeing through targeted NBIs.

Firstly, it highlights the dimension of social health and the importance of accessing and addressing loneliness [59]. This is especially important for patients with reoccurring symptoms and those who respond poorly to treatment [58]. Through continuity of care, health professionals in primary care have a crucial role in identifying and supporting patients with poor general health, which is commonly associated with multi-morbidity, a high symptom burden, and loneliness [59,69,150]. The prevalence of loneliness among residents in ALFs has increased, and more than half of the respondents reported suffering from loneliness at least sometimes.

Secondly, the thesis describes a wide range of nature-based interventions and focuses on NBIs beyond gardening. Controlled studies, including the Health Forest trial, demonstrated that the effect of NBIs is comparable to established treatments. This adds NBIs as an evidence-based form of treatment, supporting person-centered care and patient choice [28,88]. It is to be noted that the NBIs in high quality studies have been structured interventions with a clear aim. It is important to distinguish between such nature-based therapy programs and general advice and signposting. Furthermore, mediating pathways might differ between group-based vs. individual interventions [183]. The findings that the effects in group-based and individual interventions are similar [204] is interesting. Groups may be cost-effective, but above all, support social health. The importance of skilled leaders and facilitators should be emphasized [183,258]. Furthermore, implementing nature-based prescribing in primary care requires education of care professionals, as well as the development of nature-based solutions in the community and environment.

Describing these resources and providing information online supports residents, patients, and professionals. However, providing knowledge and resources is not enough. The Health Forest study demonstrated that also among residents living in a green environment, NBIs can improve health, especially mental wellbeing and self-reported sleep.

Thirdly, our findings highlight the importance of nature among older adults in ALFs. The respondents had feasible and clear wishes for nature contact and activities. This highlights their ability to describe their needs, despite possible cognitive decline. The wishes and subjective needs of older adults in long-term care are largely understudied [264]. In our qualitative findings, some participants described a deep connection with nature while others considered nature a background environment enabling activity. This was supported by the dimensions identified in the factor analysis, a finding in line with theoretical knowledge [25]. We also found a dimension describing fear and hesitation. Although most findings were very similar to those reported in younger populations, the role of autonomy and functional ability is accentuated among older adults.

The association between psychological wellbeing and nature connection, as explored through the GNCS, is a significant finding. A strong nature connection reduced the decline in psychological wellbeing, especially when mobility was poor.

The subjects discussed in this thesis challenge both professionals and laymen to see beyond diagnoses in the care of chronic disease and multimorbidity. NBIs may improve intrinsic capacity and mental wellbeing, and thereby support resilience. These entities not only improve quality of life, but they also reduce morbidity and even mortality [5,32].

7 Conclusion

Nature-based interventions, delivered through nature-based prescribing, hold potential to support mental wellbeing, health and resilience. This thesis focuses on older adults and primary care patients with chronic conditions and demonstrates positive outcomes. By providing symptom reduction and stress relief, NBIs may reduce the need for potentially harmful medications and provide quaternary prevention.

Nature connection has several dimensions. A simplification is to state that for some, the outdoors is a setting for activity, while others primarily enjoy contact with nature, and stay active to be able to go outdoors. Among primary care patients, NBIs especially support mental wellbeing. Supporting nature connection also has positive outcomes among those living in an area with accessible nature. Among older adults, nature connection is associated with psychological wellbeing, which is accentuated when mobility is poor. Supporting a connection with nature can potentially address functional decline, and nature is extremely important for older adults residing in ALFs.

While evidence supports mental health benefits, further high-quality research is needed to clarify the long-term outcomes, underlying mechanisms, and pathways to impact. Equitable access to nature necessitates addressing barriers such as mobility limitations, staffing shortages, and socioeconomic factors.

Effective implementation of NBIs requires person-centered approaches, referrals by trusted professionals, and tailored interventions that consider individual capabilities and preferences. Safety considerations, including physical, psychological, and social safety, are essential, particularly for frail participants. Gender differences and the role of facilitators in managing group dynamics also influence outcomes. The concepts of nature-based prescribing, green prescribing, nature therapy and nature-based social prescribing commonly describe similar strategies, and a clarification of the concepts would aid future evaluation of the effects.

8 Implications for clinics and future research

Nature-based interventions may be readily implemented in clinical work, as tools for signposting and nature-based solutions are available in Finland. Understanding among health professionals of the theoretical background and pathways via which nature impacts health can support patient guidance. As discussed throughout the thesis, acknowledging the dimensions of health is essential, especially when caring for those with chronic diseases and a high symptom burden. Nature-based prescribing is a form of social prescribing that complements other forms of medical care. In primary care, it is best implemented in the setting of continuity of care, which enables follow-up of effects on the individual level. Nature-based prescribing strategies may be applied in multi-professional settings, and digital tools may support guidance and health literacy. Such digital resources can support both patients and health-professionals. In addition, nature-based solutions can support health and wellbeing in the general population.

Our findings highlight the importance of a connection with nature. Older adults, including those with dementia, have similar needs and seem to build connection in the same way as younger adults. However, their functional ability needs consideration. The importance of nature appears to increase with age. Nature connection arises in childhood, but can be strengthened through meaningful experiences, and it also depends on culture. A wide range of nature-based interventions have been described, but most importantly, the participants should be active agents and have the possibility to express wishes regarding the activities, which may also take place indoors. Due to restricted autonomy, many residents in ALFs depend on others in order to go outdoors. Sufficient resources and awareness of the needs of older adults are therefore essential. Planning and facilitating NBIs requires special competence.

On the population level, outdoor visits and contact with nature should be supported. Accessibility includes both physical and social aspects. Living in a green environment is not enough; wellbeing can be improved by supporting activities.

NBIs with a targeted focus and clear aim have had very similar effects as more established rehabilitation in supporting mental health. Such NBIs provide a person-centered form of care for mild-to-moderate mental disorders, including depression and anxiety. No clinical diagnosis directly excludes NBIs as such, but the content of the intervention must consider the stage of the disease and the safety and needs of the participants. Again, individual follow-up is essential.

Social prescribing is not established in Finland. Therefore, in clinical work, adopting such strategies is a challenge to health-professionals' knowledge and use of time. Furthermore, many NBIs depend on project funding, jeopardizing their establishment in care and long-term follow-up. These obstacles are best tackled on the health-system level and developed through regional and national collaboration and initiatives. Digital platforms and registers have been launched during 2025, and these solutions will hopefully support both referral and follow-up of health promotion in clinical work. Follow-up data will inform wellbeing services and research.

Research in the field of nature and health is transdisciplinary. This is a strength and a challenge. During the last decade, several theoretical and methodological recommendations have helped to focus research and improve the quality of studies. However, there is still a need to clarify concepts and definitions in the field, and to clarify the pathways through which health effects arise. It is important to learn about the human–nature interconnection in surroundings where it is still present in a rapidly urbanizing world [78,100,101]. Cross-sectional studies are useful in establishing early evidence and guiding future research [289]. In exploring nature exposure and public health, longitudinal studies are recommended [82,97]. Digital tools, such as GPS (global positioning system) and activity data, provide interesting possibilities. As research balances between population and individual health, it is important to state whether an intervention aims to support wellbeing or to treat a disease. That said, especially in the aged population, supporting wellbeing and intrinsic capacity may have prognostic potential.

The following recommendations focus on nature-based interventions for patients with chronic disease or functional impairment. Studies should describe the population and intervention, so that future reviews may perform meta-analyses on comparable studies. Randomized controlled trials are essential in establishing the effect of interventions. In the complex reality of primary care, however, non-randomized controlled studies provide important data. The use of healthcare services, medications, functional ability, including workability, relevant medical measures, and eventually mortality can be used to assess the implementation and effects of interventions. Qualitative studies play an important role in establishing what is important to the focus group, and understanding of what outcomes are meaningful can inform larger trials. Understanding of the importance of social health and of the dimensions of loneliness is increasing. Including queries on social dimensions in implementation studies may help in understanding the reasons for poor outcomes. In the implementation of social prescribing, understanding of the attitudes and needs of health professionals is crucial. For system development, national codes enable the follow-up of health promotion in health care through registers. Exploration of cost effectiveness, including indicators such as workability, and the need for care is needed to establish nature-based prescribing.

9 Acknowledgements

Research is about exploring new grounds. After a decade as a GP, I came to realize that treating disease alone isn't enough— true wellbeing depends on self-care, a positive mindset, and meaningful connections. Inspired by my patients, I began to ask: can integrating nature into care improve health, and how can we support those who need help achieving wellbeing? As I delved into nature and health research, I came to explore diverse topics—from satellite imaging and immunology to group dynamics and city planning. The path has not always been evident, but I have not walked alone. I am thankful for the valuable insights I have gained both from both brief encounters and enduring collaboration.

The opportunity to analyze the Health Forest study was my starting point. I deeply thank my supervisor, Professor Timo Partonen for trusting me to take on the task and patiently guiding me throughout this work. The foresight of the Health Forest study is notable, reflecting the enthusiasm and patient centered approach from the team in Sibbo. Anders Mickos, Malin Heikkinen and Adela Pajunen among others, your reliance was crucial.

Joining the RECETAS project in 2021 opened a window to the world and a door to gerontology. Dr. Ulla Aalto, as a supervisor, you have challenged me to focus and specify, unwearyingly reminding me to pay attention to details. Professor emerita Kaisu Pitkälä, I admire your generosity of expertise and experience, and your eager to explore. My dear peer Laura Rautiainen and qualitative research mentor Anu Jansson, you define person-centered, always remembering the voice of the older adults. Statistician Hannu Kautiainen, your input in the Happy by Nature article was invaluable. Our small team has followed through a complex RCT; I am proud to be part of it! I express my deep appreciation to our research nurses, and to all the dedicated caregivers I have met at the ALFs.

Our international consortium mirrors the multifaceted world, but first and foremost, the strength of group effort and diverse expertise. The process of the "Connecting through nature" review became an eye-opener; we really are discovering new ground. I owe much gratitude to all collaborators and co-authors, especially Ashby Sachs, I have learnt efficient co-working and writing with you. As RECETAS is coming to an end, the work of the consortium, led by Professor Jill Litt, is starting to show. I am eager to follow up results and impact.

Research in primary care is still breaking new ground, and Docent Silja Kosola, head of research at LUVN (Western-Uusimaa Wellbeing services county), is making it happen. I am proud to have you in my thesis committee. Professor Hanna Tiirinki, our formative discussions contributed to including patient safety in this thesis. The reviewing process of this thesis became a positive experience of academic dialogue at its best, and for that, I deeply thank Associate professor Kadri Suija and Docent Erja Rappe. Research is also about communication, the language revisions by Roy

Sidall have largely improved my work. Miikka Vaskola, thank you for letting the old oak live on the cover of this thesis. I am looking forward to the upcoming discussion with Adjunct Professor Matilda van der Bosch, I am honored to have you as my opponent.

Research requires skills. With my peers in the AkaTK (Academic Health center), I have had the opportunity to learn by doing, under the leadership of Docent Niko Wasenius and Associate Professor Merja Laine, later Frida Gyllenberg, PhD. The University has three roles: research, education, and societal impact, all are present at the Department of General Practice and Primary Health Care. Associate Professors Lena Thorn and Merja, your mentorship, friendship and ability to motivate and find solutions is inspiring. The Finnish Nature and Health Research Network (LuontoTerVe) has expanded my horizon and provided valuable connections.

Mostly, I have done research parallel to my work in primary care. I thank my employer, LUVN, for making this possible. The years following the pandemic and the health system reform have been turbulent and required resilience from those working in the front line. I am happy to be part of the working community at Tapiola health center, we have grown together. A warm thanks goes to the LUVN education team, working with you is fun!

Funding has made this work possible, I thank: Finska Läkaresällskapet, Stiftelsen Dorothea Olivia, Karl Walter och Jarl Walter Perkléns minne, Lääketieteen säätiö, Yleislääketieteen säätiö, Gyllenbergs stiftelse and the Hospital District of Helsinki and Uusimaa. RECETAS is funded by European Union's Horizon 2020 Research and Innovation Programme, grant agreement no. 945095

Life is more than research and work. My greatest gratitude and love go to my husband Thomas and our children Alva and Kevin. With you, life is never dull. This work started during the pandemic, and research became a hiding place in a chaotic world. Not only have you been supportive through the project, but you have also pulled me out of that bubble by initiating small and big everyday adventures, making life fun and meaningful. Tixe, our little brother dog; although nature contact is not always relaxing or even enjoyable, it's good to get out. To my extended family and friends, your support has been both practical and mental. I have had the privilege to get boundless support from my parents. My mother Gunilla and Ola, you have been my most devoted followers. My father Tom, we share our love for the archipelago, I have come to realize how important a source of resilience it is for me. I dedicate this thesis to generations past, mormor Inge and farfar Lällä, you have demonstrated the power of psychological wellbeing and nature connection.

Helsingfors, March 2026
Annika Kolster

References

1. WHO. WHO Constitution. World Health Organisation. 5.5, 2024. 2024.
2. WHO. *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. World Health Organization; 2013.
3. Frieden TR. The Future of Public Health. *New England Journal of Medicine*. 2015;373(18):1748-1754. doi:doi:10.1056/NEJMsa1511248
4. Smith SM, Wallace E, O'Dowd T, Fortin M. Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *Cochrane Database Syst Rev*. Jan 15 2021;1(1):CD006560. doi:10.1002/14651858.CD006560.pub4
5. Aalto UL, Knuutila M, Lehti T, et al. Being actively engaged in life in old age: determinants, temporal trends, and prognostic value. *Aging Clin Exp Res*. Jul 2023;35(7):1557-1563. doi:10.1007/s40520-023-02440-9
6. Steptoe A, Deaton A, Stone AA. Subjective wellbeing, health, and ageing. *Lancet*. Feb 14 2015;385(9968):640-648. doi:10.1016/s0140-6736(13)61489-0
7. Pitkala KH, Laakkonen ML, Strandberg TE, Tilvis RS. Positive life orientation as a predictor of 10-year outcome in an aged population. *J Clin Epidemiol*. Apr 2004;57(4):409-14. doi:10.1016/j.jclinepi.2003.07.013
8. WHO. Medication safety in polypharmacy. Geneva: World Health Organization, 2019. *International Journal of Clinical Pharmacy*. 2023;45:451-460.
9. WHO. *Integrated care for older people (ICOPE): guidance for person-centred assessment and pathways in primary care*. 2019.
10. Kauppi K, Roos E, Borg P, Torkki P. Building Consensus on Domains of Wellness Using Finnish and International Expert Panels: A Delphi-Method Study. *Am J Health Promot*. Feb 2024;38(2):228-237. doi:10.1177/08901171231204147
11. Husk K, Blockley K, Lovell R, et al. What approaches to social prescribing work, for whom, and in what circumstances? A realist review. *Health Soc Care Community*. Mar 2020;28(2):309-324. doi:10.1111/hsc.12839
12. White MP, Hartig T, Martin L, et al. Nature-based biopsychosocial resilience: An integrative theoretical framework for research on nature and health. *Environ Int*. Sep 27 2023;181:108234. doi:10.1016/j.envint.2023.108234
13. Tyrväinen L, Halonen JI, Pasanen T, et al. Luontoympäristön terveysvaikutukset ja niiden taloudellinen merkitys. 2024;

14. Markevych I, Schoierer J, Hartig T, et al. Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environ Res*. Oct 2017;158:301-317. doi:10.1016/j.envres.2017.06.028

15. Chatterji S, Ustün BL, Sadana R, Salomon JA, Mathers CD, Murray CJ. The conceptual basis for measuring and reporting on health. *Global Programme on Evidence for Health Policy Discussion Paper*. 2002;45

16. Huber M, Knottnerus JA, Green L, et al. How should we define health? *BMJ*. 2011;343:d4163. doi:10.1136/bmj.d4163

17. Leung MYA, Su JJ, Lee HSE, Fung STJ, Molassiotis A. Intrinsic capacity of older people in the community using WHO Integrated Care for Older People (ICOPE) framework: a cross-sectional study. *BMC Geriatrics*. 2022;22(1)doi:10.1186/s12877-022-02980-1

18. NIH. Sign or Symptom. NCI Thesarus. Accessed 28.10, 2024.

19. WHO:n ICD-10 -tautiluokituksen ja pohjoismaisen leikkausluokituksen käyttöönottoa koskeva määräys 04.05.1995 D:13/332/95 (1995).

20. Öhman HR, Karppinen H, Lehti TE, et al. Secular trends in functional abilities, health and psychological well-being among community-dwelling 75- to 95-year-old cohorts over three decades in Helsinki, Finland. *Scandinavian Journal of Public Health*. 2022;50(4):524-531. doi:10.1177/14034948211007688

21. Routasalo PE, Tilvis RS, Kautiainen H, Pitkala KH. Effects of psychosocial group rehabilitation on social functioning, loneliness and well-being of lonely, older people: randomized controlled trial. *J Adv Nurs*. Feb 2009;65(2):297-305. doi:10.1111/j.1365-2648.2008.04837.x

22. Dhabhar FS. Effects of stress on immune function: the good, the bad, and the beautiful. *Immunol Res*. May 2014;58(2-3):193-210. doi:10.1007/s12026-014-8517-0

23. Furman D, Campisi J, Verdin E, et al. Chronic inflammation in the etiology of disease across the life span. *Nat Med*. Dec 2019;25(12):1822-1832. doi:10.1038/s41591-019-0675-0

24. Prior A, Vestergaard M, Larsen KK, Fenger-Gron M. Association between perceived stress, multimorbidity and primary care health services: a Danish population-based cohort study. *BMJ Open*. Feb 24 2018;8(2):e018323. doi:10.1136/bmjopen-2017-018323

25. Tong K, Thompson CW, Carin-Levy G, Liddle J, Morton S, Mead GE. Nature-based interventions for older adults: a systematic review of intervention types and methods, health effects and pathways. *Age Ageing*. Mar 28 2025;54(4)doi:10.1093/ageing/afaf084

26. Hyvinvoinnin ja terveyden edistämisen palvelukonsepti. The Finnish Institute for Health and Welfare. Accessed 02/06, 2023. https://thl.fi/fi/tutkimus-ja-kehittaminen/tutkimukset-ja-hankkeet/suomen-kestavan-kasvun-ohjelma-rrp-/hyvinvointia-ja-terveytta-edistavat-toimintamallit/hyvinvoinnin-ja-terveyden-edistamisen-palvelukonsepti

27. Patja K. Fyysinen terveys. *Terveyden edistäminen*. Kustannus oy Duodecim; 2022.

28. Godfrey KM, Barker DJP. Fetal programming and adult health. *Public Health Nutrition*. 2001;4(2b):611-624. doi:10.1079/PHN2001145

29. Khachatryan SG. Insomnia Burden and Future Perspectives. *Sleep Med Clin*. Sep 2021;16(3):513-521. doi:10.1016/j.jsmc.2021.05.006

30. Haapanen MJ, Niku J, Mikkola TM, et al. Observed and hidden factors underlying the accumulation of chronic diseases across eight major organ systems: a longitudinal birth cohort study. *Lancet Healthy Longev*. May 2025;6(5):100710. doi:10.1016/j.lanhl.2025.100710

31. von Hertzen L, Hanski I, Haahtela T. Natural immunity. Biodiversity loss and inflammatory diseases are two global megatrends that might be related. *EMBO Rep*. Oct 28 2011;12(11):1089-93. doi:10.1038/embor.2011.195

32. Keyes CL, Simoes EJ. To flourish or not: positive mental health and all-cause mortality. *Am J Public Health*. Nov 2012;102(11):2164-72. doi:10.2105/AJPH.2012.300918

33. Appelqvist-Schmidlechner K TK, Tamminen N, Nordling E & Solin P Mitä on positiivinen mielenterveys ja kuinka sitä mitataan? *Suomen lääkärilehti*. 2016;71(24):1759-1764.

34. Galderisi S, Heinz A, Kastrup M, Beezhold J, Sartorius N. Toward a new definition of mental health. *World Psychiatry*. Jun 2015;14(2):231-3. doi:10.1002/wps.20231

35. Ryff CD, Keyes CL. The structure of psychological well-being revisited. *J Pers Soc Psychol*. Oct 1995;69(4):719-27. doi:10.1037//0022-3514.69.4.719

36. Bautmans I, Knoop V, Amuthavalli Thiyagarajan J, et al. WHO working definition of vitality capacity for healthy longevity monitoring. *The Lancet Healthy Longevity*. 2022;3(11):e789-e796. doi:10.1016/S2666-7568(22)00200-8

37. Davydov DM, Stewart R, Ritchie K, Chaudieu I. Resilience and mental health. *Clin Psychol Rev*. Jul 2010;30(5):479-95. doi:10.1016/j.cpr.2010.03.003

38. Perälä J, Suvisaari J, Saarni SI, et al. Lifetime Prevalence of Psychotic and Bipolar I Disorders in a General Population. *Archives of General Psychiatry*. 2007;64(1):19-28. doi:10.1001/archpsyc.64.1.19

39. Markkula N, Suvisaari J, Saarni SI, et al. Prevalence and correlates of major depressive disorder and dysthymia in an eleven-year follow-up – Results from the Finnish Health 2011 Survey. *Journal of Affective Disorders*. 2015/03/01/ 2015;173:73-80. doi:10.1016/j.jad.2014.10.015

40. THLSotkanet. Mental wellbeing indicators. Accessed 01.03, 2026.

41. THLSotkanet. Mental disorders index. Accessed 01.03, 2026.

42. KELA. Tietopaketti: Sairauspoissaolot. Accessed 2.3, 2025.

43. WHO. *Promoting mental health: concepts, emerging, evidence, practice (Summary report)*. 2004.

44. Doyle DM, Link BG. On social health: history, conceptualization, and population patterning. *Health Psychol Rev*. Sep 2024;18(3):619-648. doi:10.1080/17437199.2024.2314506

45. Mäki-Opas T. Sosiaalinen terveys. In: Patja Kristiina AP, Rautava Päivi, ed. *Terveyden edistäminen*. Kustannus oy Duodecim; 2022.

46. Von Lindern E, Lymeus F, Hartig T. The restorative environment: A complementary concept for salutogenesis studies. *The handbook of salutogenesis*. 2017:181-195.

47. Vaartio-Rajalin H, Snellman F, Gustafsson Y, Rauhala A, Viklund E. Understanding Health, Subjective Aging, and Participation in Social Activities in Later Life: A Regional Finnish Survey. *J Appl Gerontol*. Jun 2024;43(6):638-649. doi:10.1177/07334648231214940

48. Dyar OJ, Haglund BJA, Melder C, Skillington T, Kristenson M, Sarkadi A. Rainbows over the world's public health: determinants of health models in the past, present, and future. *Scandinavian Journal of Public Health*. 2022;50(7):1047-1058. doi:10.1177/14034948221113147

49. Holt-Lunstad J. The Potential Public Health Relevance of Social Isolation and Loneliness: Prevalence, Epidemiology, and Risk Factors. *Public Policy & Aging Report*. 2018;27(4):127-130. doi:10.1093/ppar/prx030

50. Rautiainen LJ, Jansson AH, Knuutila M, et al. Comparing Loneliness, Social Inactivity, and Social Isolation: Associations with Health-Related Quality of Life and Mortality among Home-Dwelling Older Adults. *Gerontology*. 2024:1103-1112. doi:10.1159/000540345

51. Tilvis RS, Routasalo P, Karppinen H, Strandberg TE, Kautiainen H, Pitkala KH. Social isolation, social activity and loneliness as survival indicators in old age; a nationwide survey with a 7-year follow-up. *European Geriatric Medicine*. 2012/02/01/ 2012;3(1):18-22. doi:10.1016/j.eurger.2011.08.004

52. Jansson AH, Karisto A, Pitkälä KH. Listening to the voice of older people: dimensions of loneliness in long-term care facilities. *Ageing & Society*. 2022:1-18. doi:10.1017/S0144686X21001975

53. U.S.SurgeonGeneral'sAdvisory. *Our Epidemic of Loneliness and Isolation*. 2023. *Office of the US Surgeon General*.

54. Surkalim DL, Luo M, Eres R, et al. The prevalence of loneliness across 113 countries: systematic review and meta-analysis. *BMJ*. 2022;376:e067068. doi:10.1136/bmj-2021-067068

55. Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. *Perspectives on psychological science*. 2015;10(2):227-237.

56. Cacioppo JT, Cacioppo S. Older adults reporting social isolation or loneliness show poorer cognitive function 4 years later. *Evidence-based nursing*. 2014;17(2):59-60.

57. Lim MH, Eres R, Vasan S. Understanding loneliness in the twenty-first century: an update on correlates, risk factors, and potential solutions. *Social psychiatry and psychiatric epidemiology*. 2020;55:793-810.

58. Ahola AJ, Suojanen L-U, Joki A, Pietiläinen KH. Loneliness and its cross-sectional associations with health, health behaviours, and perceptions in Finnish patients with overweight or obesity taking part in the Healthy Weight Coaching. *Preventive Medicine*. 2024/08/01/ 2024;185:108032. doi:10.1016/j.ypmed.2024.108032

59. Freedman A, Nicolle J. Social isolation and loneliness: the new geriatric giants: Approach for primary care. *Can Fam Physician*. Mar 2020;66(3):176-182.

60. Hakamäki P, Nick R, Valli N, Kuitunen-Kaija O. Hyvinvointia edistävä toiminta helposti löydettäväksi: hyvinvoinnin ja terveyden edistämisen kansallisen palvelukonseptin määrittelyä. 2023;

61. Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. *J Am Geriatr Soc*. Dec 1983;31(12):721-7. doi:10.1111/j.1532-5415.1983.tb03391.x

62. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist*. Autumn 1969;9(3):179-86.

63. Organization WH. International Classification of Functioning, Disability, and Health. World Health Organization. 011224, 2024. Accessed 011224, 2024.

64. Karppinen H. *Older people's views related to their end of life : will-to-live, wellbeing and functioning*. . Helsingin yliopisto,; 2019.

65. Sun X, Liu W, Gao Y, et al. Comparative effectiveness of non-pharmacological interventions for frailty: a systematic review and network meta-analysis. *Age and Ageing*. 2023;52(2)doi:10.1093/ageing/afad004

66. KäypäHoito-suositus. *Multimorbidity Current Care Guidelines*. 2021.

67. Beauchamp MK, Hao Q, Kuspinar A, et al. A unified framework for the measurement of mobility in older persons. *Age and Ageing*. 2023;52(Supplement_4):iv82-iv85. doi:10.1093/ageing/afad125

68. Izquierdo M, de Souto Barreto P, Arai H, et al. Global consensus on optimal exercise recommendations for enhancing healthy longevity in older adults (ICFSR). *The Journal of nutrition, health and aging*. 2025/01/01/ 2025;29(1):100401. doi:10.1016/j.jnha.2024.100401

69. Kujanpaa TS, Jokelainen J, Auvinen JP, Timonen MJ. The association of generalized anxiety disorder and Somatic Symptoms with frequent attendance to health care services: A cross-sectional study from the Northern Finland Birth Cohort 1966. *Int J Psychiatry Med*. Mar 2017;52(2):147-159. doi:10.1177/0091217417720894

70. WONCA. The Wonca Dictionary of General/Family Practice. 16.10, 2024. Accessed 16.10, 2024.

71. Mikkola IR, Marianne; Sipilä, Raija. *Perusterveydenhuollon avovastaanottotoiminnan mallit sote-järjestelmässä, Hyvä käytäntö - konsensussuositus*. 2022.

72. Petursson H, Tomasdottir MO. On sustainability and low value care. *Scand J Prim Health Care*. Jun 2024;42(2):235-236. doi:10.1080/02813432.2024.2321525

73. Raudasoja A, Tikkinen KAO, Bellini B, et al. Perspectives on low-value care and barriers to de-implementation among primary care physicians: a multinational survey. *BMC Prim Care*. May 9 2024;25(1):159. doi:10.1186/s12875-024-02382-9

74. KäypäHoito D. Vältä viisaasti. Accessed 28.2, 2026.

75. Svensk_förening_för_allmänmedicin S. Kloka Kliniska Val. 28.2, 2026. Updated 2025-03-12. Accessed 28.2, 2026.

76. de Bell S, Alejandre JC, Menzel C, et al. Nature-based social prescribing programmes: opportunities, challenges, and facilitators for implementation. *Environ Int*. Aug 2024;190:108801. doi:10.1016/j.envint.2024.108801

77. Hämäläinen R-M, Halonen JI, Haveri H, et al. Nature step to health 2022-2032: interorganizational collaboration to prevent human disease, nature loss, and climate crisis. *The Journal of Climate Change and Health*. 2023;10:100194.

78. Hartig T, Mitchell R, de Vries S, Frumkin H. Nature and health. *Annu Rev Public Health*. 2014;35:207-28. doi:10.1146/annurev-publhealth-032013-182443

79. WMO. World meteorological organization. Accessed 28.10, 2024.

80. CBD. Convention on Biological Diversity. Convention on Biological Diversity. Accessed 28.10, 2024. https://www.cbd.int/

81. Haahtela T. A biodiversity hypothesis. *Allergy*. Aug 2019;74(8):1445-1456. doi:10.1111/all.13763

82. Rojas-Rueda D, Nieuwenhuijsen MJ, Gascon M, Perez-Leon D, Mudu P. Green spaces and mortality: a systematic review and meta-analysis of cohort studies. *Lancet Planet Health*. Nov 2019;3(11):e469-e477. doi:10.1016/S2542-5196(19)30215-3

83. WHO. *Urban green spaces and health*. 2016.

84. Marselle MR, Hartig T, Cox DTC, et al. Pathways linking biodiversity to human health: A conceptual framework. *Environment International*. 2021/05/01/ 2021;150:106420. doi:10.1016/j.envint.2021.106420

85. Li H, Browning MHEM, Rigolon A, et al. Beyond "bluespace" and "greenspace": A narrative review of possible health benefits from exposure to other natural landscapes. *Science of The Total Environment*. 2023/01/15/ 2023;856:159292. doi:10.1016/j.scitotenv.2022.159292

86. Urban green spaces: a brief for action (World Health Organization) (2017).

87. Howarth M, Brettle A, Hardman M, Maden M. What is the evidence for the impact of gardens and gardening on health and well-being: a scoping review and evidence-based logic model to guide healthcare strategy decision making on the use of gardening approaches as a social prescription. *BMJ Open*. Jul 19 2020;10(7):e036923. doi:10.1136/bmjopen-2020-036923

88. Simkin J, Ojala A, Tyrvainen L. The Perceived Restorativeness of Differently Managed Forests and Its Association with Forest Qualities and Individual Variables: A Field Experiment. *Int J Environ Res Public Health*. Jan 7 2021;18(2)doi:10.3390/ijerph18020422

89. Coventry PA, Brown JE, Pervin J, et al. Nature-based outdoor activities for mental and physical health: Systematic review and meta-analysis. *SSM Popul Health*. Dec 2021;16:100934. doi:10.1016/j.ssmph.2021.100934

90. Salonen K, Hyvönen K, Paakkolanvaara J-V, Korpela K. Flow with nature treatment for depression: participants' experiences. *Frontiers in psychology*. 2022;12:768372.

91. Sachs AL, Maso-Aguado M, Bach A, et al. Developing a new tool to capture the nature dose to reduce loneliness and improve quality of life. *MethodsX*. Dec 2024;13:102969. doi:10.1016/j.mex.2024.102969

92. Häyrinen L, Pynnönen S. A Review of the Concepts and Measurements for Connection to Nature and Environmentally Responsible Behaviour—a Call for Research on Human-Forest Relationships. *Current Forestry Reports*. 2020/12/01 2020;6(4):323-338. doi:10.1007/s40725-020-00131-6

93. Kurth C, Pihkala P. Eco-anxiety: What it is and why it matters. *Front Psychol*. 2022;13:981814. doi:10.3389/fpsyg.2022.981814

94. Jensen JK, Persson AS, Soga M. Toward a unified understanding of people's aversion to nature: biophobia. *Frontiers in Ecology and the Environment*. 2026;24(1):e70019. doi:10.1002/fee.70019

95. Pretty J. How nature contributes to mental and physical health. *Spirituality and Health International*. 2004;5(2):68-78.

96. Haahtela T, Bousquet J, Antó JM. From biodiversity to nature deficiency in human health and disease. *Porto Biomedical Journal*. 2024;9(1)

97. Yang BY, Zhao T, Hu LX, et al. Greenspace and human health: An umbrella review. *Innovation (Camb)*. Nov 28 2021;2(4):100164. doi:10.1016/j.xinn.2021.100164

98. Donovan GH, Butry DT, Michael YL, et al. The Relationship Between Trees and Human Health: Evidence from the Spread of the Emerald Ash Borer. *American Journal of Preventive Medicine*. 2013/02/01/ 2013;44(2):139-145. doi:10.1016/j.amepre.2012.09.066

99. Burkart KG, Brauer M, Aravkin AY, et al. Estimating the cause-specific relative risks of non-optimal temperature on daily mortality: a two-part modelling approach applied to the Global Burden of Disease Study. *The Lancet*. 2021;398(10301):685-697.

100. World Urbanization prospects. United Nations. Accessed 6.6.2022,

101. Yuan Y, Huang F, Lin F, Zhu P, Zhu P. Green space exposure on mortality and cardiovascular outcomes in older adults: a systematic review and meta-analysis of observational studies. *Aging Clin Exp Res*. Jul 2021;33(7):1783-1797. doi:10.1007/s40520-020-01710-0

102. Turunen AW, Halonen J, Korpela K, et al. Cross-sectional associations of different types of nature exposure with psychotropic, antihypertensive and asthma medication. *Occup Environ Med*. Feb 2023;80(2):111-118. doi:10.1136/oemed-2022-108491

103. Koneensäätiö. Biodiverse living environment as a promoter of long-term health in urban and rural areas. Koneen säätiö. Accessed 30.6, 2025.

104. Engberg E, Ojala A, Paasio H, et al. Sociodemographic factors, parental mental health and movement behaviours in the early years: the SUNRISE Finland study protocol. *Journal of Activity, Sedentary and Sleep Behaviors*. 2024/01/03 2024;3(1):3. doi:10.1186/s44167-023-00042-4

105. Franco LS, Shanahan DF, Fuller RA. A Review of the Benefits of Nature Experiences: More Than Meets the Eye. *Int J Environ Res Public Health*. Aug 1 2017;14(8)doi:10.3390/ijerph14080864

106. Sievänen T, Neuvonen, M. (toim.). *Luonnon virkistyskäyttö 2010*. Vol. 212. 2011:190. *Metlan työraportteja*.

107. Kaupunki K. Lähivihreä- Kestävä kaupunki. Ympäristöministeriö. Accessed 22-12, 2023. https://kestavakaupunki.fi/lahivihrea

108. Barboza EP, Cirach M, Khomenko S, et al. Green space and mortality in European cities: a health impact assessment study. *Lancet Planet Health*. Oct 2021;5(10):e718-e730. doi:10.1016/S2542-5196(21)00229-1

109. Knobel P, Dadvand P, Maneja-Zaragoza R. A systematic review of multi-dimensional quality assessment tools for urban green spaces. *Health & Place*. 2019/09/01/ 2019;59:102198. doi:10.1016/j.healthplace.2019.102198

110. Richardson M, Passmore H-A, Lumber R, Thomas R, Hunt A. Moments, not minutes: The nature-wellbeing relationship. *International Journal of Wellbeing*. 2021;11(1)

111. Astell-Burt T, Hartig T, Putra IGNE, Walsan R, Dendup T, Feng X. Green space and loneliness: A systematic review with theoretical and

methodological guidance for future research. *Science of The Total Environment*. 2022/11/15/ 2022;847:157521. doi:10.1016/j.scitotenv.2022.157521

112. Korpela KM, Ylén M, Tyrväinen L, Silvennoinen H. Determinants of restorative experiences in everyday favorite places. *Health & Place*. 2008/12/01/ 2008;14(4):636-652. doi:10.1016/j.healthplace.2007.10.008

113. Alahmad B, Khraishah H, Royé D, et al. Associations Between Extreme Temperatures and Cardiovascular Cause-Specific Mortality: Results From 27 Countries. *Circulation*. Jan 3 2023;147(1):35-46. doi:10.1161/circulationaha.122.061832

114. EEA. Harm to human health from air pollution in Europe: burden of disease 2023. Updated 21.6.2024. Accessed 16.10, 2024.

115. Marselle MR, Lindley SJ, Cook PA, Bonn A. Biodiversity and Health in the Urban Environment. *Curr Environ Health Rep*. Jun 2021;8(2):146-156. doi:10.1007/s40572-021-00313-9

116. Capaldi CA, Dopko RL, Zelenski JM. The relationship between nature connectedness and happiness: A meta-analysis. *Frontiers in psychology*. 2014:976.

117. Hatty MA, Smith LDG, Goodwin D, Mavondo FT. The CN-12: A Brief, Multidimensional Connection With Nature Instrument. *Front Psychol*. 2020;11:1566. doi:10.3389/fpsyg.2020.01566

118. Tiscareno-Osorno X, Demetriou Y, Marques A, et al. Systematic Review of Explicit Instruments Measuring Nature Connectedness: What Do We Know and What is Next? *Environment and Behavior*. 2023/12/01 2023;55(8-10):551-608. doi:10.1177/00139165231212321

119. Litt JS, Coll-Planas L, Sachs AL, et al. Nature-based social interventions for people experiencing loneliness: the rationale and overview of the RECETAS project. *Cities & Health*. 2024:1-14. doi:10.1080/23748834.2023.2300207

120. Freeman C, Waters DL, Buttery Y, van Heezik Y. The impacts of ageing on connection to nature: the varied responses of older adults. Article. *Health and Place*. 2019;56:24-33. doi:10.1016/j.healthplace.2019.01.010

121. Rosa CD, Profice CC, Collado S. Nature Experiences and Adults' Self-Reported Pro-environmental Behaviors: The Role of Connectedness to Nature and Childhood Nature Experiences. *Front Psychol*. 2018;9:1055. doi:10.3389/fpsyg.2018.01055

122. Arola T, Aulake M, Ott A, et al. The impacts of nature connectedness on children's well-being: Systematic literature review. *Journal of Environmental Psychology*. 2023/02/01/ 2023;85:101913. doi:10.1016/j.jenvp.2022.101913

123. Richardson M, Hunt A, Hinds J, et al. A Measure of Nature Connectedness for Children and Adults: Validation, Performance, and Insights. *Sustainability*. 2019;11(12):3250.

124. Nisbet EK, Zelenski JM. The NR-6: a new brief measure of nature relatedness. *Front Psychol*. 2013;4:813. doi:10.3389/fpsyg.2013.00813

125. Martin C, Czellar S. The extended Inclusion of Nature in Self scale. *Journal of Environmental Psychology*. 2016/09/01/ 2016;47:181-194. doi:10.1016/j.jenvp.2016.05.006

126. Sitra, Kantar. *Suomalaisten luontosuhteet*. 2021. https://media.sitra.fi/app/uploads/2021/12/suomalaisten_luontosuhteet_tutkimusraportti_v2.pdf

127. Wiens V, Soronen K, Kyngäs H, Pölkki T. Enhancing Adolescent Girls' Well-Being in the Arctic—Finding What Motivates Spending Time in Nature. *International Journal of Environmental Research and Public Health*. 2021;18(4):2052.

128. Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M. Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*. 1991/09/01/ 1991;11(3):201-230. doi:10.1016/S0272-4944(05)80184-7

129. Lanki T, Siponen T, Ojala A, et al. Acute effects of visits to urban green environments on cardiovascular physiology in women: A field experiment. *Environ Res*. Nov 2017;159:176-185. doi:10.1016/j.envres.2017.07.039

130. Kaplan R, Kaplan S. *The experience of nature: A psychological perspective*. Cambridge university press; 1989.

131. Leavell MA, Leiferman JA, Gascon M, Braddick F, Gonzalez JC, Litt JS. Nature-Based Social Prescribing in Urban Settings to Improve Social Connectedness and Mental Well-being: a Review. *Curr Environ Health Rep*. Dec 2019;6(4):297-308. doi:10.1007/s40572-019-00251-7

132. Pasanen T, Johnson K, Lee K, Korpela K. Can Nature Walks With Psychological Tasks Improve Mood, Self-Reported Restoration, and Sustained Attention? Results From Two Experimental Field Studies. *Front Psychol*. 2018;9:2057. doi:10.3389/fpsyg.2018.02057

133. Haahtela T, Laatikainen T, Alenius H, et al. Hunt for the origin of allergy–comparing the Finnish and Russian Karelia. *Clinical & Experimental Allergy*. 2015;45(5):891-901.

134. Kondrashova A, Reunanen A, Romanov A, et al. A six-fold gradient in the incidence of type 1 diabetes at the eastern border of Finland. *Annals of medicine*. 2005;37(1):67-72.

135. Roslund MI, Parajuli A, Hui N, et al. A Placebo-controlled double-blinded test of the biodiversity hypothesis of immune-mediated diseases: Environmental microbial diversity elicits changes in cytokines and increase in T regulatory cells in young children. *Ecotoxicology and Environmental Safety*. 2022/09/01/ 2022;242:113900. doi:10.1016/j.ecoenv.2022.113900

136. Haahtela T, Valovirta E, Saarinen K, et al. The Finnish Allergy Program 2008-2018: Society-wide proactive program for change of management to mitigate allergy burden. *J Allergy Clin Immunol*. Aug 2021;148(2):319-326.e4. doi:10.1016/j.jaci.2021.03.037

137. Roslund MI, Nurminen N, Oikarinen S, et al. Skin exposure to soil microbiota elicits changes in cell-mediated immunity to pneumococcal vaccine. *Scientific Reports*. 2024/08/10 2024;14(1):18573. doi:10.1038/s41598-024-68235-8

138. Gustafsson J, Ojala A, Hiltunen P, et al. Parental Mental Well-Being and Frequency of Adult-Child Nature Visits: The Mediating Roles of Parents' Perceived Barriers. *Int J Environ Res Public Health*. Jun 25 2021;18(13)doi:10.3390/ijerph18136814

139. Puhakka S, Pyky R, Lankila T, et al. Physical Activity, Residential Environment, and Nature Relatedness in Young Men-A Population-Based

MOPO Study. *Int J Environ Res Public Health*. Oct 22 2018;15(10)doi:10.3390/ijerph15102322

140. Korpilo S, Willberg E, Müürisepp K, et al. Restoring nature, enhancing active mobility: The role of street greenery in the EU's 2024 restoration law. *Ambio*. 2025/04/10 2025;doi:10.1007/s13280-025-02178-w

141. Cesari M, Sumi Y, Han ZA, et al. Implementing care for healthy ageing. *BMJ Glob Health*. Feb 2022;7(2)doi:10.1136/bmjgh-2021-007778

142. Amuthavalli Thiyagarajan J, Mikton C, Harwood RH, et al. The UN Decade of healthy ageing: strengthening measurement for monitoring health and wellbeing of older people. *Age and Ageing*. 2022;51(7)doi:10.1093/ageing/afac147

143. Tynkkynen L-K, Pulkki J, Tervonen-Gonçalves L, Schön P, Burström B, Keskimäki I. Health system reforms and the needs of the ageing population—an analysis of recent policy paths and reform trends in Finland and Sweden. *European Journal of Ageing*. 2022/06/01 2022;19(2):221-232. doi:10.1007/s10433-022-00699-x

144. Vetrano DL, Calderón-Larrañaga A, Marengoni A, et al. An International Perspective on Chronic Multimorbidity: Approaching the Elephant in the Room. *J Gerontol A Biol Sci Med Sci*. Sep 11 2018;73(10):1350-1356. doi:10.1093/gerona/glx178

145. Lehto MT, Kauppila T, Kautiainen H, Laine MK, Rahkonen O, Pitkälä KH. Symptomatic diagnoses in primary care: an observational cohort study. *BJGP Open*. Dec 2024;8(4)doi:10.3399/bjgpo.2023.0234

146. WONCA. The European Definition of General Practice/Family Medicine. WONCA Europe 2023 Edition doi:https://www.woncaeurope.org/file/41f61fb9-47d5-4721-884e-603f4afa6588/WONCA_European_Definitions_2_v7.pdf#page=1.00 Accessed 13.4.2025.

147. Windak A, Rochfort A, Jacquet J. The revised European definition of general practice/family medicine. A pivotal role of one health, planetary health and sustainable development goals. Taylor & Francis; 2024. p. 2306936.

148. Sandvik H, Hetlevik Ø, Blinkenberg J, Hunskaar S. Continuity in general practice as predictor of mortality, acute hospitalisation, and use of out-of-hours care: a registry-based observational study in Norway. *British Journal of General Practice*. 2022;72(715):e84-e90. doi:10.3399/bjgp.2021.0340

149. Huhtakangas M, Kyngas H, Bloigu R, Kanste O. Differentiating middle-aged long-term and short-term frequent attenders by means of the Northern Finland Birth Cohort 1966 Study. *Scand J Caring Sci*. Sep 2021;35(3):813-823. doi:10.1111/scs.12896

150. Strombom Y, Magnusson P, Karlsson J, Fredrikson M. Health-related quality of life among frequent attenders in Swedish primary care: a cross-sectional observational study. *BMJ Open*. Jul 30 2019;9(7):e026855. doi:10.1136/bmjopen-2018-026855

151. Cruwys T, Wakefield JRH, Sani F, Dingle GA, Jetten J. Social Isolation Predicts Frequent Attendance in Primary Care. *Ann Behav Med*. Sep 13 2018;52(10):817-829. doi:10.1093/abm/kax054

152. NFGP. Core Values of General Practice. Nordic Federation of General Practice. Accessed 4.8, 2025.

153. Health and welfare inequalities. Finnish Institute for Health and Welfare. Accessed 31.3, 2023.

154. OECD. *Suomi: Maan terveysprofiili 2023, State of Health in the EU,*. 2023. *OECD Publishing, Paris/European Observatory on Health Systems and Policies, Brussels*.

155. Litvinova TLKkK. *Finland: health system summary 2023*. 2023.

156. Mielikäinen L, Kuronen R. Sosiaalihuollon laitos-ja asumispalvelut 2022: Sosiaalihuollon ympärivuorokautisten laitos-ja asumispalveluiden asiakasmäärä edellisen vuoden tasolla. Tilastoraportti 29/2023. Helsinki: THL, 2023. 2023.

157. Aalto UL, Finne-Soveri H, Kautiainen H, Ohman H, Roitto HM, Pitkala KH. Relationship between Anticholinergic Burden and Health-Related Quality of Life among Residents in Long-Term Care. *J Nutr Health Aging*. 2021;25(2):224-229. doi:10.1007/s12603-020-1493-2

158. Jansson AH, Savikko N, Kautiainen H, Roitto H-M, Pitkala KH. Changes in prevalence of loneliness over time in institutional settings, and associated factors. *Arch Gerontol Geriatr*. Jul-Aug 2020;89:104043. doi:10.1016/j.archger.2020.104043

159. Kotwal AA, Steinman MA, Cenzer I, Smith AK. Use of High-risk Medications Among Lonely Older Adults: Results From a Nationally Representative Sample. *JAMA Internal Medicine*. 2021;181(11):1528-1530. doi:10.1001/jamainternmed.2021.3775

160. Pitkala KH, Routasalo P, Kautiainen H, Tilvis RS. Effects of psychosocial group rehabilitation on health, use of health care services, and mortality of older persons suffering from loneliness: a randomized, controlled trial. *J Gerontol A Biol Sci Med Sci*. Jul 2009;64(7):792-800. doi:10.1093/gerona/glp011

161. Haverinen EH, Elonheimo HM, Tolonen HK, Jousilahti PJ, Wennman HJC. The effects of long-term physical activity interventions in communities: Scoping review in the Nordic countries. *Scand J Public Health*. Mar 2022;50(2):272-286. doi:10.1177/14034948211020599

162. Baker PR, Francis DP, Soares J, Weightman AL, Foster C. Community wide interventions for increasing physical activity. *Cochrane Database Syst Rev*. Jan 5 2015;1(1):CD008366. doi:10.1002/14651858.CD008366.pub3

163. Livingston G, Huntley J, Sommerlad A, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *Lancet*. Aug 8 2020;396(10248):413-446. doi:10.1016/S0140-6736(20)30367-6

164. Valenzuela PL, Ruilope LM, Santos-Lozano A, et al. Exercise benefits in cardiovascular diseases: from mechanisms to clinical implementation. *Eur Heart J*. Jun 1 2023;44(21):1874-1889. doi:10.1093/eurheartj/ehad170

165. Ngandu T, Lehtisalo J, Solomon A, et al. A 2 year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial. *The Lancet*. 2015;385(9984):2255-2263. doi:10.1016/S0140-6736(15)60461-5

166. Kolu P, Kari JT, Raitanen J, et al. Economic burden of low physical activity and high sedentary behaviour in Finland. *J Epidemiol Community Health*. Jul 2022;76(7):677-684. doi:10.1136/jech-2021-217998

167. UKK-instituutti. *Liikkumalla terveyttä – askel kerrallaan. Viikoittainen liikkumisen suositus 18–64-vuotiaille*. 2019.

168. Committee P. *Physical Activity Guidelines Advisory Committee Scientific Report*. 2018. *Physical Activity Guidelines Advisory Committee PAG*.

169. Salmi L, Hasanen E, Simula M, Virmasalo I, Muukkonen P. Perceived barriers to physical activity in the social spaces of low socioeconomic status suburbs. *Wellbeing, Space and Society*. 2023/12/01/ 2023;5:100164. doi:10.1016/j.wss.2023.100164

170. Morgan GS, Willmott M, Ben-Shlomo Y, Haase AM, Campbell RM. A life fulfilled: positively influencing physical activity in older adults - a systematic review and meta-ethnography. *BMC Public Health*. Apr 2 2019;19(1):362. doi:10.1186/s12889-019-6624-5

171. Bergbom I, Nåden D, Nyström L. Katie Eriksson's caring theories. Part 1. The caritative caring theory, the multidimensional health theory and the theory of human suffering. *Scandinavian Journal of Caring Sciences*. 2022;36(3):782-790. doi:10.1111/scs.13036

172. Lee I-M, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The lancet*. 2012;380(9838):219-229.

173. Hoogendijk EO, Dent E, Koivunen K. Intrinsic capacity: an under-researched concept in geriatrics. *Age and Ageing*. 2023;52(10)doi:10.1093/ageing/afad183

174. Johansson MN, Amanda; Albarqouni, Loai. et al. Guidelines Recommending That Clinicians Advise Patients on Lifestyle Changes: A Popular but Questionable Approach to Improve Public Health. *Annals of Internal Medicine*. 2024;0(0):null. doi:10.7326/annals-24-00283 %m 39250805

175. Muhl C, Mulligan K, Bayoumi I, Ashcroft R, Godfrey C. Establishing internationally accepted conceptual and operational definitions of social prescribing through expert consensus: a Delphi study. *BMJ Open*. 2023;13(7):e070184. doi:10.1136/bmjopen-2022-070184

176. de Bell S, Alejandre JC, Menzel C, et al. Nature-based social prescribing programmes: opportunities, challenges, and facilitators for implementation. *Environment International*. 2024/08/01/ 2024;190:108801. doi:10.1016/j.envint.2024.108801

177. Social prescribing: applying All Our Health. GOV.UK (www.gov.uk). Accessed 3.3, 2023. https://www.gov.uk/government/publications/social-prescribing-applying-all-our-health/social-prescribing-applying-all-our-health

178. Lee H, Koh SB, Jo HS, et al. Global Trends in Social Prescribing: Web-Based Crawling Approach. *J Med Internet Res*. May 22 2023;25:e46537. doi:10.2196/46537

179. Litt JS, Coll-Planas L, Sachs AL, Masó Aguado M, Howarth M. Current Trends and Future Directions in Urban Social Prescribing. *Current Environmental Health Reports*. 2023/12/01 2023;10(4):383-393. doi:10.1007/s40572-023-00419-2

180. Lapin Hyvinvointilähete. Accessed 22-12, 2023. https://hyvinvointilahete.fi/

181. Rapo E, Johansson E, Jonsson F, Hornsten A, Lundgren AS, Nilsson I. Critical components of social prescribing programmes with a focus on older

adults - a systematic review. *Scand J Prim Health Care*. Sep 2023;41(3):326-342. doi:10.1080/02813432.2023.2237078

182. Lynch M, Jones CR. Social prescribing for frequent attenders in primary care: an economic analysis. *Frontiers in Public Health*. 2022;10:902199.

183. Masterton W, Carver H, Parkes T, Park K. Greenspace interventions for mental health in clinical and non-clinical populations: What works, for whom, and in what circumstances? *Health Place*. Jul 2020;64:102338. doi:10.1016/j.healthplace.2020.102338

184. Pasanen TP, White MP, Elliott LR, et al. Urban green space and mental health among people living alone: The mediating roles of relational and collective restoration in an 18-country sample. *Environ Res*. Jun 11 2023:116324. doi:10.1016/j.envres.2023.116324

185. Zingmark M, Ankre R, Wall-Reinius S. Promoting outdoor recreation among older adults in Sweden - a theoretical and empirical foundation for the development of an intervention. *Arch Public Health*. Dec 27 2021;79(1):232. doi:10.1186/s13690-021-00762-6

186. Artmann M, Chen X, Iojă C, et al. The role of urban green spaces in care facilities for elderly people across European cities. *Urban Forestry & Urban Greening*. 2017/10/01/ 2017;27:203-213. doi:10.1016/j.ufug.2017.08.007

187. Zhang Y, Wu L, Zhao W, Zheng L, Zuo L. Nature's shield – Harnessing green spaces to combat dementia: A global meta-analysis. *Neuroscience & Biobehavioral Reviews*. 2025/11/01/ 2025;178:106360. doi:10.1016/j.neubiorev.2025.106360

188. Dadvand P, Bartoll X, Basagana X, et al. Green spaces and General Health: Roles of mental health status, social support, and physical activity. *Environ Int*. May 2016;91:161-7. doi:10.1016/j.envint.2016.02.029

189. Lahart I, Darcy P, Gidlow C, Calogiuri G. The Effects of Green Exercise on Physical and Mental Wellbeing: A Systematic Review. *Int J Environ Res Public Health*. Apr 15 2019;16(8)doi:10.3390/ijerph16081352

190. Pasanen TP, White MP, Wheeler BW, Garrett JK, Elliott LR. Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environ Int*. Oct 2019;131:105016. doi:10.1016/j.envint.2019.105016

191. Puhakka S, Lankila T, Pyky R, et al. Satellite Imaging-Based Residential Greenness and Accelerometry Measured Physical Activity at Midlife-Population-Based Northern Finland Birth Cohort 1966 Study. *Int J Environ Res Public Health*. Dec 9 2020;17(24)doi:10.3390/ijerph17249202

192. Korsberg M, Aalto-Nevalainen P, Kivisaari T, Martikainen M, Miettinen M. Suomi liikkeelle–liikunnallisen elämäntavan ja toimintakyvyn poikkihallinnollinen ohjelma: Ohjelma-asiakirja. 2024;

193. Pasanen TP, Tyrvainen L, Korpela KM. The relationship between perceived health and physical activity indoors, outdoors in built environments, and outdoors in nature. *Appl Psychol Health Well Being*. Nov 2014;6(3):324-46. doi:10.1111/aphw.12031

194. Astell-Burt T, Feng X, Kolt GS. Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: evidence from 260,061 Australians. *Prev Med*. Nov 2013;57(5):601-6. doi:10.1016/j.ypmed.2013.08.017

195. Triguero-Mas M, Donaire-Gonzalez D, Seto E, et al. Natural outdoor environments and mental health: Stress as a possible mechanism. *Environ Res*. Nov 2017;159:629-638. doi:10.1016/j.envres.2017.08.048

196. Wang D, Lau KK, Yu R, Wong SYS, Kwok TTY, Woo J. Neighbouring green space and mortality in community-dwelling elderly Hong Kong Chinese: a cohort study. *BMJ Open*. Aug 1 2017;7(7):e015794. doi:10.1136/bmjopen-2016-015794

197. Liljegren M, Bengtsson A, Lindahl G, Wijk H. Older Adults' Needs and Wishes for Contact With the Outdoors at Residential Care Facilities: Implications for Theory and Practice. *Herd*. Oct 2024;17(4):132-149. doi:10.1177/19375867241276296

198. Korpela KM, Ylén M, Tyrväinen L, Silvennoinen H. Favorite green, waterside and urban environments, restorative experiences and perceived health in Finland. *Health Promotion International*. 2010;25(2):200-209. doi:10.1093/heapro/daq007

199. Nguyen P-Y, Astell-Burt T, Rahimi-Ardabili H, Feng X. Effect of nature prescriptions on cardiometabolic and mental health, and physical activity: a systematic review. *The Lancet Planetary Health*. 2023/04/01/ 2023;7(4):e313-e328. doi:10.1016/S2542-5196(23)00025-6

200. Stock S, Bu F, Fancourt D, Mak HW. Longitudinal associations between going outdoors and mental health and wellbeing during a COVID-19 lockdown in the UK. *Sci Rep*. 2022;12(1):10580. doi:10.1038/s41598-022-15004-0

201. Fullam J, Hunt H, Lovell R, et al. A handbook for nature on prescription to promote mental health. *University of Exeter Version*. 2021;1

202. Kondo MC, Oyekanmi KO, Gibson A, South EC, Bocarro J, Hipp JA. Nature prescriptions for health: A review of evidence and research opportunities. *International Journal of Environmental Research and Public Health*. 2020;17(12):4213.

203. Busk H, Ahler J, Bricca A, et al. Exercise-based rehabilitation in and with nature: a scoping review mapping available interventions. *Ann Med*. 2023;55(2):2267083. doi:10.1080/07853890.2023.2267083

204. Adewuyi FA, Knobel P, Gogna P, Dadvand P. Health effects of green prescription: A systematic review of randomized controlled trials. *Environ Res*. Nov 1 2023;236(Pt 2):116844. doi:10.1016/j.envres.2023.116844

205. Green prescribing toolkit. 23.5, 2024.

206. Litt JS, Alaimo K, Harrall KK, et al. Effects of a community gardening intervention on diet, physical activity, and anthropometry outcomes in the USA (CAPS): an observer-blind, randomised controlled trial. *The Lancet Planetary Health*. 2023;7(1):e23-e32. doi:10.1016/S2542-5196(22)00303-5

207. Hyvönen K, Salonen K, Paakkolanvaara J-V, Väkeväinen P, Korpela K. Effects of nature-based intervention in the treatment of depression: A multi-center, randomized controlled trial. *Journal of Environmental Psychology*. 2023/02/01/ 2023;85:101950. doi:https://doi.org/10.1016/j.jenvp.2022.101950

208. Yeon P-S, Kim I-O, Kang S-N, et al. Effects of Urban Forest Therapy Program on Depression Patients. *International Journal of Environmental Research and Public Health*. 2023;20(1):507.

209. Shin WS, Shin CS, Yeoun PS. The influence of forest therapy camp on depression in alcoholics. *Environmental Health and Preventive Medicine*. 2012/01/01 2012;17(1):73-76. doi:10.1007/s12199-011-0215-0

210. Corazon SS, Nyed PK, Sidenius U, Poulsen DV, Stigsdotter UK. A Long-Term Follow-Up of the Efficacy of Nature-Based Therapy for Adults Suffering from Stress-Related Illnesses on Levels of Healthcare Consumption and Sick-Leave Absence: A Randomized Controlled Trial. *International Journal of Environmental Research and Public Health*. 2018;15(1):137.

211. Sahlin E, Ahlborg G, Jr., Tenenbaum A, Grahn P. Using nature-based rehabilitation to restart a stalled process of rehabilitation in individuals with stress-related mental illness. *Int J Environ Res Public Health*. Feb 9 2015;12(2):1928-51. doi:10.3390/ijerph120201928

212. Garside R, Orr N, Short R, et al. Therapeutic nature: nature-based social prescribing for diagnosed mental health conditions in the UK. *Final Report for DEFRA*. 2020;

213. Stigsdotter UK, Corazon SS, Sidenius U, Nyed PK, Larsen HB, Fjorback LO. Efficacy of nature-based therapy for individuals with stress-related illnesses: randomised controlled trial. *The British Journal of Psychiatry*. 2018;213(1):404-411. doi:10.1192/bjp.2018.2

214. Dolling A, Nilsson H, Lundell Y. Stress recovery in forest or handicraft environments – An intervention study. *Urban Forestry & Urban Greening*. 2017/10/01/ 2017;27:162-172. doi:10.1016/j.ufug.2017.07.006

215. Høegmark S, Andersen TE, Grahn P, Mejldal A, Roessler KK. The Wildman Programme—Rehabilitation and Reconnection with Nature for Men with Mental or Physical Health Problems—A Matched-Control Study. *International Journal of Environmental Research and Public Health*. 2021;18(21):11465.

216. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for information*. 2018;34(4):285-291.

217. Morris JN, Fries BE, Mehr DR, et al. MDS Cognitive Performance Scale©. *Journal of Gerontology*. 1994;49(4):M174-M182. doi:10.1093/geronj/49.4.M174

218. Pitkala KH, Rautiainen L, Aalto UL, et al. Participants' baseline characteristics and feedback of the nature-based social intervention "friends in nature" among lonely older adults in assisted living facilities in finland: a randomised controlled trial of the RECETAS EU-project. *BMC Geriatr*. Oct 7 2024;24(1):812. doi:10.1186/s12877-024-05408-0

219. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. Nov 1975;12(3):189-98. doi:10.1016/0022-3956(75)90026-6

220. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-83. doi:10.1016/0021-9681(87)90171-8

221. Merikanto I, Kronholm E, Peltonen M, Laatikainen T, Lahti T, Partonen T. Relation of chronotype to sleep complaints in the general Finnish population. *Chronobiol Int*. Apr 2012;29(3):311-7. doi:10.3109/07420528.2012.655870

222. Tilvis RS, Laitala V, Routasalo P, Strandberg TE, Pitkala KH. Positive life orientation predicts good survival prognosis in old age. *Arch Gerontol Geriatr*. Jul-Aug 2012;55(1):133-7. doi:10.1016/j.archger.2011.06.030

223. Malterud K. Systematic text condensation: a strategy for qualitative analysis. *Scand J Public Health*. Dec 2012;40(8):795-805. doi:10.1177/1403494812465030

224. Malterud K. Developing and promoting qualitative methods in general practice research: Lessons learnt and strategies convened. *Scand J Public Health*. Nov 2022;50(7):1024-1033. doi:10.1177/14034948221093558

225. Maguire M, Delahunt B. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland journal of higher education*. 2017;9(3)

226. Metsämuuronen J. *Tutkimuksen tekemisen perusteet ihmistieteissä* vol 3. Gummerus oy; 2006.

227. Costello AB, Osborne JW. Best Practices in Exploratory Factor Analysis: Four Recommendations for Getting the Most From Your Analysis. *Evaluation*. 10:7.

228. Tyrväinen L, Savonen E-M, Simkin J. Kohti suomalaista terveysmetsän mallia. 2017;

229. Matila A, Koistinen A., & Lahti, E. Metsä terveyden ja hyvinvoinnin edistäjänä — väliraportti. In: raportteja T, ed. Tapio oy; 2018.

230. Koponen P, Borodulin K, Lundqvist A, Sääksjärvi K, Koskinen S. Terveys, toimintakyky ja hyvinvointi Suomessa: FinTerveys 2017-tutkimus. 2018;

231. Tennant R, Hiller L, Fishwick R, et al. The Warwick-Edinburgh Mental Well-being Scale (WEMWBS): development and UK validation. *Health Qual Life Outcomes*. Nov 27 2007;5:63. doi:10.1186/1477-7525-5-63

232. Taggart F S-BS, Parkinson. Warwick-Edinburgh Mental Well-being Scale (WEMWBS) User Handbook. NHS Health Scotland; 2019. doi:https://s3.amazonaws.com/helpscout.net/docs/assets/5f97128852faff0016af3a34/attachments/5fe10a9eb624c71b7985b8f3/WEMWBS-Scale.pdf

233. Shah N, Cader M, Andrews WP, Wijesekera D, Stewart-Brown SL. Responsiveness of the Short Warwick Edinburgh Mental Well-Being Scale (SWEMWBS): evaluation a clinical sample. *Health Qual Life Outcomes*. Dec 22 2018;16(1):239. doi:10.1186/s12955-018-1060-2

234. Maheswaran H, Weich S, Powell J, Stewart-Brown S. Evaluating the responsiveness of the Warwick Edinburgh Mental Well-Being Scale (WEMWBS): group and individual level analysis. *Health Qual Life Outcomes*. Dec 27 2012;10:156. doi:10.1186/1477-7525-10-156

235. Page MJ, Moher D, Bossuyt PM, et al. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ*. Mar 29 2021;372:n160. doi:10.1136/bmj.n160

236. Rodríguez-Romero R, Herranz-Rodríguez C, Kostov B, Gené-Badia J, Sisó-Almirall A. Intervention to reduce perceived loneliness in community-dwelling older people. *Scand J Caring Sci*. 2021;35(2):366-374. doi:10.1111/scs.12852

237. Fan C-C, Choy C-S, Huang C-M, et al. The effects of a combination of 3D virtual reality and hands-on horticultural activities on mastery, achievement motives, self-esteem, isolation and depression: a quasi-

experimental study. *BMC Geriatr*. 2022;22(1):744. doi:10.1186/s12877-022-03431-7

238. Cross DR. *The effects of an outdoor adventure program on perceptions of alienation and feelings of personal control among at-risk adolescents*. 1999.

239. Mourao I, Mouro CV, Brito LM, Costa SR, Almeida TC. Impacts of therapeutic horticulture on happiness and loneliness in institutionalized clients with mental health conditions. *British Journal of Occupational Therapy*. 2022;85(2):111-119. doi:10.1177/03080226211008719

240. Tse MM. Therapeutic effects of an indoor gardening programme for older people living in nursing homes. *J Clin Nurs*. 2010;19(7-8):949-58. doi:10.1111/j.1365-2702.2009.02803.x

241. Lin T-Y, Huang C-M, Hsu H-P, et al. Effects of a combination of three-dimensional virtual reality and hands-on horticultural therapy on institutionalized older adults' physical and mental health: Quasi-experimental design. *Journal of Medical Internet Research*. 2020;22(11):11. doi:10.2196/19002

242. Meore A, Sun S, Byma L, et al. Pilot evaluation of horticultural therapy in improving overall wellness in veterans with history of suicidality. *Complement Ther Med*. 2021;59:102728. doi:10.1016/j.ctim.2021.102728

243. Wood CJ, Barton JL, Wicks CL. The Impact of Therapeutic Community Gardening on the Wellbeing, Loneliness, and Life Satisfaction of Individuals with Mental Illness. *Int J Environ Res Public Health*. 2022;19(20)doi:10.3390/ijerph192013166

244. Sempik J, Rickhuss C, Beeston A. The effects of social and therapeutic horticulture on aspects of social behaviour. *The British Journal of Occupational Therapy*. 2014;77(6):313-319. doi:10.4276/030802214X14018723138110

245. Kotera Y, Fido D. Effects of Shinrin-Yoku Retreat on Mental Health: a Pilot Study in Fukushima, Japan. *International Journal of Mental Health and Addiction*. 2021;doi:10.1007/s11469-021-00538-7

246. Levinger P, Panisset M, Dunn J, et al. Exercise interveNtion outdoor proJect in the cOmmunitY for older people - results from the ENJOY Seniors Exercise Park project translation research in the community. *BMC Geriatr*. 2020;20(1):446. doi:10.1186/s12877-020-01824-0

247. Sachs AL, Coringrato E, Sprague N, Turbyfill A, Tillema S, Litt J. Rationale, Feasibility, and Acceptability of the Meeting in Nature Together (MINT) Program: A Novel Nature-Based Social Intervention for Loneliness Reduction with Teen Parents and Their Peers. *Int J Environ Res Public Health*. 2022;19(17)doi:10.3390/ijerph191711059

248. Howarth M, Rogers M, Withnell N, McQuarrie C. Growing spaces: an evaluation of the mental health recovery programme using mixed methods. *J Res Nurs*. 2018;23(6):476-489. doi:10.1177/1744987118766207

249. Chen Y-M, Ji J-Y. Effects of Horticultural Therapy on Psychosocial Health in Older Nursing Home Residents A Preliminary Study. *Journal of Nursing Research*. 2015;23(3):167-171. doi:10.1097/jnr.0000000000000063

250. Howarth ML, McQuarrie C, Withnell N, Smith E. The influence of therapeutic horticulture on social integration. *Journal of Public Mental Health*. 2016;15(3):136-140. doi:10.1108/JPMH-12-2015-0050

251. Barclay R, Webber S, Ripat J, et al. Safety and feasibility of an interactive workshop and facilitated outdoor walking group compared to a workshop alone in increasing outdoor walking activity among older adults: a pilot randomized controlled trial. *Pilot Feasibility Stud*. 2018;4:179. doi:10.1186/s40814-018-0367-4

252. Muurinen S, Savikko N, Soini H, Suominen M, Pitkälä K. Nutrition and psychological well-being among long-term care residents with dementia. *J Nutr Health Aging*. Feb 2015;19(2):178-82. doi:10.1007/s12603-014-0519-z

253. Victor CR. Loneliness in Care Homes: A Neglected Area of Research? *Aging Health*. 2012/12/01 2012;8(6):637-646. doi:10.2217/ahe.12.65

254. Thompson C, Halcomb E, Masso M. The contribution of primary care practitioners to interventions reducing loneliness and social isolation in older people-An integrative review. *Scand J Caring Sci*. Feb 2 2023;doi:10.1111/scs.13151

255. Lonergan-Cullum M, Hooker SA, Levy R, Ricco J. A New Pandemic of Loneliness. *J Am Board Fam Med*. May-Jun 2022;35(3):593-596. doi:10.3122/jabfm.2022.03.210461

256. Suvisaari J, Appelqvist-Schmidlechner K, Solin P, et al. Psyykkisen kuormittuneisuuden ja positiivisen mielenterveyden muutokset suomalaisessa aikuisväestössä vuosina 2017-2020: FinTerveys 2017-seurantatutkimuksen tuloksia. 2021;

257. Ek S. Gender differences in health information behaviour: a Finnish population-based survey. *Health Promot Int*. Sep 2015;30(3):736-45. doi:10.1093/heapro/dat063

258. Heikkinen M. Hälsofrämjande Hälsoskog gruppverksamhet i Sibbo kommuns social- och hälsovårdstjänster - upplevelser ur ett deltagarperspektiv. 2022

259. Astell-Burt T, Hipp JA, Gatersleben B, et al. Need and Interest in Nature Prescriptions to Protect Cardiovascular and Mental Health: A Nationally-Representative Study With Insights for Future Randomised Trials. *Heart Lung Circ*. Jan 2023;32(1):114-123. doi:10.1016/j.hlc.2022.11.008

260. Korpela KM, Ylen M. Perceived health is associated with visiting natural favourite places in the vicinity. *Health Place*. Mar 2007;13(1):138-51. doi:10.1016/j.healthplace.2005.11.002

261. Chan SHM, Qiu L, Esposito G, Mai KP, Tam K-P, Cui J. Nature in virtual reality improves mood and reduces stress: evidence from young adults and senior citizens. *Virtual Reality*. 2023/12/01 2023;27(4):3285-3300. doi:10.1007/s10055-021-00604-4

262. Chen Y, Yuan Y. The neighborhood effect of exposure to blue space on elderly individuals' mental health: A case study in Guangzhou, China. *Health Place*. May 2020;63:102348. doi:10.1016/j.healthplace.2020.102348

263. Clarke PJ, Yan T, Keusch F, Gallagher NA. The Impact of Weather on Mobility and Participation in Older U.S. Adults. *Am J Public Health*. Jul 2015;105(7):1489-94. doi:10.2105/AJPH.2015.302582

264. Shiells K, Pivodic L, Holmerova I, Van den Block L. Self-reported needs and experiences of people with dementia living in nursing homes: a scoping review. *Aging Ment Health*. Oct 2020;24(10):1553-1568. doi:10.1080/13607863.2019.1625303

265. Salonen K. *Kokonaisvaltainen luontokokemus hyvinvoinnin tukena*. University of Tampere; 2020.

266. Teixeira A, Gabriel R, Martinho J, et al. Connectedness to Nature Does Not Explain the Variation in Physical Activity and Body Composition in Adults and Older People. *Int J Environ Res Public Health*. Nov 14 2021;18(22)doi:10.3390/ijerph182211951

267. AHRQ. Six Domains of Healthcare Quality. Agency for Healthcare Research and Quality, Rockville Accessed 0612, 2024. https://www.ahrq.gov/talkingquality/measures/six-domains.html

268. Stiglitz JE, Sen A, Fitoussi J-P. Report by the commission on the measurement of economic performance and social progress. The Commission Paris; 2009.

269. Haveri H, Simkin J. Luontoympäristöjen mahdollisuudet terveyden edistämisessä: ovatko metsäkylvyt osa tulevaisuuden sairaanhoitoa? *Duodecim*. 2023;139(10):851-859.

270. Aivelo T, Lehtimäki J. Luonnon monimuotoisuus edistää kansanterveyttä. *Duodecim*. 2021;

271. Salonen K, Hirvonen J, Ilmarinen K, Paakkolanvaara J-V, Peuraniemi T, Saarinen S. Turvallisuuden moninaisuus

Green Care -toiminnassa. *Kuntoutus*. 2021;44(2)

272. Ojala A, Neuvonen M, Leinikka M, Huotilainen M, Yli-Viikari A, Tyrväinen L. Virtuaaliluontoympäristöt työhyvinvoinnin voimavarana: Virtunature-tutkimushankkeen loppuraportti. 2019;

273. Giang TA, Cheng JY, Kwok HYF, et al. Effectiveness of Horticultural Therapy in Older Adults without Dementia: A Systematic Review and Meta-Analysis. *J Am Med Dir Assoc*. Dec 2024;25(12):105296. doi:10.1016/j.jamda.2024.105296

274. Malmivaara A. Applicability of evidence from randomized controlled trials and systematic reviews to clinical practice: A conceptual review. *J Rehabil Med*. Jun 3 2021;53(6):jrm00202. doi:10.2340/16501977-2843

275. Marx W, Manger SH, Blencowe M, et al. Clinical guidelines for the use of lifestyle-based mental health care in major depressive disorder: World Federation of Societies for Biological Psychiatry (WFSBP) and Australasian Society of Lifestyle Medicine (ASLM) taskforce. *World J Biol Psychiatry*. Jun 2023;24(5):333-386. doi:10.1080/15622975.2022.2112074

276. Tester-Jones M, White MP, Elliott LR, et al. Results from an 18 country cross-sectional study examining experiences of nature for people with common mental health disorders. *Sci Rep*. Nov 6 2020;10(1):19408. doi:10.1038/s41598-020-75825-9

277. Puntscher S, Stojkov I, Arvandi M, et al. Systematic literature review of economic studies on nature-based social prescribing for health improvement. *BMC Primary Care*. 2026/03/14 2026;doi:10.1186/s12875-026-03258-w

278. Laatikainen O. Medication-related adverse events in health care. 2020;

279. Kolster A. Luontoperusteinen hoito Suomen perusterveydenhuollossa. *Yleislääkäri*. 2024;39(4):13-16.

280. Martin L, White MP, Elliott LR, et al. Mechanisms underlying the associations between different types of nature exposure and sleep duration:

An 18-country analysis. *Environ Res*. Jun 1 2024;250:118522. doi:10.1016/j.envres.2024.118522

281. Donovan GH, Gatziolis D, Douwes J. Relationship between exposure to the natural environment and recovery from hip or knee arthroplasty: a New Zealand retrospective cohort study. *BMJ Open*. Sep 20 2019;9(9):e029522. doi:10.1136/bmjopen-2019-029522
282. THL. HYTE toimintakoodit päivittyvät 1.9.2025. THL. Accessed 23.9, 2025. https://thl.fi/-/uudet-hyvinvoinnin-ja-terveyden-edistamisen-toimenpidekoodit-nyt-kaytettavissa
283. Hyvinvointilähete uusi toimintamalli. Sitra. Accessed 22.2, 2023.
284. Kankus J, Vihriälä M. Green Care-menetelmien käytettävyys Ylitornion vankilassa. 2021;
285. Salminen T, Turpeenniemi E. Hyvinvointia luonnosta: Työttömien osallisuuden tukeminen luontokokemusten avulla Sallassa. 2015;
286. Astell-Burt T, Pappas E, Redfern J, Feng X. Nature prescriptions for community and planetary health: unrealised potential to improve compliance and outcomes in physiotherapy. *J Physiother*. Jul 2022;68(3):151-152. doi:10.1016/j.jphys.2022.05.016
287. Halonen J KA, Pasanen T,, A S. *Terveyttä luonnosta -ohjelma (2026–2035)*. 2026. 1/2026.
288. THL. HYTE toimintamallien arviointi. Terveyden ja hyvinvoinnin laitos. Accessed 30.7, 2025.
289. Wang X, Cheng Z. Cross-Sectional Studies: Strengths, Weaknesses, and Recommendations. *Chest*. Jul 2020;158(1s):S65-s71. doi:10.1016/j.chest.2020.03.012

Appendices

Appendix 1: Developing the Gerontological Nature Connection Scale (GNCS)

Appendix 1 describes the development of the Gerontological Nature Connection Scale (GNCS). **In bold** are the 12 statements included in the GNCS.

The table was originally published as supplementary material for article III, "Happy by nature: Nature connection as a source of resilience for older adults in assisted living facilities".

nr	Statement/ Question	Theoretical background	Response total n = 854 n (%)			Comment, including reason for exclusion from GNCS
			Yes	No	Can't say	
1	Nature is important to me	General importance of nature.[1]	820 (95.7)	20 (2.3)	17 (2)	Low variance in answers.
2	**I have access to nature as often as I desire**	Possibility to interact with nature, potential barriers to nature contact, dependence on others.	437 (51.1)	403 (47.1)	15 (2.8)	Responses *can't say* are included in category **no** in the final nature score model.
3	Nature helps me relax	Subjective physical and psychological health effects.[2]	752 (87.9)	52 (6.1)	52 (6.1)	Low variance in answers.
4	It is important to protect nature	Nature connection, pro-environmental mindset.[1]	838 (97.7)	4 (0.5)	14 (1.6)	Low variance in answers.
5	My relationship with nature is an important part of who I am	Social health-Intrapersonal aspects. Nature connection. Emotional aspects.[2]	648 (75.7)	38 (4.4)	170 (19.9)	Question difficult to interpret; high rate of "Can't say" responses.
6	It is easier to breath outdoors	Subjective physical health effects.	749 (87.6)	67 (7.8)	39 (4.6)	Low variance in answers.
7	**I feel less pain when in nature**	Subjective physical and psychological health effects.	411 (48.2)	158 (18.5)	283 (33.2)	Responses *can't say* are included in category **no**.
8	**I get topics for discussion from nature**	Social health-Interpersonal aspects. Nature connection.[2]	679 (79.7)	118 (13.8)	55 (6.5)	Responses *can't say* are included in category **no.**
9	Nature brings back good memories	Social health-Intrapersonal aspects. Nature connection.[2]	782 (91.7)	33 (3.9)	38 (4.5)	Low variance in answers. Overlapping question with negative memories.
10	**It is easy to move outdoors**	Subjective physical health effect, the importance of physical activity, potential barriers to nature contact.	506 (59.3)	320 (37.5)	28 (3.3)	Responses *can't say* are included in category **no.**
11	I am afraid of falling or	Side-effects, barriers to nature contact.	487 (57.3)	344 (40.5)	19 (2.2)	Not limited to the outdoors. Prevention

	slipping outdoors					of falls should always be considered.
12	**It is also possible to experience nature indoors**	Ways to interact with nature, preferred interventions.	587 (68.4)	184 (21.4)	82 (9.6)	Responses *can't say* are included in category **no**.
13	My relatives think I should go outdoors	Social health-Interpersonal aspects.[2] Potential barrier to nature contact. Dependence on others.	436 (50.8)	98 (11.4)	318 (37.3)	Question difficult to interpret; high rate of "Can't say" responses. Many respondents did not have close relatives.
14	It is difficult to go outdoors	Possibility to interact with nature, boundaries to nature contact.	428 (50.2)	406 (47.7)	18 (2.1)	Overlapping question. Did not correlate in EFA.
15	**Nature brings back bad memories**	Side-effects, barriers to nature contact.	145 (17.0)	681 (79.9)	26 (3.1)	Responses *can't say* are included in category **no**. Responses inverted in model.
16	I am afraid of getting hurt outdoors	Barriers to nature contact and especially physical activity.	339 (39.7)	499 (58.5)	15 (1.8)	Not limited to the outdoors, prevention of accidents should always be considered. Did not correlate in EFA.
17	**I feel part of something bigger in nature**	Social health-Intrapersonal aspects. Nature connectedness.	415 (48.9)	219 (25.8)	215 (25.3)	Responses *can't say* included in category **no**.
18	**Insects and tics are a danger to me**	Side-effects, boundaries to nature contact.	313 (36.8)	470 (55.2)	68 (8.0)	Responses *can't say* are included in category **no**. Responses inverted in model.
19	Nature is boring	Side-effects, barriers to nature contact.	66 (7.7)	748 (87.8)	38 (4.5)	Low variance in answers, did not correlate in EFA.
20	**Being outdoors**	Ways to interact with nature.	733 (86.0)	107 (12.6)	12 (1.4)	Responses *can't say* are included in category **no**.
21	**Gardening/ caring for flowers**	Ways to interact with nature. Gardening and horticulture are the most researched types of nature-based interventions.	459 (54.0)	377 (44.4)	14 (1.6)	Responses *can't say* are included in category **no**.
22	**Looking at pictures or paintings with nature themes**	Ways to interact with nature, preferred interventions.	643 (75.7)	176 (20.7)	30 (3.5)	Responses *can't say* are included in category **no**.

23	Nature's sounds (e.g. birdsong)	Ways to interact with nature, preferred interventions.	753 (87.8)	82 (9.7)	14 (1.6)	Low variance in answers, did not correlate in EFA.
24	Fresh air	Ways to interact with nature, preferred interventions.	832 (98.0)	13 (1.5)	4 (0.5)	Low variance in answers.
25	Nature-related TV programs	Ways to interact with nature, preferred interventions.	706 (83.2)	125 (14.7)	18 (2.1)	Question partly overlapping (visual activity). Low variance in answers, did not correlate in EFA.
26	The view from the window	Ways to interact with nature, preferred interventions.	767 (90.2)	61 (7.2)	22 (2.6)	Low variance in answers, did not correlate in EFA.
27	**Contact with animals**	Assistance animals are a common type of nature-based intervention.	624 (73.3)	207 (24.3)	20 (2.4)	Responses *can't say* are included in category **no**.
	EFA: Exploratory factor analysis					
	References:	[5,12,115,131]				