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Boyd, F., Allen, C., Robinson, J.M. et al. (2024) The past, present, and future of nature and place-based interventions for human health. *Landscape Research*, 49 (1). pp. 129-145.
ISSN: 0142-6397

<https://doi.org/10.1080/01426397.2023.2244430>

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To cite this article: Francesca Boyd, Camilla Allen, Jake M. Robinson & Nicole Redvers (01 Nov 2023): The past, present, and future of nature and place-based interventions for human health, Landscape Research, DOI: [10.1080/01426397.2023.2244430](https://doi.org/10.1080/01426397.2023.2244430)

To link to this article: <https://doi.org/10.1080/01426397.2023.2244430>



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Published online: 01 Nov 2023.



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The past, present, and future of nature and place-based interventions for human health

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ABSTRACT

The benefits of exposure to nature for human health and wellbeing have been evidenced throughout history and across global civilisations. However, research on nature and place-based interventions for human health often centres around a reactive healthcare model rather than fully considering the cultural and historical scope of holistic approaches to health. Adopting a context-setting approach, the article signposts readers to periods, places, and practices which have exemplified or advanced our collective global understanding of health and place. This narrative review demonstrates how different disciplines, and cultural knowledges can provide a foundation to develop nature-based interventions and further curiosity to learn from other practices. The COVID-19 pandemic has changed how some people connect with their environments and consider global health. There is now an opportunity to reflection on, and ethically engage with, different practices and approaches to transition towards a more sustainable future which integrates landscape planning with health promotion.

KEYWORDS

Green prescriptions; nature-based interventions; urban nature; planetary health; microbiome

Introduction

For centuries, approaches to human health have utilised the benefits of engaging with nature, from plant-based medicines to the salutary properties of 'fresh air' and biodiverse environments (Thwaites, Helleur, & Simkins, 2005). Today, differing models of healthcare systems worldwide re-engage with this concept in different ways. This includes preventative approaches, such as using immersive forest experiences for stress relief through to specialised gardens to aid surgery out-patient recovery (Dobson, 2017; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010). In addition, the adoption of nature-based interventions as non-clinical responses to medical conditions has gained momentum in the past decade, particularly in Western societies (Bragg & Atkins, 2016). Most recently, the COVID-19 lockdowns in the UK (and reflected across Europe) have seen a sustained revival in the public health benefits of visiting local green spaces (Natural England, 2021), the perspective from which this paper originated.

As research and interest in nature-based interventions for human health and wellbeing expands, the history and multicultural context of health and place can be overlooked. These

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contexts are important because innovation is often the reconfiguration of past ideas (Alves, Marques, Saur, & Marques, 2007). Reflecting on the past can also help us learn from bygone and ongoing successes and avoid ill-fated efforts. Additionally, we can benefit from respectfully and ethically participating in knowledge exchange between cultures. For example, the rich knowledges of Indigenous Peoples can provide Western societies with insights into how to move forward with an ecologically based mindset; however, this is only possible with a clear recognition of Indigenous rights to their Land-bases and cultures that host these knowledges. Furthermore, traditional ecological knowledges are often hyper-localised and continue to be exploited (Robinson et al., 2021). Therefore, deep listening, engaging, and partnering with Indigenous Peoples on their terms is essential. Although there is no pan-Indigenous science, we can learn from broader Indigenous philosophical perspectives, such as the view that human and ecosystem health are deeply intertwined. Thus, in addition to Western nature-health narratives, we discuss other cultural perspectives, pointing to holistic avenues of thinking.

This article aims to demonstrate the benefits of building on the momentum behind nature-based health initiatives by reflecting on other disciplines and cultural knowledges. Initially, we provide evidential context for the development of nature's role in health and wellbeing, followed by different interpretations of natural environments and nature engagement. We then give an overview of place- and nature-based health interventions, reflecting on multicultural, historical, and present approaches, and conclude with future opportunities. Throughout the article, we highlight how mitigation of environmental stressors, the restorative properties of natural environments for health, and the benefits of engagement with nature can be interpreted as health interventions. This narrative review was collated by working across disciplines and expanding each author's area of expertise into its historical and cultural background through journal searches (via Scopus, Web of Science, and Google Scholar).

Nature and wellbeing: evidential context

The accumulation of socioeconomic and environmental conditions determines health and wellbeing inequalities throughout the life course (Marmot & Bell, 2012). Numerous studies have evidenced the effects of natural environments on lowering levels of health inequity related to deprivation and urbanisation (Frumkin, 2002; Rigolon, Browning, McAnirlin, & Yoon, 2021; Shanahan, Fuller, Bush, Lin, & Gaston, 2015). Studies have found strong relationships between higher self-reported health and greater amounts of nature-based features close to the home, especially if the quality of the natural environment is considered good (Lovell, Depledge, & Maxwell, 2018). Evidence to support specific psychological benefits of engaging with nature includes global studies showing reduced stress and anxiety, increased perceived wellbeing, and improved concentration (Lovell et al., 2018; Nath, Zhe Han, & Lechner, 2018; Van den Bosch & Sang, 2017). There is also a strong link between greener environments and better cognitive development, healthier immune systems, and lower rates of obesity (Bratman et al., 2019; Lovell et al., 2018; Marselle et al., 2021).

The World Health Organisation (WHO) and the UK Government have identified and published on urban greenspaces and health equality in urban areas, especially regarding mental health (Douglas, Lennon, & Scott, 2017; Public Health England, 2020). Furthermore, reflections on the evolution of green infrastructure in urban areas highlight the need for collaborative approaches across different sectors (Mell, 2017; Sullivan, Frumkin, Jackson, & Chang, 2014). In addition, the COVID-19 pandemic has brought to the forefront the health and wellbeing implications of the inequity of access to greenspace (Vicenzotti & Waterton, 2021).

Whilst a wealth of evidence supports the positive association between natural environments and wellbeing, the contextual factors, interrelations and co-exposures are not comprehensively understood (Markevych et al., 2017; Wendelboe-Nelson, Kelly, Kennedy, & Cherrie, 2019). At present, at least three potential pathways have been identified: reducing harm (mitigating noise or air pollution),

restoring capacities (attention restoration theory and physiological stress recovery) and building capacities (facilitation of physical activity and social interaction) (Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015; Dobson et al., 2021; Kaplan, 1995). Whilst posing a challenge to test, there is evidence of an innate preference for natural environments over built environments and an attraction to nature across diverse cultures from a young age (Capaldi et al., 2015). There is also growing evidence for a biological mechanism to restoration and immunoregulation via exposure to diverse environmental microbiomes (Vermeulen, Schymanski, Barabási, & Miller, 2020). The past 20 years have seen a revival in nature-based interventions, with diverse evidence demonstrating the physical and mental health benefits (Bragg & Leck, 2017; Hartig, Mitchell, de Vries, & Frumkin, 2014). The integration of the natural environment in synthesis with medical interventions has brought a return to the historical use of nature-based features in Western hospital and health intervention design (e.g. the return of hospital gardens, therapeutic landscapes research and GP's engagement with green prescriptions) (Dobson, 2017; Tester-Jones et al., 2020; Van den Berg, 2017).

Natural environments and engagement: different interpretations

As mentioned, there are different interpretations of what constitutes a 'natural environment'. Here we do not seek to define the term but instead, consider how 'natural environments' have been used to create health in place. For example, some consider a designed garden or urban park to be natural (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Sturm & Cohen, 2014). Others consider environments with minimal human impact to be natural, while others will state that *all* environments are natural, including the anthropogenic types. The justification for the latter view is that humans are constituents of the natural world, and as such, their constructs are also natural (Cooke & Lewis, 2010; Dickinson, 2013). Indeed, not only does an intricate spectrum for the interpretation of natural environments appear to exist, but there are asymmetries in how we view ourselves in relation to the rest of nature. Our view of nature has evolved along with us and differs considerably between individuals and cultures. Some cultures view nature as a densely tangled web of interconnected subjects (including humans) and not simply a collection of discrete objects (de Castro, 2019; Gratani, Sutton, Butler, Bohensky, & Foale, 2016; Salmón, 2000). The multidimensional experience of the natural environment creates passive and active engagements often simultaneously (de Bell, Graham, & White, 2020).

Importantly, how nature supports human health also depends on individual ontological and sociocultural perspectives, and natural environments are paradoxically both the source of disease and disaster and the wellspring of health (Hartig et al., 2014). From one perspective, our surrounding environments provide 'ecosystem services' essential to our survival (Maosew, Wongmun, & Boonyanuphap, 2019; Persson, 2016). Another view is that the health of humans and that of the planet are deeply intertwined (Redvers, 2021), exemplified by the planetary health paradigm and advancements in the research of microbiomes – the diverse consortium of microbes and their theatre of activity (Prescott & Logan, 2018; Robinson, Mills, & Breed, 2018). This creates continuity between these new and evolving paradigms, ceremonies, songlines, and memory spaces in Indigenous Nations to the creation of greenspaces for public health in Western societies, with natural environments underpinning human health throughout history.

Place, nature and health-based interventions across cultures and throughout history

Foundational beliefs of humans and nature

The threads of different cultural and historical approaches to health and place can be seen as weaved into modern medicine, wellbeing, and social care approaches today. Here we present a

selection to spark further curiosity and encourage current 'health and place' practitioners of any discipline and from varied cultural traditions to explore and reflect.

Indigenous knowledges

For thousands of years, Indigenous Peoples such as the First Nations of Canada, Quechua of Peru, and Aboriginal Peoples of Australia, amongst many others, have held views of health and wellbeing that are distinctly different to Western perspectives, particularly those with biomedical foci (McLennan & Khavarpour, 2004; Stewart, 2008). Indigenous approaches to mental health have often been described with notions of holism or 'oneness'. Indeed, interdependence with nature and community and cultural identity are central to Indigenous mental health models (Stewart, 2008). Throughout Aboriginal Australia, approaches to healing may include ceremonies, herbal remedies (using an intricate knowledge of the flora and fauna of their land) and holistic practices steeped in the conception of interrelatedness between nature or 'land' and the embodiment of culture and spirituality (Devanesen, 2000; Griffiths & Russell, 2018; Johnston, Jacups, Vickery, & Bowman, 2007; Selin, 1997).

This interrelated perspective is seen in Western society's holistic models of health which describe the interrelatedness of human health with that of the planet and its ecosystems (e.g. Planetary Health) (Prescott & Logan, 2018). The ontological and epistemological views of many Indigenous Peoples have long reflected deep ecological principles (Harmsworth & Awatere, 2013; Morgan, 2015), however, their knowledges have and continue to be marginalised, with little overt recognition or protection. Due to ongoing racism and social exclusion (BMJ, 2020), on top of long histories of research extraction from Indigenous communities, Western healthcare models and systems have much work to do to repair relationships that would enable effective partnerships and learning to facilitate knowledge exchange. Any decision by Indigenous Peoples not to share their knowledge must be respected. There is also a need for careful attention paid to real and perceived bio-cultural piracy (commercial exploitation), community intellectual property rights, free, informed prior consent (FPIC), and Indigenous data sovereignty. Regardless, healthcare systems would do well to listen and learn from Indigenous leaders, who often provide a deep ecocentric view of humans being 'extensions of the earth' (Dudgeon & Bray, 2018), and model nature stewardship as a fundamental responsibility. Indigenous Land-based healing, practices, and learning pedagogies exemplify the Land not only as a place to go spend time in, but something to be in relationship with as part of the healing process (Redvers, Yellow Bird, Quinn, Yunkaporta, & Arabena, 2020; Redvers et al. 2020).

Current notions of nature-based interventions and therapies, have rich, ancient and multicultural foundations. Therefore, we could also seek out the rich and varied examples that exist throughout human culture and history as evidence of an interconnected view of human and planetary health.

Traditional medicine of Asia

In the established literature, there are many holistic health models, including Traditional Chinese Medicine (TCM) and Ayurveda. TCM identified that energy (known as qi or ch'i) circulated in the body along with blood three thousand years before it was 'discovered' by Western medicine (Chau, 2000). The mind-body system in the Indian practice of Ayurveda, the science of life, emphasises the healing power of meditation and the importance of a balanced and varied diet. Nature is considered to be a state in which desires are moderated, and conflict avoided, and which holds the potential to integrate human philosophical and biomedical practices for the benefit of nature and the environment (Morandi, Tosto, Sartori, & Roberti di Sarsina, 2011). As people travelled the globe, traditional medicines and knowledge mixed, and the ancient Peoples

who developed principles of Ayurveda and Ancient Greek healthcare interacted with those who developed Homeopathy, Sri Lankan Hela Wedakama and Egyptian Unani (Adhikari & Paul, 2018). Today this evolution of integrated approaches returns with some elements of TCM being incorporated and accepted into the UK's healthcare practice with NICE's recommendation of acupuncture, a practice common in TCM, to treat specific types of pain (NICE guideline, 2021).

A renaissance for traditional medicine has also occurred in the case of Kampo in Japan. Kampo is a herb formula-focused approach originating in China (206BC-220AD), of which a tailored Japanese version developed during the Edo period (from 1600 onwards) (Watanabe et al., 2011). This independent version focused on the treatment of symptoms with a concentrated number of herbal formulas. During the 19th century, this practice was almost completely lost in favour of Western medicine, but after World War Two, practitioners began blending the Western and traditional approaches (Watanabe et al., 2011). This revival, along with supportive clinical trials, saw the return of Kampo to mainstream healthcare in Japan, with 148 different herbal formulas now covered by healthcare insurance (Watanabe et al., 2011).

Europe

The ancient Greeks have been credited with 'revolutionising the practice of Western medicine' (Chang, Lad, & Lad, 2007; Tsermoulas, Aidonis, & Flint, 2014). Considered the 'Father of Medicine' Greek physician Hippocrates of Kos moved beyond supernatural conceptions of disease and religious components of aetiology and pioneered what were considered to be, by Western societies, novel concepts of disease by defining health as a state of 'dynamic equilibrium between the internal and external environments' (Tountas, 2009, p. 1, Suvajdžić, Đendić, Sakač, Čanak, & Dankuc, 2016). This developed into the humoral pathology model, where interacting phenomena, including the environment, were seen to determine harmony in bodily fluids (blood, phlegm, bile and black bile) and subsequently health (Figure 1). This shifted the focus towards a basic conception of the social determinants of health, highlighting the importance of supportive environments in disease prevention (i.e. proactive healthcare) (Bujalkova, Straka, & Jureckova, 2001).

One of Hippocrates' primary considerations was that some diseases were psychosomatic and intricately linked with the natural and social environments. This premise was developed further to determine evidence-based causal relationships between the environment and human disease (Katsambas & Marketos, 2007). Some consider Hippocrates to have laid the steppingstones for future progressive philosophies of Western medicine, in particular those that recognise the importance of environmental factors in maintaining a 'healthy mind in a healthy body' (Kleisiaris, Sfakianakis, & Papatthanasidou, 2014). Hippocrates was a fervent supporter of natural therapy, with the immediate landscape providing healing plants and locations (Batman, 2012; Stamatakis, Hamer, & Murphy, 2018).

In the ancient Mediterranean, physicians, alongside the herb gatherers (ρίζοτομος, rhizotomus), were essential figures in health. The practice across Europe of picking and drying plants found in forests and grasslands gave us the word 'drug', derived from the Anglo-Saxon verb *drigan*, to dry (Hill, 1915). As well as using plants as sources of drugs, the Romans believed the health-giving properties of air were central to the recovery process. To encourage recovery, Roman military hospitals used courtyards known as 'valetudinarians' to allow fresh air to travel through the building (Thwaites et al., 2005). This aligns with the long-held supposition that infectious diseases were communicated by miasmas, 'bad air,' until the advent of microbiology was able to attest to the existence of bacterial vectors for diseases like cholera (Thwaites et al., 2005).

Adapting landscapes for health

The traditions of gardens as anthropogenic spaces in which plants were selected for various uses are found in diverse ancient cultures from Mexico to China (Hill, 1915). Indeed, the function of

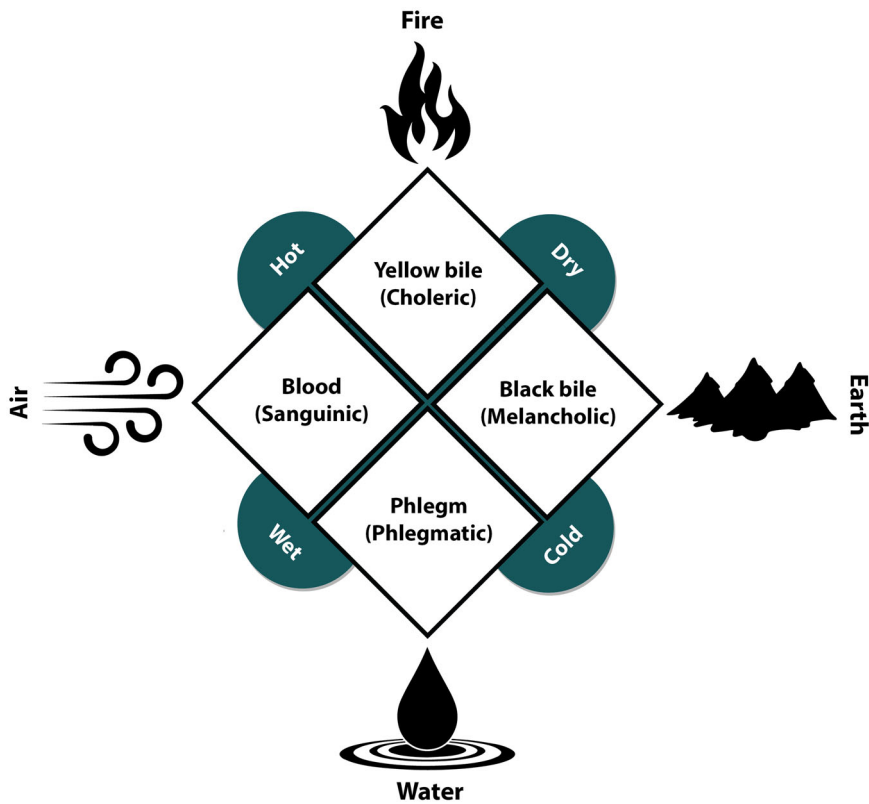


Figure 1. Hippocrates' humoral pathology. Although it is an erroneous model in respect of current knowledge of physiology and disease aetiology, it does highlight the shift in thinking for the explicit considerations of the external environment's influence on human disease via interaction with bodily fluids. Source Produced by authors, adapted from Bujalkova et al., 2001.

gardens as a refuge and place of contemplation or healing is a central part of the conception of what the word garden means (Grahn & Stigsdotter, 2003). The idea of the garden as an enclosed space begins in the protection and cultivation of plants. Examples are found in ancient Jewish, Assyrian, and Indic cultures and draw from the oasis concept (Crowe, 1994). The ideas of healing waters can also be explored here with blue space vital to the oasis and visions of paradise (Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017; Ward Thompson, 2011).

In the West, the enclosures and oases that informed the early gardens were later developed alongside monasteries, forming the earliest physic gardens. Physic and botanical gardens provide historical examples of one key pathway to health through the identification and cultivation of medicinal plants, themselves a product of the human instinct to perpetuate plants for culinary, medicinal, or aesthetic benefits they held (Hill, 1915). The medieval physic gardens of Kew, Cologne and Venice were founded by physicians and were places of instruction in the science of botany and medicine. The cultivation of plants for therapeutic, culinary and economic exploitation was furthered in the development of botanical gardens. This aligned colonial, economic, and academic interests, creating global networks for the expansion and exploitation of plants for drugs, food, fuel and fibre and creating the ornamental horticulture industry (Dixon Hunt, 2012).

The early public park movement, exemplified in Joseph Paxton's design for Birkenhead Park in Liverpool, became an international phenomenon when the idea was taken up by Frederick Law Olmsted and Calvert Vaux in their design for Central Park in New York (Ward Thompson, 2011). Nature was nurtured into the urban landscape as a place for countering disease and physical ill-health (Ward Thompson, 2011). Whilst within the Western landscape and urban design canon, the salutary nature of green spaces was understood, even if not demonstrated by science,

William Penn had produced a green urban area plan for Philadelphia in the United States along with a model of wide, tree-lined streets (1682). The Prime Minister, William Pitt the Elder, debated the value of 'green lungs' in London in Parliament (1766). The intertwined histories of cities and gardens define one of the foundations of the discipline of landscape architecture, with the study of plants for the social, economic, and environmental amelioration of growing and developing urban conurbations essential to an understanding of how humans have sought to alter the world around them (Fischer & Maisels, 1994; LeGates & Stout, 2011; Morris, 2013). These factors found expression in the parks and gardens of the 19th and 20th centuries in Britain, where the urban fabric was treated to preserve and create ameliorating green spaces for cities choked by the polluted atmosphere (Hoskins, 2004).

Public parks were proposed as vital assets to reduce disease, crime, and social unrest (Maller et al., 2009). These free-to-access spaces facilitated public events and contained aesthetically appealing features such as ornamental ponds and elaborate floral beds (Layton-Jones, 2018). In 1873 The Kyrle Society formed as advocates of the need for public open spaces in urban areas. The legacy of this group's political influence can be seen today in many of London's protected greenspaces. The society was founded on the human requirements for fresh air, music, literature and open greenspaces away from the 'rattle of motors' (Hill, 1905, p. 314). In 1877, the introduction into law of the Metropolitan Open Space Act consecrated the requirement for green open spaces to be integrated into urban and rural areas under the sanity district authority (similar to modern-day public health department responsibility) (Open Spaces Act 1887, n.d.). These spaces were designated as a public health intervention from the polluted and cramped industrial city housing conditions. Furthermore, the founder of the Salvation Army, William Booth, sought to provide respite and recovery from the social ills of urban life through his strategy of urban - and then rural - rehabilitation, articulated in Booth's (1890) book, *In Darkest England and the Way Out*.

Reminiscent of the Roman valetudinarians the benefits of exposure to natural environments continued into the design of hospitals. As seen in the 1868 rebuild of St Thomas' Hospital London, the Victorian Pavilion hospital design focused on hygiene, fresh air and cross-ventilation through courtyards, outward-facing wards and low corridors (Dobson, 2017; Thwaites et al., 2005). Hospital gardens were an essential part of the therapeutic regimen, with Great Oldman Street Hospital encouraging routine fresh air prescribing time outside to treat pulmonary conditions (Dobson, 2017; HHARP, 2010).

20th century development in technology and return to restoration in nature for health

The 20th century saw the rapid development of medicine and technology, not least in response to two catastrophic world wars, necessitating innovation in treating millions of soldiers and civilians. These advances superseded the influence of nature as part of the health and wellbeing approach (Dobson, 2017). At a similar time, the role of public parks changed from health provision to optional amenities within urban infrastructure and design (Maller et al., 2009). However, this dichotomy between medicine and nature was not consistent, as evidenced by the emergence of preventative and curative therapies that utilised the natural world. The development of the disciplines of landscape architecture and town planning also sought to foster a civic renaissance through creating beautiful and productive landscapes, of which only the seismic change wrought by conflict could bring into being (Woudstra, 2018).

The First World War also brought a significant development in military medicine. The challenges and limitations of field hospitals, coupled with the war's psychological impact on soldiers, were distinct from other conflicts (Carden-Coyne, 2014). Innovation in treating infectious diseases, injuries, and damage to soldiers' mental health resulted in new treatments, procedures, and hospitals, including how landscapes were utilised for health (Loughran, 2017). In Cambridge,

UK, the 1st Eastern General Hospital was created on open ground as a temporary field hospital after capacity in the colonnades of the Colleges were filled up by the wounded. Housing thousands of men, the hospital was a temporary construction with asbestos and fabric walls to let fresh air in and represented a large-scale experiment in outdoor treatment (Reznick, 2004). As well as the well-tended gardens of the 1st Eastern, other hospitals innovated with rotating revolving shelters to catch the sun and private roof gardens to afford those recuperating some privacy. Contact with nature provided succour for men fighting in the trenches, regular contact with birds and animals, and growing food, providing comfort and distraction. Furthermore, imagery drawn from nature has been interpreted as demonstrating the healing power of fragile non-human life forms as a counterpoint to industrialised warfare (Carden-Coyne, 2020).

Whilst technology provided advancements in healing, there was simultaneously a return to the value of nature and place for health. The value of trees in the reconstruction and rehabilitation of post-war Britain saw the creation of the Forestry Commission and forester education facilities. The voluntary work students complemented these efforts to ease mental health issues through activities like beekeeping and carpentry (Baker, 1944). Although many nature writers have expressed the value of spending time in forests and woodland settings, the concept of directing people as a form of treatment is international and was formally adopted by the Forest Agency of the Japanese government in 1982 and renewed in the Agency's 2005 'Therapeutic Effects of Forests Plan' (Tsunetsugu, Park, & Miyazaki, 2010). 'Shinrin-yoku' focused on an immersive forest experience to reduce stress and encourage relaxation. The traditional Japanese practice of complete immersion, or bathing, in a forest is designed to allow for physiological relaxation and immune function recovery (Hansen, Jones, & Tocchini, 2017). The therapeutic benefits have included improved cardiovascular and respiratory system and mental health (Hansen et al., 2017; Ideno et al., 2017).

Towards the end of the 20th Century, sedentary lifestyle behaviours increased associated health conditions in Western societies, such as cardiovascular diseases, diabetes, and obesity (Barton, Hine, & Pretty, 2009; WHO, 2002). The New Zealand government deemed this an epidemic, and as part of the associated health strategy, they created tailored non-clinical approaches to target specific demographic groups (Ministry of Health, 2004). Considered the first national health intervention of its kind, New Zealand ministry of health launched its Green Prescription programme in the late 1990s (Patel, Schofield, Kolt, & Keogh, 2011). The programme uses a transtheoretical model of behaviour change focused on physical activity and is considered 'green' due to the absence of medicine rather than the explicit presents of 'green nature'. This whole-body approach is still in use today, with the programme evaluated as effective (Hamlin, Yule, Elliot, Stoner, & Kathiravel, 2016). However, it is challenged by GP perception of how patients respond to non-medical prescriptions, and by poor uptake and adherence in some areas (Gribben, Goodyear-Smith, Grobbelaar, O'Neill, & Walker, 2000; Patel et al., 2011). This reflects the challenge of integrating this approach within the healthcare culture in New Zealand. Since its inception, the programme has expanded to include a family programme aimed at reducing childhood obesity (Anderson et al., 2017).

Present day

21st century use of nature-based interventions

Reminiscent of the previously discussed holistic models of health, it is slowly being recognised that public health approaches across the globe need to shift from reactive treatment to proactive preventative measures. There has been increased international acknowledgement of the need for urban environments to integrate greenspaces into people's lives to support public health (WHO, 2017). The UK's National Health Service (NHS) is moving to a preventative model of care within the community focused on the upstream determinants of health (social, economic and environmental) (NHS

England, 2014). This includes increased recognition for community-led interventions and the role of the natural environment in supporting health and wellbeing. Furthermore, as demand for access to public green space increased in the UK during the COVID-19 pandemic, there was increased attention to the public health and wellbeing value of these urban landscapes (LEEP, 2022).

In the past two decades, there has been increased international uptake in nature-based interventions, from large-scale health initiatives such as Canada's 30x30 nature challenge through to the revised focus on healing gardens in Sweden. The 30x30 nature challenge aims to reconnect residents with their local natural environments for 30 minutes a day for 30 days. Since 2013, thousands of businesses and individuals have participated (Nisbet, 2013). The healing gardens in Sweden and the UK (successor of the monastery and physic gardens) focus research, and development, on the afforded benefits of specialist landscapes (Buck, 2016; Dobson, 2017; Grahn & Stigsdotter, 2003; Hospitalfield, 2016). The value of outdoor space has been returned to Great Ormond Street Hospital with the development of a courtyard garden (Dobson, 2017). In the USA, Public Health policy has begun to consider ways to improve wellbeing and health through access to nature (Sullivan et al., 2014).

Current 'green prescriptions'

The use of nature within an intervention has been turned into a whole sector within Western medicine, putting the patient at the centre of the decision and creating opportunities for innovation in non-clinical treatment has seen the evolution of 'green prescriptions' (other names include; GRx, nature prescriptions, park prescriptions, nature-based intervention). Green prescriptions are theorised to be successful due to three elements; mobilising restoration through nature, positive social contact and facilitating meaningful activity (Bragg & Atkins, 2016). An intervention aims to increase the participant's connection to nature as a pathway to improve wellbeing. As discussed earlier in the article, this pathway is not comprehensively understood with theories based on human evolution, recuperation from city life and an innate connection to the natural environment (Capaldi et al., 2015, Sudimac, Sale, & Kühn, 2022).

Green prescriptions in the UK have developed to encompass activities in nature, from art with plants to wilderness experiences (Hunt, Bragg, Stancliffe, Williams, & Preston, 2017). This can range from passive engagement in place, such as a social group activity in an urban green area to active engagement, such as gardening. Some managed greenspaces have installed trails that include equipment and guidance, while other activities are scheduled with a pre-planned route (Centre for Sustainable Healthcare, 2019). As this sector continues to grow in the UK, it is essential to maintain shared knowledge on the success and failures of different interventions. It is also essential to centre understandings of health equity, with the clear acknowledgement that not all communities and populations have easy accessibility to nature. Just as this paper recommends that a practitioner develop an understanding of historical, cultural and place-based approaches to interventions, there should be shared knowledge transfer between current practices.

The future

The increased attention from health providers to the salutogenic benefits of the environment has instigated research into 'dose response' (Barton & Pretty, 2010; Shanahan et al., 2016). Dose of nature frameworks create recommendations on how much, how frequently and what quality of environment people require to gain the associated health outcomes. We may need a better understanding of these dynamics to ascertain what types or characteristics of greenspaces need to be incorporated into urban spaces design and nature-based interventions (Dobson et al., 2021; Shanahan et al., 2016). Simultaneously, developments in virtual and augmented reality have made the technology more accessible and readily available. The ability to exposure those

with limited access to 360-degree videos of nature may provide alternatives when physical or high-quality environments are not available (Browning, Mimnaugh, van Riper, Laurent, & LaValle, 2019). Findings from trials in workplaces, education and healthcare settings have found positive wellbeing outcomes when accessing restorative outdoor environments (Adhyaru & Kemp, 2022; Browning et al., 2019; Hugh-Jones, Ulor, Nugent, Walshe, & Kirk, 2023).

The microbiome and exposome

The interactions which occur between place and health have positive and negative aspects. Until the end of the 20th century, it was widely accepted that exposure to microorganisms (e.g. bacteria, viruses, archaea, protozoans, and fungi) posed a considerable risk to public health (Timmis et al., 2019). However, our knowledge of the complexities of microbial ecology, including the myriad beneficial roles that microbes play, has increased dramatically due to advances in DNA sequencing technology (Boughner & Singh, 2016; Cao, Fanning, Proos, Jordan, & Srikumar, 2017). As a result, some researchers consider public health to be amid a paradigm shift, one that recognises the importance of the human-microbe relationship and the vital roles microbes play in supporting all life on Earth (Cavicchioli et al., 2019; Robinson & Jorgensen, 2020).

Building on this knowledge, disturbance (or 'dysbiosis') to the microbiome (i.e. the consortium of microbes in a given environment) in the human body has been implicated in a plethora of non-communicable diseases including asthma, diabetes, and inflammatory bowel disease (Cortez et al., 2019; Durack, Boushey, & Lynch, 2016; Sokol et al., 2017). Moreover, the prevalence of these diseases is increasing, coinciding with a global megatrend of biodiversity loss (Haahtela, 2019). Growing evidence suggests that exposure to the rich variety of microorganisms in the (natural) environment can have significant positive regulatory influences on the immune system and, as a study recently demonstrated, potentially anxiety-reducing effects (Deckers, Lambrecht, & Hammad, 2019; Liddicoat et al., 2020; Sbihi et al., 2019). Exploring the relationship between the environmental microbiome and human health is an emerging field. Some researchers focus on how ecological restoration and landscape design could be optimised to enhance the relationship between environmental and human health (Mills et al., 2019; Robinson et al., 2018).

A relatively new field encompasses microbiome research in public health, that is, 'exposome' research. Investigating all exposures (e.g. chemical compounds from the environment) throughout the human life course is collectively termed the exposome (Escher et al., 2017; Vermeulen et al., 2020). Exposome research underscores the importance of the environment in human health; whilst the idea was conceived over a decade ago, there are inherent barriers to overcome (Wild, 2005). This includes the heterogeneous nature and dynamic complexity associated with exposures of different kinds. However, advances in research suggest that a more personalised approach to medicine, including a deeper understanding of natural environmental exposures, could be on the horizon (Renz et al., 2017).

Rekindling 'old' relationships with nature

We have discussed the potential future of nature and human health research from an atomistic perspective, i.e. analysing microscopic components of natural environments and investigating the implications of their interactions with humans. However, there are potential counter-arguments for the future or at least opportunities for less materialist complementary approaches to the nature and human health relationship. For example, re-establishing our ancient connections with the rest of the natural world. There is also an argument to learn from the rich knowledge of 'environmental stewardship' as a proactive healthcare intervention. As habitat destruction increases (and often disproportionately on Indigenous Peoples' land), human contact with wild-life and novel organisms also increases (Mwangi, Figueiredo, & Criscitiello, 2016). This, in turn, is

associated with the emergence of zoonotic disease outbreaks, a salient notion in light of the recent COVID-19 pandemic (O'Callaghan-Gordo & Antó, 2020). In urbanised countries, areas with a higher ratio of green space were associated with lower racial disparity in COVID-19 infection rates (Lu et al., 2021). The co-benefits of understanding and integrating nature into all planning are far-reaching (Bratman et al., 2019). Further emphasis on protecting and understanding the human health benefits associated with the planetary health paradigm is required.

Another area of research that has emerged in the last two decades is people's connection to nature. Some research defines this as measurable 'nature connectedness' or 'nature relatedness' (Hughes, Rogerson, Barton, & Bragg, 2019; Mayer & Frantz, 2004; Nisbet, Zelenski, & Murphy, 2009). Connection to nature research investigates peoples' emotional, spiritual and cognitive connection with the natural world (Martin et al., 2020). This has been associated with pro-ecological behaviours and positive wellbeing (Howell, Dopko, Passmore, & Buro, 2011; Pritchard, Richardson, Sheffield, & McEwan, 2020). Importantly, there is a degree of plasticity in one's emotional connection to nature (Mayer & Frantz, 2004). Many Indigenous communities take nature connection a step further in understanding, whereby humans are in and of themselves nature (i.e. interconnected with nature), with no ability to isolate humans and nature as separate elements (Redvers, Yellow Bird, et al., 2020). Moving away from the transactional model of relating to the natural world is relevant to both dimensions. There is no time like the present to ensure that we learn from our past (successes and ill-fated efforts) and also listen respectfully to other cultures and communities to set the foundations for a paradigm shift in the nature-human health relationship. There is no time like the present to start.

Conclusions

Human history is rich with examples of the health benefits of engaging with nature in the immediate landscape, from cultivating cures to the emotional support in its restorative dimensions. As healthcare models evolve in this area, practitioners and policymakers should support continued improvements and knowledge sharing. To do so, we must acknowledge the intricate links between human health and that of the natural world. This has been demonstrated across cultures and histories through practices, aspects of which can retrospectively be interpreted as nature-based interventions. This paper highlights many opportunities to listen respectfully, engage, and learn from traditional approaches and Indigenous Peoples. However, this must be done with humility and respect for the longest stewards of the Land. Future developments in nature and place-based intervention for human health should include a holistic approach and collaborations at local, national and global scales. These approaches should aim to be achieved through community-led allyship with compassion towards both human and environmental needs.

This narrative review demonstrates the growing opportunity within the nature-health dialogue to rebalance and consider the natural environment as a partner and co-creator of human health. The COVID-19 pandemic, with the emergence of zoonotic disease and limits on time outdoors, brought the intertwined relationship between humans and nature to the forefront. Progress in approaches can help people understand how to connect with their environment and transition towards a more sustainable future that integrates landscape planning with health promotion. Reflecting on different practices and holistic approaches, such as those signposted in this article, will hopefully contribute to this transition. As discussed, a combination of modern scientific methods and traditional knowledges and philosophies would support the development of a holistic and sustainable approach to health and nature care.

Acknowledgements

The author would like to thank the reviewers and editor in their contribution to reviewing this paper.

Disclosure statement

The authors declares that they have no relevant or material financial interests that relate to the content of this paper.

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References

- Adhikari, P. P., & Paul, S. B. (2018). History of Indian traditional medicine: A medical inheritance. *Asian Journal of Pharmaceutical and Clinical Research*, 11(1), 421. doi:10.22159/ajpcr.2018.v11i1.21893
- Adhyaru, J. S., & Kemp, C. (2022). Virtual reality as a tool to promote wellbeing in the workplace. *Digital Health*, 8, 20552076221084473. doi:10.1177/20552076221084473
- Alves, J., Marques, M. J., Saur, I., & Marques, P. (2007). Creativity and innovation through Multidisciplinary and Multisectoral Cooperation. *Creativity and Innovation Management*, 16(1), 27–34. doi:10.1111/j.1467-8691.2007.00417.x
- Anderson, Y. C., Wynter, L. E., Grant, C. C., Cave, T. L., Derraik, J. G. B., Cutfield, W. S., & Hofman, P. L. (2017). A novel home-based intervention for child and adolescent obesity: The results of the Whānau Pakari randomized controlled trial. *Obesity*, 25(11), 1965–1973. doi:10.1002/oby.21967
- Baker, R. S. B. (1944). *I Planted Trees*. Lutterworth Press. <http://www.sidalc.net/cgi-bin/wxis.exe/?IisScript=APN.xis&method=post&formato=2&cantidad=1&expresion=mfn=002518>
- Barton, J., Hine, R., & Pretty, J. (2009). The health benefits of walking in greenspaces of high natural and heritage value. *Journal of Integrative Environmental Sciences*, 6(4), 261–278. doi:10.1080/19438150903378425
- Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology*, 44(10), 3947–3955. doi:10.1021/es903183r
- Batman, D. C. (2012). Hippocrates: "Walking is man's best medicine!". *Occupational Medicine*, 62(5), 320–322. doi:10.1093/occmed/kqs084
- Booth, W. (1890). *In Darkest England and the way out*. Cambridge: Cambridge University Press.
- Boughner, L. A., & Singh, P. (2016). Microbial ecology: Where are we now? *Postdoc Journal*, 4(11), 3–17. doi:10.14304/SURYAJPR.V4N11.2

- Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, 10(1), 456. doi:10.1186/1471-2458-10-456
- Bragg, R., & Atkins, G. (2016). A review of nature-based interventions for mental health care. *Natural England Commissioned Reports*, 204.
- Bragg, R., & Leck, C. (2017). *Good practice in social prescribing for mental health: The role of nature-based interventions* (Issue 228).
- Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., ... Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances*, 5(7), eaax0903. doi:10.1126/sciadv.aax0903
- Browning, M. H. E. M., Mimnaugh, K. J., van Riper, C. J., Laurent, H. K., & LaValle, S. M. (2019). Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. *Frontiers in Psychology*, 10, 2667. doi:10.3389/fpsyg.2019.02667
- Buck, D. (2016). *Gardens and health: Implications for policy and practice*. <https://www.kingsfund.org.uk/publications/gardens-and-health>.
- Bujalkova, M., Straka, S., & Jureckova, A. (2001). Hippocrates' humoral pathology in nowadays reflections. *Bratislavske Lekarske Listy*, 102(10), 489–492. https://www.researchgate.net/publication/11557294_Hippocrates%27_humoral_pathology_in_nowaday%27s_reflections.
- Cao, Y., Fanning, S., Proos, S., Jordan, K., & Srikumar, S. (2017). A Review On The Applications Of Next Generation Sequencing Technologies As Applied To Food-Related Microbiome Studies. *Frontiers in Microbiology*, 8, 1829. doi:10.3389/fmicb.2017.01829
- Capaldi, C., Passmore, H.-A., Nisbet, E., Zelenski, J., & Dopko, R. (2015). Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. *International Journal of Wellbeing*, 5(4), 1–16. doi:10.5502/ijw.v5i4.449
- Carden-Coyne, A. (2020). Butterfly touch: Rehabilitation, nature and the haptic arts in the First World War. *Critical Military Studies*, 6(2), 176–203. doi:10.1080/23337486.2019.1612151
- Carden-Coyne, A. (2014). *The politics of wounds: Military patients and medical power in the first world war*. Oxford: Oxford University Press.
- Cavicchioli, R., Ripple, W. J., Timmis, K. N., Azam, F., Bakken, L. R., Baylis, M., ... Webster, N. S. (2019). Scientists' warning to humanity: Microorganisms and climate change. *Nature Reviews. Microbiology*, 17(9), 569–586. doi:10.1038/s41579-019-0222-5
- Centre for Sustainable Healthcare. (2019). *Green Health Routes*. <https://sustainablehealthcare.org.uk/what-we-do/green-space/green-health-routes>.
- Chang, A., Lad, E. M., & Lad, S. P. (2007). Hippocrates' influence on the origins of neurosurgery. *Neurosurgical Focus*, 23(1), 1–3. doi:10.3171/FOC-07/07/E9
- Chau, P.-L. (2000). Ancient Chinese had their fingers on the pulse. *Nature*, 404(6777), 431–431. doi:10.1038/35006734
- Cooke, J., & Lewis, R. (2010). The nature of circulation: The urban political ecology of Chicago's Michigan Avenue Bridge, 1909–1930. *Urban Geography*, 31(3), 348–368. doi:10.2747/0272-3638.31.3.348
- Cortez, R. V., Taddei, C. R., Sparvoli, L. G., Angelo, A. G. S., Padilha, M., Mattar, R., & Daher, S. (2019). Microbiome and its relation to gestational diabetes. *Endocrine*, 64(2), 254–264. doi:10.1007/s12020-018-1813-z
- Crowe, S. (1994). *Garden design*. UK: Garden Art Press.
- de Bell, S., Graham, H., & White, P. C. L. (2020). Evaluating dual ecological and well-being benefits from an urban restoration project. *Sustainability*, 12(2), 695. doi:10.3390/su12020695
- de Castro, E. V. (2019). Exchanging perspectives. *Common Knowledge*, 25(1–3), 21–42. doi:10.1215/0961754X-7299066
- Deckers, J., Lambrecht, B. N., & Hammad, H. (2019). How a farming environment protects from atopy. *Current Opinion in Immunology*, 60, 163–169. doi:10.1016/J.COI.2019.08.001
- Devanesen, D. (2000). Traditional aboriginal medicine practice in the Northern Territory. *International Symposium on Traditional Medicine*, 1–16. <https://www.digitalibrary.health.nt.gov.au/prodjspui/handle/10137/2703>.
- Dickinson, E. (2013). The misdiagnosis: Rethinking "Nature-deficit disorder". *Environmental Communication*, 7(3), 315–335. doi:10.1080/17524032.2013.802704
- Dixon Hunt, J. (2012). *A world of gardens*. London: Reaktion Books Ltd.
- Dobson, J., Birch, J., Brindley, P., Henneberry, J., McEwan, K., Mears, M., ... Jorgensen, A. (2021). The magic of the mundane: The vulnerable web of connections between urban nature and wellbeing. *Cities*, 108, 102989. doi:10.1016/j.cities.2020.102989
- Dobson, J. (2017). Hospital gardens are making a comeback. *BMJ*, 359, j5627. doi:10.1136/bmj.j5627
- Douglas, O., Lennon, M., & Scott, M. (2017). Green space benefits for health and well-being: A life-course approach for urban planning, design and management. *Cities*, 66, 53–62. doi:10.1016/j.cities.2017.03.011
- Dudgeon, P., & Bray, A. (2018). Indigenous healing practices in Australia. *Women & Therapy*, 41(1–2), 97–113. doi:10.1080/02703149.2017.1324191

- Durack, J., Boushey, H. A., & Lynch, S. V. (2016). Airway microbiota and the implications of dysbiosis in Asthma. *Current Allergy and Asthma Reports*, 16(8), 52. doi:10.1007/s11882-016-0631-8
- Escher, B. I., Hackermüller, J., Polte, T., Scholz, S., Aigner, A., Altenburger, R., ... Wambaugh, J. F. (2017). From the exposome to mechanistic understanding of chemical-induced adverse effects. *Environment International*, 99, 97–106. doi:10.1016/j.envint.2016.11.029
- Fischer, P. M., & Maisels, C. K. (1994). The emergence of civilization: From hunting and gathering to agriculture, cities, and the state in the Near East. *American Journal of Archaeology*, 98(4), 776–777. doi:10.2307/506556
- Frumkin, H. (2002). Urban sprawl and public health [Editorial Material]. *Public Health Reports*, 117(3), 201–217. doi:10.1016/S0033-3549(04)50155-3
- Gascon, M., Zijlema, W., Vert, C., White, M. P., & Nieuwenhuijsen, M. J. (2017). Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health*, 220(8), 1207–1221. doi:10.1016/j.ijheh.2017.08.004
- Grahn, P., & Stigsdotter, U. A. (2003). Landscape planning and stress. *Urban Forestry & Urban Greening*, 2(1), 1–18. doi:10.1078/1618-8667-00019
- Gratani, M., Sutton, S. G., Butler, J. R. A., Bohensky, E. L., & Foale, S. (2016). Indigenous environmental values as human values. *Cogent Social Sciences*, 2(1), 1185811. doi:10.1080/23311886.2016.1185811
- Gribben, B., Goodyear-Smith, F., Grobbelaar, M., O'Neill, D., & Walker, S. (2000). The early experience of general practitioners using green prescription. *The New Zealand Medical Journal*, 113(1117), 372–373. <http://www.ncbi.nlm.nih.gov/pubmed/11050901>
- Griffiths, B., & Russell, L. (2018). What we were told: Responses to 65 000 years of Aboriginal history. *Aboriginal History Journal*, 42, 31–53. <https://research.monash.edu/en/publications/what-we-were-told-responses-to-65000-years-of-aboriginal-history> doi:10.22459/AH.42.2018.02
- Haahtela, T. (2019). A biodiversity hypothesis. *Allergy*, 74(8), 1445–1456. doi:10.1111/all.13763
- Hamlin, M. J., Yule, E., Elliot, C. A., Stoner, L., & Kathiravel, Y. (2016). Long-term effectiveness of the New Zealand Green Prescription primary health care exercise initiative. *Public Health*, 140, 102–108. doi:10.1016/j.puhe.2016.07.014
- Hansen, M. M., Jones, R., & Tocchini, K. (2017). Shinrin-Yoku (Forest Bathing) and nature therapy: A state-of-the-art review. *International Journal of Environmental Research and Public Health*, 14(8), 851. doi:10.3390/IJERPH14080851
- Harmsworth, G. R., & Awatere, S. (2013). Indigenous Māori Knowledge and Perspectives of Ecosystems. *Ecosystem Services in New Zealand – Conditions and Trends*, 274–286. https://www.landcareresearch.co.nz/_data/assets/pdf_file/0007/77047/2_1_Harmsworth.pdf.
- Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health*, 35, 207–228. doi:10.1146/annurev-publhealth-032013-182443
- HHARP. (2010). *Fresh Air, even when it's Freezing*. HHARP. <http://www.hharp.org/library/gosh/general/fresh-air.html?fbclid=IwAR2AvvTpbRQHdGr-YOFerSHKX43CHIM4zvsbekt0HwwCVNY3EoPMvsAnuxk>.
- Hill, A. W. (1915). The history and functions of botanic gardens. *Annals of the Missouri Botanical Garden*, 2(1/2), 185. doi:10.2307/2990033
- Hill, O. (1905). *The Kyrle Society*. London: Charity Organisation Review.
- HM Government. (n.d.). Open Spaces Act 1887. Retrieved November 30, 2021, from <https://www.legislation.gov.uk/ukpga/Vict/50-51/32/contents/enacted>.
- Hoskins, J. A. (2004). The green lungs of London. *Indoor and Built Environment*, 13(4), 247–248. doi:10.1177/1420326X04046196
- Hospitalfield. (2016). *The Garden and Garden Buildings at Hospitalfield*. <https://hospitalfield.org.uk/the-garden-and-garden-buildings-at-hospitalfield-the-first-stage-of-capital-development-to-start/>.
- Howell, A. J., Dopko, R. L., Passmore, H.-A., & Buro, K. (2011). Nature connectedness: Associations with well-being and mindfulness. *Personality and Individual Differences*, 51(2), 166–171. doi:10.1016/j.paid.2011.03.037
- Hughes, J., Rogerson, M., Barton, J., & Bragg, R. (2019). Age and connection to nature: When is engagement critical? *Frontiers in Ecology and the Environment*, 17(5), 265–269. doi:10.1002/fee.2035
- Hugh-Jones, S., Ulor, M., Nugent, T., Walshe, S., & Kirk, M. (2023). The potential of virtual reality to support adolescent mental well-being in schools: A UK co-design and proof-of-concept study. *Mental Health & Prevention*, 30, 200265. doi:10.1016/j.mhp.2023.200265
- Hunt, A., Bragg, R., Stancliffe, R., Williams, R., & Preston, B. (2017). *Transforming Mental Health and Dementia Provision with the Natural Environment, Conference Report 2017*. [http://networks.sustainablehealthcare.org.uk/sites/default/files/media/Transforming Mental Health and Dementia Provision with the Natural Environment - Executive Summary_0.pdf](http://networks.sustainablehealthcare.org.uk/sites/default/files/media/Transforming%20Mental%20Health%20and%20Dementia%20Provision%20with%20the%20Natural%20Environment%20-%20Executive%20Summary_0.pdf).
- Ideno, Y., Hayashi, K., Abe, Y., Ueda, K., Iso, H., Noda, M., ... Suzuki, S. (2017). Blood pressure-lowering effect of Shinrin-yoku (Forest bathing): A systematic review and meta-analysis. *BMC Complementary and Alternative Medicine*, 17(1), 409. doi:10.1186/s12906-017-1912-z
- Johnston, F. H., Jacups, S. P., Vickery, A. J., & Bowman, D. M. J. S. (2007). Ecohealth and aboriginal testimony of the Nexus between human health and place. *EcoHealth*, 4(4), 489–499. doi:10.1007/s10393-007-0142-0

- Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169–182. doi:10.1016/0272-4944(95)90001-2
- Katsambas, A., & Marketos, S. (2007). Hippocratic messages for modern medicine (the vindication of Hippocrates). *Journal of the European Academy of Dermatology and Venereology*, 21(6), 859–861. doi:10.1111/j.1468-3083.2007.02231.x
- Kleisiaris, C. F., Sfakianakis, C., & Papathanasiou, I. V. (2014). Health care practices in ancient Greece: The Hippocratic ideal. *Journal of Medical Ethics and History of Medicine*, 7, 4263393. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4263393/>
- Layton-Jones, K. (2018). The enduring benefit of a Victorian legacy. <https://historicengland.org.uk/whats-new/debate/recent/public-parks/the-victorian-legacy/>.
- LEEP. (2022). Land, Environment, Environment and Policy Institute News. Parks and green spaces of England and Wales valued at £25.6 billion a year. Retrieved June 22, 2022, from <https://www.exeter.ac.uk/research/leep/news-and-events/news/articles/parksandgreenspacesofengla.php>.
- LeGates, R. T., & Stout, F. (2011). *The city reader*. New York: Routledge. doi:10.4324/9780203869260
- Liddicoat, C., Sydnor, H., Cando-Dumancela, C., Dresken, R., Liu, J., Gellie, N. J. C., ... Breed, M. F. (2020). Naturally-diverse airborne environmental microbial exposures modulate the gut microbiome and may provide anxiolytic benefits in mice. *The Science of the Total Environment*, 701, 134684. doi:10.1016/J.SCITOTENV.2019.134684
- Loughran, T. (2017). *Shell-shock and medical culture in First World War Britain*. London: Cambridge University Press.
- Lovell, R., Depledge, M., & Maxwell, S. (2018). *Health and the natural environment: A review of evidence, policy, practice and opportunities for the future*. 1–161. <http://randd.defra.gov.uk>.
- Lu, Y., Chen, L., Liu, X., Yang, Y., Sullivan, W. C., Xu, W., ... Jiang, B. (2021). Green spaces mitigate racial disparity of health: A higher ratio of green spaces indicates a lower racial disparity in SARS-CoV-2 infection rates in the USA. *Environment International*, 152, 106465. doi:10.1016/j.envint.2021.106465
- Maller, C., Townsend, M., Leger, L. S., Henderson-Wilson, C., Pryor, A., Prosser, L., & Moore, M. (2009). Healthy parks, healthy people: The health benefits of contact with nature in a park context. *The George Wright Forum*, 26(2), 51–83. https://www.researchgate.net/publication/228644595_Healthy_parks_healthy_people_The_health_benefits_of_contact_with_nature_in_a_park_context.
- Maosew, K., Wongmun, A., & Boonyanuphap, J. (2019). Change in economic value of forest ecosystem services caused by landslides in the upstream region of the lower northern Thailand. *Songklanakarin Journal of Science and Technology*, 41(2), 421–434. doi:10.14456/sjst-psu.2019.53
- Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A. M., ... Fuertes, E. (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental Research*, 158, 301–317. doi:10.1016/j.envres.2017.06.028
- Marmot, M., & Bell, R. (2012). Fair society, healthy lives. *Public Health*, 126(Suppl 1), S4–S10. doi:10.1016/j.puhe.2012.05.014
- Marselle, M. R., Hartig, T., Cox, D. T., de Bell, S., Knapp, S., Lindley, S., ... de Vries, S. (2021). Pathways linking biodiversity to human health: A conceptual framework. *Environment International*, 150, 106420. doi:10.1016/j.envint.2021.106420
- Martin, L., White, M. P., Hunt, A., Richardson, M., Pahl, S., & Burt, J. (2020). Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours. *Journal of Environmental Psychology*, 68, 101389. doi:10.1016/j.jenvp.2020.101389
- Mayer, F. S., & Frantz, C. M. P. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, 24(4), 503–515. doi:10.1016/j.jenvp.2004.10.001
- McLennan, V., & Khavarpour, F. (2004). Culturally appropriate health promotion: Its meaning and application in Aboriginal communities. *Health Promotion Journal of Australia*, 15(3), 237–239. doi:10.1071/HE04237
- Mell, I. C. (2017). Green infrastructure: Reflections on past, present and future praxis. *Landscape Research*, 42(2), 135–145. doi:10.1080/01426397.2016.1250875
- Mills, J. G., Brookes, J. D., Gellie, N. J. C., Liddicoat, C., Lowe, A. J., Sydnor, H. R., ... Breed, M. F. (2019). Relating urban biodiversity to human health with the 'Holobiont' concept. *Frontiers in Microbiology*, 10, 550. doi:10.3389/fmicb.2019.00550
- Ministry of Health. (2004). *Tracking the Obesity Epidemic: New Zealand 1977–2003*. <http://www.moh.govt.nz/phi>.
- Morandi, A., Tosto, C., Sartori, G., & Roberti di Sarsina, P. (2011). Advent of a link between Ayurveda and Modern Health Science: The proceedings of the First International Congress on Ayurveda, "Ayurveda: The Meaning of Life – Awareness, Environment, and Health" March 21–22, 2009, Milan, Italy. In *Evidence-based complementary and alternative medicine* (Vol. 2011, p. 929083). London: Hindawi Limited. doi:10.1155/2011/929083
- Morgan, J. (2015). Indigenous Australians and the struggle for health equality. *The Lancet. Respiratory Medicine*, 3(3), 188–189. doi:10.1016/S2213-2600(15)00045-4
- Morris, A. E. J. (2013). *History of urban form before the industrial revolution*. Milton Park: Routledge. doi:10.4324/9781315841199
- Mwangi, W., Figueiredo, P. D., & Criscitiello, M. F. (2016). One health: Addressing global challenges at the nexus of human, animal, and environmental health. *PLoS Pathogens*, 12(9), e1005731. doi:10.1371/JOURNAL.PPAT.1005731

- Nath, T. K., Zhe Han, S. S., & Lechner, A. M. (2018). Urban green space and well-being in Kuala Lumpur, Malaysia. *Urban Forestry & Urban Greening*, 36, 34–41. doi:10.1016/j.ufug.2018.09.013
- Natural England. (2021). *The people and nature survey for England: Data and publications from Adults survey year 1 (April 2020–March 2021) (Official Statistics) main findings*.
- NHS England. (2014). *Five year forward view*. October. <https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf>.
- NICE guideline. (2021). *Chronic pain (primary and secondary) in over 16s: Assessment of all chronic pain and management of chronic primary pain*. <https://www.nice.org.uk/guidance/ng193/chapter/Recommendations>.
- Nisbet, E. K. (2013). *Results of the David Suzuki Foundation 30x30 Nature Challenge English Survey*. 1–18. <https://davidssuzuki.org/wp-content/uploads/2013/07/results-30x30-nature-challenge-english-survey-may-2013.pdf>.
- Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The nature relatedness scale. *Environment and Behavior*, 41(5), 715–740. doi:10.1177/0013916508318748
- O’Callaghan-Gordo, C., & Antó, J. M. (2020). COVID-19: The disease of the anthropocene. *Environmental Research*, 187, 109683. doi:10.1016/j.envres.2020.109683
- Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine*, 15(1), 18–26. doi:10.1007/s12199-009-0086-9
- Patel, A., Schofield, G. M., Kolt, G. S., & Keogh, J. W. (2011). General practitioners’ views and experiences of counselling for physical activity through the New Zealand Green Prescription program. *BMC Family Practice*, 12(1), 119. doi:10.1186/1471-2296-12-119
- Persson, E. (2016). Option value, substitutable species, and ecosystem services. *Environmental Ethics*, 38(2), 165–181. doi:10.5840/enviroethics201638214
- Prescott, S., & Logan, A. (2018). Larger than life: Injecting hope into the planetary health paradigm. *Challenges*, 9(1), 13. doi:10.3390/challe9010013
- Pritchard, A., Richardson, M., Sheffield, D., & McEwan, K. (2020). The relationship between nature connectedness and Eudaimonic well-being: A meta-analysis. *Journal of Happiness Studies*, 21(3), 1145–1167. doi:10.1007/s10902-019-00118-6
- Public Health England. (2020). *Improving access to greenspace*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904439/Improving_access_to_greenspace_2020_review.pdf.
- Redvers, N., Yellow Bird, M., Quinn, D., Yunkaporta, T., & Arabena, K. (2020). Molecular decolonization: An Indigenous microcosm perspective of planetary health. *International Journal of Environmental Research and Public Health*, 17(12), 4586. doi:10.3390/ijerph17124586
- Redvers, J. (2020). “The land is a healer”: Perspectives on land-based healing from Indigenous practitioners in northern Canada. *International Journal of Indigenous Health*, 15(1), 90–107. doi:10.32799/ijih.v15i1.34046
- Redvers, N., Nadeau, M., & Prince, D. (2020). Urban land-based healing: A Northern intervention strategy. *International Journal of Indigenous Health*, 16(2), 33177. doi:10.32799/ijih.v16i2.33177
- Redvers, N. (2021). The determinants of planetary health. *The Lancet. Planetary Health*, 5(3), e111–e112. doi:10.1016/S2542-5196(21)00008-5
- Renz, H., Holt, P. G., Inouye, M., Logan, A. C., Prescott, S. L., & Sly, P. D. (2017). An exposome perspective: Early-life events and immune development in a changing world. *The Journal of Allergy and Clinical Immunology*, 140(1), 24–40. doi:10.1016/J.JACI.2017.05.015
- Reznick, J. (2004). *Healing the nation: Soldiers and the culture of caregiving in Britain during the Great War*. New York: Manchester University Press.
- Rigolon, A., Browning, M. H. E. M., McAnirlin, O., & Yoon, H. (V). (2021). Green space and health equity: A systematic review on the potential of green space to reduce health disparities. *International Journal of Environmental Research and Public Health*, 18(5), 2563. doi:10.3390/ijerph18052563
- Robinson, J. M., Gellie, N., MacCarthy, D., Mills, J. G., O’Donnell, K., & Redvers, N. (2021). Traditional ecological knowledge in restoration ecology: A call to listen deeply, to engage with, and respect Indigenous voices. *Restoration Ecology*, 29(4), e13381. doi:10.1111/rec.13381
- Robinson, J. M., & Jorgensen, A. (2020). Rekindling old friendships in new landscapes: The environment–microbiome–health axis in the realms of landscape research. *People and Nature*, 2(2), 339–349. doi:10.1002/pan3.10082
- Robinson, J. M., Mills, J., & Breed, M. (2018). Walking ecosystems in microbiome-inspired green infrastructure: An ecological perspective on enhancing personal and planetary health. *Challenges*, 9(2), 40. doi:10.3390/challe9020040
- Salmón, E. (2000). Kincentric ecology: Indigenous perceptions of the human-nature relationship. *Ecological Applications*, 10(5), 1327–1332. doi:10.1890/1051-0761(2000)010[1327:KEIPOT]2.0.CO;2
- Sbihi, H., Boutin, R. C., Cutler, C., Suen, M., Finlay, B. B., & Turvey, S. E. (2019). Thinking bigger: How early-life environmental exposures shape the gut microbiome and influence the development of asthma and allergic disease. *Allergy*, 74(11), 2103–2115. doi:10.1111/all.13812
- Selin, H. (1997). *Encyclopaedia of the history of science, technology, and medicine in non-western cultures*. Amsterdam: Kluwer Academic.

- Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports*, 6, 28551. doi:10.1038/srep28551
- Shanahan, D. F., Fuller, R. A., Bush, R., Lin, B. B., & Gaston, K. J. (2015). The health benefits of urban nature: How much do we need? *BioScience*, 65(5), 476–485. doi:10.1093/biosci/biv032
- Sokol, H., Leducq, V., Aschard, H., Pham, H.-P., Jegou, S., Landman, C., ... Beaugerie, L. (2017). Fungal microbiota dysbiosis in IBD. *Gut*, 66(6), 1039–1048. doi:10.1136/GUTJNL-2015-310746
- Stamatakis, E., Hamer, M., & Murphy, M. H. (2018). What Hippocrates called 'Man's best medicine': walking is humanity's path to a better world. *British Journal of Sports Medicine*, 52(12), 753–754. doi:10.1136/BJSPORTS-2018-099371
- Stewart, S. L. (2008). Promoting Indigenous mental health: Cultural perspectives on healing from Native counsellors in Canada. *International Journal of Health Promotion and Education*, 46(2), 49–56. doi:10.1080/14635240.2008.10708129
- Sturm, R., & Cohen, D. (2014). Proximity to urban parks and mental health. *The Journal of Mental Health Policy and Economics*, 17(1), 19–24. <http://www.ncbi.nlm.nih.gov/pubmed/24864118>
- Sudimac, S., Sale, V., & Kühn, S. (2022). How nature nurtures: Amygdala activity decreases as the result of a one-hour walk in nature. *Molecular Psychiatry*, 27(11), 4446–4452. doi:10.1038/s41380-022-01720-6
- Sullivan, W. C., Frumkin, H., Jackson, R. J., & Chang, C.-Y. (2014). Gaia meets asclepius: Creating healthy places. *Landscape and Urban Planning*, 127, 182–184. doi:10.1016/j.landurbplan.2014.03.005
- Suvajdžić, L., Dendić, A., Sakač, V., Čanak, G., & Dankuc, D. (2016). Hippocrates-the father of modern medicine Hipokrat-otac moderne medicine. *Vojnosanitetski Pregled*, 73(12), 1181–1186. doi:10.2298/VSP1502121315
- Tester-Jones, M., White, M. P., Elliott, L. R., Weinstein, N., Grellier, J., Economou, T., ... Fleming, L. E. (2020). Results from an 18 country cross-sectional study examining experiences of nature for people with common mental health disorders. *Scientific Reports*, 10(1), 19408. doi:10.1038/s41598-020-75825-9
- Thwaites, K., Helleur, E., & Simkins, I. M. (2005). Restorative urban open space: Exploring the spatial configuration of human emotional fulfilment in urban open space. *Landscape Research*, 30(4), 525–547. doi:10.1080/01426390500273346
- Timmis, K., Cavicchioli, R., Garcia, J. L., Nogales, B., Chavarría, M., Stein, L., ... Harper, L. (2019). The urgent need for microbiology literacy in society. *Environmental Microbiology*, 21(5), 1513–1528. doi:10.1111/1462-2920.14611
- Tountas, Y. (2009). The historical origins of the basic concepts of health promotion and education: The role of ancient Greek philosophy and medicine. *Health Promotion International*, 24(2), 185–192. doi:10.1093/heapro/dap006
- Tsermoulas, G., Aidonis, A., & Flint, G. (2014). The skull of Chios: Trepanation in Hippocratic medicine. *Journal of Neurosurgery*, 121(2), 328–332. doi:10.3171/2014.4.JNS131886
- Tsunetsugu, Y., Park, B.-J., & Miyazaki, Y. (2010). Trends in research related to “Shinrin-yoku” (taking in the forest atmosphere or forest bathing) in Japan. *Environmental Health and Preventive Medicine*, 15(1), 27–37. doi:10.1007/s12199-009-0091-z
- Van den Berg, A. E. (2017). From green space to green prescriptions: Challenges and opportunities for research and practice. *Frontiers in Psychology*, 8, 268. doi:10.3389/fpsyg.2017.00268
- Van den Bosch, M., & Sang, Å. O. (2017). Urban natural environments as nature-based solutions for improved public health—A systematic review of reviews. *Environmental Research*, 158, 373–384. doi:10.1016/j.envres.2017.05.040
- Vermeulen, R., Schymanski, E. L., Barabási, A.-L., & Miller, G. W. (2020). The exposome and health: Where chemistry meets biology. *Science*, 367(6476), 392–396. doi:10.1126/SCIENCE.AAY3164
- Vicenzotti, V., & Waterton, E. (2021). Practicing care in a global pandemic. *Landscape Research*, 46(1), 1–7. doi:10.1080/01426397.2021.1873485
- Ward Thompson, C. (2011). Linking landscape and health: The recurring theme. *Landscape and Urban Planning*, 99(3–4), 187–195. doi:10.1016/j.landurbplan.2010.10.006
- Watanabe, K., Matsuura, K., Gao, P., Hottenbacher, L., Tokunaga, H., Nishimura, K., ... Witt, C. M. (2011). Traditional Japanese Kampo Medicine: Clinical research between modernity and traditional medicine – The state of research and methodological suggestions for the future. *Evidence-Based Complementary and Alternative Medicine*, 2011, 1–19. doi:10.1093/ecam/nea067
- Wendelboe-Nelson, C., Kelly, S., Kennedy, M., & Cherrie, J. (2019). A scoping review mapping research on green space and associated mental health benefits. *International Journal of Environmental Research and Public Health*, 16(12), 2081. doi:10.3390/ijerph16122081
- WHO. (2002). *Physical inactivity is a leading cause of disease and disability, warns WHO*. <https://www.who.int/media-centre/news/releases/release23/en/>
- WHO. (2017). *Urban Green space interventions and health review of impacts and effectiveness*. World Health Organization. <http://www.euro.who.int/en/health-topics/environment-and-health/urban-health/publications/2017/urban-green-space-interventions-and-health-a-review-of-impacts-and-effectiveness.-full-report-2017>
- Wild, C. P. (2005). Complementing the genome with an “exposome”: The outstanding challenge of environmental exposure measurement in molecular epidemiology. *Cancer Epidemiology, Biomarkers & Prevention*, 14(8), 1847–1850. doi:10.1158/1055-9965.EPI-05-0456
- Woudstra, J. (2018). Designing the garden of Geddes: The master gardener and the profession of landscape architecture. *Landscape and Urban Planning*, 178, 198–207. doi:10.1016/j.landurbplan.2018.05.023