



# The Impact of Forests and Open Landscapes on the Physical and Mental Health of the Public

**Keren Kaplan Mintz <sup>1, 2</sup> | Ofira Ayalon <sup>2, 3</sup> | Orly Nathan <sup>3</sup>  
Tzipi Eshet <sup>3</sup> | Asaf Karavani <sup>4</sup>**

---

1 Shamir Research Institute  
2 University of Haifa  
3 Samuel Neaman Institute  
4 Forest Department, KKL-JNF

## Abstract

The Forest Management Policy of Israel (FMP) provides an obligatory professional basis for managing Israel's forests in a goal-oriented and sustainable manner, while stressing the importance of the cultural services they supply. This article presents a literature review as part of a study funded by Keren Kayemeth Le-Israel - Jewish National Fund's (KKL-JNF) Forestry Division, focusing on the contribution of KKL-JNF forests to the physical and mental health of visitors and on the cultural and psychological services they supply. The development of knowledge in this field, and its adaptation to Israeli culture, will maximize the contribution to public health by: (1) promoting and encouraging informed and focused recreational activities (2) promoting cooperation with civil society and organizations engaged in health, education, and community activities (3) establishing the importance of forest conservation and its economic benefits in the eyes of the public and decision-makers. In addition, based on the importance of promoting physical

and emotional health and cultural services to all population groups, the study also examines the differences between Jewish and Arab society in Israel concerning the benefits derived from forests, and provides recommendations from a multicultural perspective.

The article provides a broad survey of the beneficial effects of time spent in forests on health and emotional well-being and of how recreational, cultural, and sports activities benefit their participants. The reviewed literature proposes five main channels that explain nature's contribution to promoting physical and emotional health: reducing stress and cognitive burden; an environment (including nature, in general, and forests, in particular) that encourages physical activity; an environment that encourages social ties; better air quality in nature, and specifically forests; and the effect of natural substances, such as essential oils emanating from the trees that improve health.

The first part of the article reviews the forest's contribution to emotional and physical health, the effect of being in forests on emotional stress, positive and negative emotions and sense of happiness, the effect of being in forests on level of attentiveness and other cognitive measures, and the impact of visiting forests have on physical health parameters. The second part discusses the factors explaining the contribution of forests to emotional and physical health, and the third part demonstrates applications for promoting well-being based on the research findings.

### Keywords

Physical health, mental health, connection to nature, social connections

The World Health Organization (WHO) defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 2006). During the past decades, it has become widely accepted that human health is directly related to lifestyle. We now understand that many of the illnesses people suffer from in the modern world are related to their lifestyle. The connection between body and mind is also understood, particularly between mental stress and bodily phenomena and various diseases (Engel, 1977; Hartig et al., 2014). Extensive literature in the psychological and medical world points to the benefits of spending time in nature in general, and in forests specifically, for human mental and physical health (Kaplan, 1995; Russell, 2012; Kuo, 2015; Donnelly and MacIntyre, 2019). Furthermore, over the years various therapeutic and educational approaches have developed based on the realization of the importance of the connection to nature, such as therapeutic gardening, forest meditation and forest education (Bratman et al., 2012; Russell, 2012; Donnelly and MacIntyre, 2019). These approaches broaden our understanding of the contribution that contact with nature and forests make to health, and of possible implementations in KKL-JNF forests. Tourism based on the health benefits of spending time in nature has also begun to develop in recent years, as can be found in Japan, Italy and the United States (Ladner, 2017; Association of Nature and Forest Therapy Guides and Programs, 2020). Another important and significant aspect of the benefits of forests to people are the cultural services they provide as a major element in the ecosystem services provided by open

spaces, according to the Millennium Ecosystem Assessment (2004). These services include non-material benefits (capabilities, experiences and encounters) that people get from forests (thanks to people-nature connections) via spiritual enrichment, cognitive development, physical and mental health, contemplation/reflection, esthetic recreation and experience, including, for example, knowledge systems, social relations and esthetic values. Forests throughout the world serve as major and central recreational sites, venues for sports and leisure activity and family recreation. Along with provisional and regulatory services, government agencies and private bodies have begun to appreciate the significance of the cultural services provided by forests (Bell, 2009; Nesbitt et al. 2017; Dodev et al., 2020).

The appreciation of the importance of nature for mental health led to the development of a new important concept that links the veteran concept of ecosystem services and the psychological benefits for people: psychological ecosystem services (Bratman et al., 2012, 2019).

In the following review, we will discuss the various aspects of nature's contribution in general, and forests specifically, to physical and mental health and possible explanations provided in the scientific literature.

### The influence of time spent in the forest on mental stress, positive and negative feelings and happiness

Thousands of studies have been conducted in the last four decades on the contribution of spending time in nature in general, and in forests specifically, to the reduction of mental stress and the increase of positive feelings and happiness. The fact that spending time in nature reduces the levels of mental stress and contributes to positive feelings and happiness has been consistently proven (Hartig et al., 2014). The results show that spending time in nature and walking outdoors has a beneficial effect on people.

It has been found that contact with nature contributes to promoting a higher level of positive feelings and happiness, and to reducing mental stress, which is expressed in both self-reported measures and physiological parameters (Hartig et al., 1991; Park et al., 2011; Li et al., 2016; Seymour, 2016; Bach Pagès et al., 2020). Studies show that in situations of unusual cognitive or mental stress, nature has a beneficial effect on people (Hartig et al., 2003; Tyrväinen et al., 2019). The benefits of contact with nature in general and forests in particular, versus being in the city, come from two major paths: a) the relative benefits contact with nature per se has

with reducing negative feelings and stress and in promoting positive feelings, b) just being in nature affects the feeling of increased stress and negative feelings caused by urban factors such as noise and pollution.

More than half of human society now lives and works in urban environments, so that daily contact with open areas can serve as a coping mechanism for the mental and cognitive overload felt in daily life (Hartig et al., 2003; Tyrväinen et al., 2019; Grilli and Sacchelli, 2020).

In addition to studies conducted on people while spending time in nature, there are also studies based on broad-distribution questionnaires, which examined possible associations between the time a person spends in nature and mental and emotional parameters. In these studies, respondents were asked to note the amount of time they spend in nature within a given period, and to report various mental and physical health parameters (Hug et al., 2009; Shanahan et al., 2016; White et al., 2019; Grilli and Sacchelli, 2020).

An extensive study conducted in England that examined the relation between the amount of time spent weekly in nature and mental and physical health parameters, found that 120 minutes a week is the ideal time to spend in nature, in order to gain maximal benefit. Less time had no significant benefit and more time did not significantly increase the benefit. The researchers noted that the time could be divided in various manners throughout the week: one long outing or a number of small ones (White et al., 2019).

### **The effect of time spent in the forest on the level of concentration and other cognitive parameters**

Contact with nature in general, and with forests in particular also contributes to cognitive aspects. Cognitive skills in studies are measured by testing attention and concentration capabilities, such as tasks that require language editing, block-design tests and memory tests. Just as nature reduces stress, time spent in nature affects cognitive function, and has been shown to improve concentration and other cognitive abilities (Hartig et al., 1991; Hartig and Staats, 2006; Bratman et al., 2012; Gidlow et al., 2016 and Bratman et al., 2019). Studies that evaluated the correlation between time spent in nature and attention parameters, found that extended exposure to nature (whether by frequent visits or repeated visits, but not one-time visits) have a positive effect on attention parameters in both children suffering from attention deficit disorders (ADHD) and in children without this disorder (Taylor et al., 2002; Taylor and Kuo,

2011). Consequently, learning environments near trees and vegetation during the school day have a positive effect on attention-deficit disorders. The more greenery there is and the more opportunities to be active in nature, the lower the level of attention-deficit disorder symptoms in pre-school and school children (Mårtensson et al., 2009; Di Carmine and Berto, 2020).

### **The effect of forest visits on physical health parameters**

Over the years, many studies have indicated the benefits of spending time in nature in general, and in forests specifically on the physical health of the public. There follows a description of the major findings on the topic:

#### **Benefits to cardiovascular health**

Despite the progress in preventing and treating heart disease, it is still one of the major causes of mortality in the world. Environmental hazards are a major part of infirmity; therefore, a green environment can significantly reduce morbidity (Yeager et al., 2020). One of these studies was performed by Li et al. (2011) and examined blood pressure and cardio-vascular parameters in a group of men walking in an urban environment and a week later in the forest. The blood pressure levels in the participants were significantly lower in forests than in urban environments. Urine adrenaline levels were also significantly lower following a walk in the forest than their levels before the walk. Other studies that focused on EKG parameters also found advantages to walking in the forest over walking in the city. The overall conclusion of these studies was that walking in a green environment reduces the activity of the sympathetic nervous system and leads to higher level of tranquility than similar activity in the city (Kobayashi et al., 1999; Li et al., 2011). An extensive review paper that dealt with specific effects of forests on physical and mental health indicated that spending time in the forest promotes human health and has a positive effect on the cardiovascular system and other systems as well (Meyer-Schulz and Bürger-Arndt, 2019).

#### **Beneficial effect on hormone levels**

The hormone cortisol is the major element secreted by the body as a physiological response to stress, therefore decreases in its levels affects the activity of the autonomous nervous system. Decreases in cortisol secretion create a feeling of relaxation, and have been observed in visitors to conifer forests and broad-leaved forests (Li et al., 2010;

Bach Pagès et al., 2020). Furthermore, physical activity in forests (e.g. walking) has a greater effect on reducing saliva cortisol levels than a passive outing, such as observing in the forest (Park et al., 2010). It was also found that a multi-week plan for treatment in the forest contributed to reducing cortisol levels, compared to a control group (Meyer-Schulz and Bürger-Arndt, 2019).

### **Beneficial effects on weight gain and obesity**

A review of 57 epidemiological studies on the correlation between the extent of green spaces in residential areas and weight gain (Luo et al., 2020) found that more than half the studies reported a positive correlation between increased accessibility to green spaces and a lower probability of obesity or weight gain in different population groups, of varying ages from children to older adults. Seven epidemiological studies showed a positive correlation between the amount of green spaces in the area of residence and a low BMI (body mass index) in the subjects of the study. Among other things, an association was found between the amount of vegetation in the area and various weight gain indexes, such as BMI, waist size and the percentage of fat in the body (Sander et al., 2017).

### **Beneficial effects on people with sensory and motor disabilities**

Recently studies have been published on population groups with special needs and their association with green environments. The results stress the need for additional research that will focus on the constraints facing people with mobility disabilities and their contact with natural spaces. The scope of the disabilities is very broad and it is difficult to include the diverse needs in this short review. Nevertheless, existing studies on the subject show that one of the challenges facing people with special needs is related to frequency of their visits to forests. A survey conducted in Denmark on the extent of greenspace use, showed that the frequency of visits of people with disabilities in forests is very low. More than 40% never visited a forest at all, or did so only rarely (Stigsdotter et al., 2018).

Qualitative studies support these data and express the voice of people with disabilities who describe the numerous barriers and constraints that prevent them from visiting nature, as opposed to the feelings of tranquility and empowerment expressed by those who are able to be in direct contact with nature (Corazon et al., 2019). Furthermore, it was found that the time spent by these populations in forests contributed to

their feelings of belonging to the community and to society, as forests are spaces that bring people together allowing them to meet others and enjoy their company. On the other hand, forests also allowed them to escape and distance themselves from other people (O'Brien and Morris, 2014).

### **Forest Bathing – Shinrin-yoko**

*Shinrin-yoko* – Forest Bathing – is entering deep into the forest and walking in it in order to renew physical and mental energy and rehabilitate and cure health issues resulting from our sedentary lifestyle. Forest bathing is an ancient practice in Japan and the new name given to it by Tomahidu Akiyama from the Japanese Forest Service was intended to facilitate a number of practical recommendations for achieving welfare and mental and physical health. These include walking, sitting, observing and exercising among trees; eating balanced meals from local and organic food sources, and, if possible, bathing in warm springs (Lawton, 2017; Park et al. 2010). Therefore, forest bathing can serve as a means of reducing stress and could help with physiological relaxation, i.e. increase the activity of the parasympathetic nervous system. This increase is usually observed in relaxation caused by music or meditation (Morita et al., 2007).

"Forest therapy" is very similar to "forest bathing". It includes activities in both an enclosed space and in a forest for two days, whose objective is to refresh, relax and restore attention. This method too is beginning to receive research attention. In Seoul, a study was conducted on 61 people who suffered chronic widespread pain. During the study, heart rate and NK cells (natural killer cells, whose function is to attack infected body cells) were recorded. Thirty-three of them spent time in the forest following treatment and reported significant physiological improvement, a significant decrease in pain and depression and an improvement in quality of life. Their measurements showed reduced heart rate and increased NK cell activity. Forest therapy is apparently an effective intervention for mitigating pain and psychological and physiological symptoms related to chronic pain syndromes (Han et al. 2016) and even for preventing depression (Rosa et al., 2021).

### **Beneficial effect on recuperating patients**

A study conducted between 1972 and 1981 showed a considerable post-operative improvement in the health of people exposed to tree scenery from their window, a decrease in pain levels and shorter recuperation (Seymour, 2016). The hospitalization time of patients exposed to green scenery was shorter, their mood was better and they required less painkillers (Ulrich, 1981). Ulrich's study was the basis of the NHS Forest project, in which over 65,000 trees were planted near more than 150 medical centers that joined the project between 2008 and 2020 (Centre for Sustainable Healthcare, 2021). The main objectives of the project were to increase the use of forests and parks near medical centers to improve patient recuperation and rehabilitation, to enhance staff welfare, to plant forests near medical centers and to create a pool of scientifically based projects on the effect of nature and forests on health (Centre for Sustainable Healthcare, 2018). This study and others conducted in its wake, contributed greatly to modifying architectural planning of new hospitals, based on the assumption that landscaping and vegetation can be effective means for improving patient recuperation (Anderson, 2019).

### **Factors explaining the contribution of forests to mental and physical health**

Two major psychological factors explain the beneficial contribution of nature to reducing stress and restoring attention. Both theories claim that contact with nature reduces mental and cognitive load, but provide different explanations regarding the mechanism. The first theory considers attention resources as the primary factor for reducing stress and emotional improvement. The second one considers stress reduction as the primary factor in improving the state of cognitive resources.

**The Attention Restoration Theory – ART** proposed by Rachel and Stephen Kaplan (Kaplan and Kaplan, 1989; Kaplan, 1995; Tyrväinen et al., 2019) believes that nature is the source for restoring people's attention resources, therefore spending time in nature can lead to cognitive and emotional restoration. According to the theory, daily life includes many efforts of directed attention, which is directed to something that naturally would not draw attention. This could be a learning task, a work task or various situations during a day that require attention or extra care. This sort of directed attention requires investing resources, and when it occurs over a long

time, it leads to tiredness, concentration difficulties and nervousness. Nature is filled with stimuli that attract the eye naturally (e.g. sunlight between trees or the sight of a sunset), and which attract attention delicately in a manner that does not require intensive investment of cognitive resources. The experience of spending time in the city, on the other hand, involves devoting focused attention to sights, whether in order to avoid getting harmed (e.g. being careful of moving cars), or as part of the demanding day to day life that requires focused attention at work and in inter-personal relations. Therefore, while urban life requires ongoing investment of attention resources, which leads to tiredness and nervousness, spending time in nature is a restorative experience for our cognitive, as well as for our spiritual resources (Bratman et al., 2012; Tyrväinen et al., 2019).

The second major theory is the Stress Reduction Theory proposed by Ulrich (1983). This theory is based on an evolutionary assumption according to which humans developed in a natural environment that provided the basic and necessary conditions for survival. This instilled in humans the concept of the natural environment as a source of plenty with the natural potential to support their survival. Consequently, the sight of nature has a healing effect on people, as it is unconsciously conceived as a "safe haven" with the best potential for survival. According to the theory, this leads to automatic psychological and biological processes that reduce feelings of mental stress and negative feelings and increase positive feelings (Ulrich, 1983; Bratman et al., 2012; Tyrväinen et al., 2019).

In addition to these two theories, a number of other explanations appear in the literature regarding how spending time in nature promotes spiritual and cognitive welfare:

### **Social interactions**

Humans are social organisms and the psychological research literature claims that social relations are essential for human development and health. Many concepts, which are part of theories in developmental, clinical and social psychology note the great significance of connecting with others for developing mental health and proper development, including "connection", "social norms", "the need to belong" and more (Ryan and Deci, 2000; Holt-Lunstad et al., 2010). One of the advantages of nature is that in some cases, outings in nature take place with a group, and therefore, some of the benefits of nature are probably a result of the fact that it allows quality time and positive experiences in a social and family framework. Thus, part of the enjoyment is not just from

contact with nature but also with the social opportunities it creates (White et al., 2013; Hartig et al., 2014). Despite the logic of the issue, research on the topic is limited (Hartig et al., 2014) up to now. Researchers that did study the subject focused mainly on evaluating the statistical relation between nature in the subject's area of residence and the feeling of social solidarity and support, and only a few studies were conducted on people who actually visit forests (Sugiyama et al., 2008; Maas et al., 2009).

### **Physical and sport activity in forests**

Another reason presented in the literature for the beneficial effect of nature in general, and forests specifically on human health, is that they encourage physical activity. Regular physical activity can reduce the risk of early death, morbidity and various illnesses that have been mentioned above. Moreover, limited physical activity encourages endorphin secretion, hormones that also contribute to improving psychological parameters (Maugeri and Musumeci, 2021). Furthermore, lack of physical activity is one of the causes of obesity, which is among the public health risks in urban societies. Recently the term "green and blue exercise" has become common in western society in the context of activity in open areas – physical activity in green areas such as parks and forests and in the vicinity of water sources, and even in them, such as swimming. This combination between exercise and nature offers inexpensive and accessible solutions to public health challenges, particularly in the fields of mental health and obesity (Donnelly and MacIntyre, 2019).

An active visit to a forest or park is defined as a visit that contains sufficient physical activity that agrees with the public health recommendations – at least 20 minutes of high intensity vigorous activity or at least 30 minutes of moderate activity (Tesler et. al., 2018). Various studies have shown that there is a significant performance gap between physical activity in natural surroundings outside compared to physical activity in enclosed areas.

Among other things, physical activity in natural surroundings improves positive feelings, and reduces feelings of stress, confusion, anger, etc. Moreover, participants in these activities report feelings of greater pleasure and satisfaction from outdoor activity (Thompson, 2007; Hug et al., 2009; USA Department of Agriculture, 2018). Plaut et al. (2015) emphasized that the usual tendency is to target programs that encourage active lifestyle in forests at the general public. Nevertheless, it is particularly important to focus these programs on specific target populations and in areas in which health inequality is most significant, e.g. families with small

children, people with disabilities, peripheral disadvantaged communities, the elderly, etc. This approach is even more important as in the mapping they conducted, they found, that the average number of recreational and sport facilities such as pedestrian paths, bicycle trails, play and active recreation installations, and healthy walking tracks, is lower in northern Israel than in the rest of the country.

In Britain the research agency of the Forestry Commission conducted more than 30 studies and social and economic projects to understand the contribution of forests to increasing mental and physical wellbeing by promoting physical activity as well. A meta-analysis of data from the studies found that activity conducted in woodlands and forests has the most significant health benefits (O'Brien and Morris, 2014).

In 2011, the U.S. Forest Service published a study that assessed the contribution of forests to public health from the aspect of providing opportunities for physical activity and spending time in nature. The data was collected from a database that tracked forest visitors between 2004 and 2009. The study assessed the various visitor activities in the forest using METS units (measurements to estimate activity intensity). The study showed that forests probably contribute significantly to physical activity of the American public, and it is possible to improve public health by continuous focused investment in infrastructure for physical activity. Activities in the forest that have METS scores over 4 include hikes, excursions and walks (about 20% of the activity), skiing (19%) and biking (Kline et al., 2011). Despite the differences between Israel and the US, regarding skiing for example, we can learn from the methodology of data and information collection and their analysis (US Department of Agriculture and US Forest Service, n.d.).

### **Sensory exposure**

As with physical activity and healthy eating, contact with nature contributes to controlling circadian body rhythms (biological clock) and to physical vitality. Studies show that neurological rhythms improve after grounding or physical contact with the earth's surface: by walking barefoot on the ground and sitting outside the electrons in the ground pass into the body and control the circadian rhythms (Chevalier et al., 2012). The concept that the presence of plants and vegetation in human surroundings can have health benefits is relatively new (Yeager et al., 2020). It is based on the biologist Edward Wilson's biophilia (our natural affinity for life) hypothesis, according to which humans have an innate tendency to look for connections with nature and wonder at it by observing natural phenomena related to

growth of plants and trees (Wilson, 1984). Therefore, the connection with natural materials and experiences in nature has a positive influence on health (Ryan et al., 2014; Donelly and MacIntyre, 2019). The exposure to artificial urban environments can have a negative on human health, unlike green surroundings that have been found to have a positive effect on the general health of residents (Lee et al., 2011). Figure 1 presents the factors linking outings in nature and improvement in physical health and mental well-being.

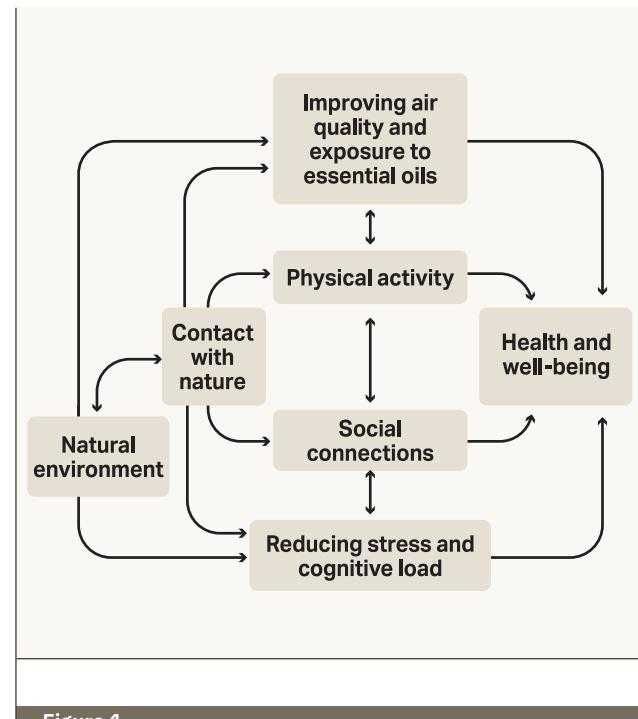
### Applications to promote health

The potential contribution of forests and open spaces to promote and improve public health will increase with the help of its integration in other types of benefits that forests provide to humans, such as preserving biodiversity, mitigating greenhouse gas emissions, adaptation to climate change and other provisioning and regulating services (Karjalainen et al., 2010; Grilli and Saccelli, 2020).

A major example of a project focusing on the issue of health and forests, is the European Union project that started in 2004, Forests, Trees and Human Health and Well-Being, COST Action E39 (Forest Research and O'Brien, 2021). Hundreds of researchers from the EU and other countries (including Tsipi Eshet, one of the authors of this paper) gathered to promote the understanding of how forests contribute to health, and to assess if the field of forestry can help promote a healthier lifestyle and improved mental health. As part of the project, reports were prepared on the status of research and initiatives in all the EU countries, on national public health policy and on the priorities of the countries, as well as an analysis of the potential possibilities in the field of forestry. The project promoted the concept of forests as a resource that improves the quality of life and health of the population (Nilsson, 2011).

### The Current Situation and the Future Potential in Israel

The Forestry Management Policy in Israel (Osem et al., 2014) set the professional benchmark for goal-oriented and sustainable management of Israel's forests, and emphasized the importance of the cultural services they provide. The contribution forest make to physical and mental health of Israel's population is a major element of these cultural services. The development of knowledge of the subject in Israel and its adaptation to the manner in which the local population uses its open spaces, will allow the latent health potential in forests to be realized in various manners.



**Figure 1**

The factors that mediate between outings in nature and benefits to health and mental well-being. The data is from several sources: Hartig et al., 2003, 2014; Li et al., 2010, 2011, 2016; Tyrväinen et al., 2019.

### Making forests accessible to the public

Accessibility and encouraging reasonable public activity will promote physical and mental health while preserving the ecological values in the forest. KKL-JNF managed forests are open free of charge to the public at all times. This makes them a magnet for the public, and consequently the open spaces with the greatest potential to promote physical and mental activity in the public. As part of its involvement in preparing forest master plans KKL-JNF promotes planning that takes a broad view of the various perspectives of visitor experience in forest. Thus, developing central gathering areas at the entrance to forests, near main thoroughfares, allows for extensive visitor infrastructure and intensive management, maximal accessibility (including for special needs population: physical and cognitive disabilities, visual and hearing impairments, and the like) and reaching forests via public transport (if available). Intelligent adaptive development of infrastructures in forests has great potential to encourage physical and sportive activity, such as running, walking, off-road biking and climbing.

## Development and intensification of focused collaborations that promote public health

Focused collaborations have significant potential to promote physical and mental health in the public, and can promote the use of forests in a manner that increases awareness of ecological values in the forest and their preservation. Thus, community initiatives and developing focused activities originating with the people living nearby and express their desires, encourage and promote activity and presence in the forest. As we have presented in this paper, forests and vegetation are effective means to improve patient recuperation and rehabilitation, and it is therefore recommended to promote collaborative initiatives to establish accessible forests near hospitals, rehab centers, assisted living facilities and institutions for people with special needs.

## Strengthening forest protection

Israel is one of the most densely populated countries in the world, and most of its inhabitants reside in urban settlements. The urban lifestyle and the realization of the toll on people's health because of distancing from nature, intensifies the need of people for experiences related to spending time in open spaces. This has been intensified during the COVID pandemic. Therefore, it is of utmost importance to strengthen forest protection both legally and conceptually by exposing the public and decision makers to the health and economic benefits of forests.

The current literature review is the first stage in a study funded by the KKL-JNF Forestry Division that deals with the ways in which forests and open spaces in Israel contribute to the physical and mental health of forest visitors and quantifies the economic value of this benefit. The next part of the study will help formulate focused activity with great potential from the perspective of public health. This activity will help make the forest accessible to visitors, and encourage judicious public activity, while preserving the ecological values in the forest, developing and intensifying focused collaborations with agencies involved in health, education and community, and strengthen forest preservation, planning and management accordingly.

## References

Anderson DC. 2019. Bricks and morals - Hospital buildings, do no harm. *Journal of General Internal Medicine*, 34(2), 312-316.

Association of Nature and Forest Therapy Guides and Programs. 2020. *What is Forest Therapy?* <https://www.natureandforesttherapy.org>

Bach Pagès A, Peñuelas J, Clarà J, Llusià J, Campillo I, López F, and Maneja R. 2020. How should forests be characterized in regard to human health? Evidence from existing literature. *International Journal of Environmental Research and Public Health*, 17(3), 1027.

Bell S. 2009. *European Forest Recreation and Tourism: A Handbook* (1st ed.). Taylor and Francis. <https://doi.org/10.4324/9780203872079>

Bratman GN, Anderson CB, Berman MG, Cochran B, de Vries S, and Daily GC. 2019. Nature and mental health: An ecosystem service perspective. *Science Advances*, 5(7), eaax0903.

Bratman GN, Hamilton JP, and Daily GC. 2012. The impacts of nature experience on human cognitive function and mental health: Nature experience, cognitive function, and mental health. *Annals of the New York Academy of Sciences*, 1249(1), 118-136.

Centre for Sustainable Healthcare. 2018. *10 Year Impact Review*. [https://sustainablehealthcare.org.uk/sites/default/files/final\\_report.pdf](https://sustainablehealthcare.org.uk/sites/default/files/final_report.pdf)

Centre for Sustainable Healthcare. 2021. Welcome. NHS Forest – Growing forests for health. <https://nhsforest.org/>

Chevalier G, Sinatra ST, Oschman JL, Sokal K, and Sokal P. 2012. Earthing: Health implications of reconnecting the human body to the earth's surface electrons. *Journal of Environmental and Public Health*, 2012, 291541.

Corazon SS, Gramkow MC, Poulsen DV, Lygum VL, Zhang G, and Stigsdotter UK. 2019. I would really like to visit the forest, but it is just too difficult: A qualitative study on mobility disability and green spaces. *Scandinavian Journal of Disability Research*, 20(1), 1-13.

Di Carmine F and Berto R. 2020. Contact with nature can help ADHD children to cope with their symptoms. A state of the evidence and future lines of research. *Visions for Sustainability*, 14, 1-11.

Dodev Y, Zhiyanski M, Glushkova M, and Shin WS. 2020. Forest welfare services –The missing link between forest policy and management in the EU. *Forest Policy and Economics*, 118, 102249.

Donnelly AA and MacIntyre TE (Eds). 2019. *Physical Activity in Natural Settings: Green and Blue Exercise*. Routledge.

Engel G. 1977. The need for a new medical model: A challenge for biomedicine. *Science*, 196(4286), 129-136.

Forest Research and O'Brien L. 2021. *Forests, Trees and Human Health and Well-being* (COST Action E39). <https://www.forestresearch.gov.uk/research/forests-trees-and-human-health-and-well-being-cost-action-e39/>

Gidlow CJ, Jones MV, Hurst G, Masterson D, Clark-Carter D, Tarvainen MP, Smith G, and Nieuwenhuijsen M. 2016. Where to put your best foot forward: Psycho-physiological responses to walking in natural and urban environments. *Journal of Environmental Psychology*, 45, 22-29.

Grilli G and Sacchelli S. 2020. Health benefits derived from forest: A review. *International Journal of Environmental Research and Public Health*, 17(17), 6125.

Han JW, Choi H, Jeon YH, Yoon CH, Woo JM, and Kim W. 2016. The effects of forest therapy on coping with chronic widespread pain: Physiological and psychological differences between participants in a forest therapy program and a control group. *International Journal of Environmental Research and Public Health*, 13(3), 255.

Hartig T, Mang M, and Evans GW. 1991. Restorative effects of natural environment experiences. *Environment and Behavior*, 23(1), 3-26.

Hartig T, Evans GW, Jamner LD, Davis DS, and Gärling, T. 2003. Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, 23(2), 109-123.

Hartig T, Mitchell R, de Vries S, and Frumkin H. 2014. Nature and Health. *Annual Review of Public Health*, 35(1), 207-228.

Hartig T and Staats H. 2006. The need for psychological restoration as a determinant of environmental preferences. *Journal of Environmental Psychology*, 26(3), 215-226.

Holt-Lunstad J, Smith TB, and Layton JB. 2010. Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, 7(7), e1000316.

Hug SM, Hartig T, Hansmann R, Seeland K, and Hornung R. 2009. Restorative qualities of indoor and outdoor exercise settings as predictors of exercise frequency. *Health and Place*, 15(4), 971-980.

Kaplan R and Kaplan S. 1989. *The Experience of Nature: A Psychological Perspective*. Cambridge: Cambridge University Press.

Kaplan S. 1995. The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169-182.

Karjalainen E, Sarjala T, and Raitio H. 2010. Promoting human health through forests: Overview and major challenges. *Environmental Health and Preventive Medicine*, 15(1), 1-8.

Kline JD, Rosenberger RS, and White EM. 2011. A national assessment of physical activity in us national forests. *Journal of Forestry*, 109(6), 343-351.

Kobayashi H, Ishibashi K, and Noguchi H. 1999. Heart rate variability; an index for monitoring and analyzing human autonomic activities. *Applied Human Science: Journal of Physiological Anthropology*, 18(2), 53-59.

Kuo M. 2015. How might contact nature promote human health? Promising mechanisms and a possible central pathway. *Frontiers in Psychology*, 6, 1093.

Ladner M. 2017. 10 Places to Forest Bathe in South Korea. Culture Trip. <https://theculturetrip.com/asia/south-korea/articles/10-places-to-forest-bathe-in-south-korea/>

Lawton, R. The healing power of nature. The idea that immersing yourself in forests and nature has a healing effect is far more than just folk wisdom (in Hebrew). <https://aeon.co/essays/why-forests-and-rivers-are-the-most-potent-health-tonic-around>

Lee J, Park BJ, Tsunetsugu Y, Ohira T, Kagawa T, and Miyazaki Y. 2011. Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health*, 125(2), 93-100.

Li OT, Kobayashi M, Wakayama Y, Inagaki H, Katsumata M, Hirata Y, and Li Q. 2010. Effect of forest bathing trips on human immune function. *Environmental Health and Preventive Medicine*, 15(1), 9-17.

Li Q, Kobayashi M, Kumeda S, Ochiai T, Miura T, Kagawa T, Imai M, Wang Z, Otsuka T, and Kawada T. 2016. Effects of forest bathing on cardiovascular and metabolic parameters in middle-aged males. *Evidence-Based Complementary and Alternative Medicine*, 2016, 2587381.

Li Y, Hirata K, Shimizu T, Suzuki H, Kawada T, and Kagawa T. 2011. Acute effects of walking in forest environments on cardiovascular and metabolic parameters. *European Journal of Applied Physiology*, 111(11), 2845-2853.

Luo Y, Huang W, Liu X, Markevych I, Bloom MS, Zhao T, Heinrich J, Yang B, and Dong G. 2020. Greenspace with overweight and obesity: A systematic review and meta-analysis of epidemiological studies up to 2020. *Obesity Reviews*, obr.13078.

Maas J, van Dillen SME, Verheij RA, and Groenewegen PP. 2009. Social contacts as a possible mechanism behind the relation between green space and health. *Health and Place*, 15(2), 586-595.

Mårtensson F, Boldemann C, Söderström M, Blennow M, Englund JE, and Grahn P. 2009. Outdoor environmental assessment of attention promoting settings for preschool children. *Health and Place*, 15(4), 1149-1157.

Maugeri G and Musumeci G. 2021. Adapted physical activity to ensure the physical and psychological well-being of COVID-19 patients. *Journal of Functional Morphology and Kinesiology*, 6(1), 13.

Meyer-Schulz K and Bürger-Arndt R. 2019. Les effets de la forêt sur la santé physique et mentale. Une revue de la littérature scientifique. *Santé Publique*, S1(HS), 115.

Millennium Ecosystem Assessment. 2004. *Ecosystems and Human Well-Being: A Framework for Assessment*. <https://www.millenniumassessment.org/en/Framework.html>

Morita E, Fukuda S, Nagano J, Hamajima N, Yamamoto H, Iwai Y, Nakashima T, Ohira H, and Shirakawa T. 2007. Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. *Public Health*, 121(1), 54-63.

Nesbitt L, Hotte N, Barron S, Cowan J, and Sheppard, SRJ. 2017. The social and economic value of cultural ecosystem services provided by urban forests in North America: A review and suggestions for future research. *Urban Forestry & Urban Greening*, 25, 103-111.

Nilsson K, Sangster M, Gallis C, Hartig T, Vries S, Seeland K, and Schipperijn J (Eds). 2011. *Forests, Trees, and Human Health*. Springer Verlag. <https://drive.google.com/file/d/1KxPg2YS9h5mwHwdE2XR9d4VxpndF7DSv/view?usp=sharing>

O'Brien L and Morris J. 2014. Well-being for all? The social distribution of benefits gained from woodlands and forests in Britain. *Local Environment*, 19(4), 356-383.

Osem Y, Brand D, Tauber Y, Perevolotsky A and Zoref C. 2014. *Forest management policy of Israel – policy and guidelines for planning and managing forests*. Jerusalem: KKL-JNF Forestry Division and Publications Unit, Public Relations Division (in Hebrew).

Park BJ, Tsunetsugu Y, Kasetani T, Kagawa T, and 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.

Park FK, Kasetani T, Takayama N, Kagawa T, and Miyazaki Y. 2011. Relationship between psychological responses and physical environments in forest settings. *Landscape and Urban Planning*, 102(1), 24-32.

Plaut P, Moran M, Mitterani M and Golan L. 2015. *KKL-JNF forests, parks, recreation and activity area – environments that promote health*. The Center for Urban and Regional

Studies, the Faculty of Architecture and Town Planning, the Technion, Haifa (in Hebrew).

**Rosa CD, Larson LR, Collado S, and Profice CC.** 2021. Forest therapy can prevent and treat depression: Evidence from meta-analyses. *Urban Forestry and Urban Greening*, 57, 126943.

**Russell KC.** 2012. Therapeutic uses of nature. In: Clayton SD (Ed). *The Oxford Handbook of Environmental and Conservation Psychology*. Oxford: Oxford University Press. <https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199733026.001.0001/oxfordhb-9780199733026-e-23>

**Ryan CO, Browning WD, Clancy JO, Andrews SL, and Kallianpurkar NB.** 2014. Biophilic design patterns: Emerging nature-based parameters for health and well-being in the built environment. *ArchNet-IJAR: International Journal of Architectural Research*, 8(2), 62.

**Ryan RM and Deci EL.** 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, 25(1), 54-67.

**Sander HA, Ghosh D, and Hodson CB.** 2017. Varying age-gender associations between body mass index and urban greenspace. *Urban Forestry and Urban Greening*, 26, 1-10.

**Seymour V.** 2016. The human–nature relationship and its impact on health: A critical review. *Frontiers in Public Health*, 4, 260.

**Shanahan DF, Bush R, Gaston KJ, Lin BB, Dean J, Barber E, and Fuller RA.** 2016. Health benefits from nature experiences depend on dose. *Scientific Reports*, 6(1), 28551.

**Stigsdotter UK, Corazon, SS, and Ekholm O.** 2018. A nationwide Danish survey on the use of green spaces by people with mobility disabilities. *Scandinavian Journal of Public Health*, 46(6), 597-605.

**Sugiyama T, Leslie E, Giles-Corti B, and Owen N.** 2008. Associations of neighbourhood greenness with physical and mental health: Do walking, social coherence and local social interaction explain the relationships? *Journal of Epidemiology and Community Health*, 62(5), e9–e9.

**Taylor AF, Kuo FE, and Sullivan WC.** 2002. Views of nature and self-discipline: Evidence from inner city children. *Journal of Environmental Psychology*, 22(1-2), 49-63.

**Taylor FA and Kuo FE.** 2011. Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Applied Psychology: Health and Well-Being*, 3(3), 281-303.

**Tesler R, Plaut P, and Endvelt R.** 2018. The effects of an urban forest health intervention program on physical activity, substance abuse, psychosomatic symptoms, and life satisfaction among adolescents. *International Journal of Environmental Research and Public Health*, 15(10), 2134.

**Thompson ER.** 2007. Development and validation of an internationally reliable short-form of the Positive and Negative Affect Schedule (PANAS). *Journal of Cross-Cultural Psychology*, 38(2), 227-242.

**Tyrväinen L, O'Brien L, and Baue N.** 2019. Impacts of forests on human health and wellbeing. In: Marušáková L and Sallmannshofer M (Eds). *Health and Sustainable Forest Management*. Liaison Unit Bratislava: FOREST EUROPE. pp. 30-56. [https://foresteurope.org/wp-content/uploads/2017/08/Forest\\_book\\_final\\_WEBpdf.pdf](https://foresteurope.org/wp-content/uploads/2017/08/Forest_book_final_WEBpdf.pdf)

**Ulrich RS.** 1981. Natural versus urban scenes: Some psychophysiological effects. *Environment and Behavior*, 13(5), 523-556.

**Ulrich RS.** 1983. Aesthetic and affective response to natural environment. In: Altman I and Wohlwill JF (Eds). *Behavior and the Natural Environment*. US: Springer. pp. 85-125.

**USA Department of Agriculture and US Forest Service.** (n.d.). *About the Agency*. <https://www.fs.usda.gov/about-agency>

**USA Department of Agriculture.** 2018. *Urban Nature for Human Health and Well-Being: A Research Summary for Communicating the Health Benefits of Urban Trees and Green Space*. FS-1096. Washington, DC. 24.

**White AI, Grellier J, Wheeler BW, Hartig T, Warber SL, Bone A, Depledge MH, and Fleming LE.** 2019. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports*, 9(1), 7730.

**White MP, Pahl S, Ashbullby K, Herbert S, and Depledge MH.** 2013. Feelings of restoration from recent nature visits. *Journal of Environmental Psychology*, 35, 40-51.

**Wilson EO.** 1984. *Biophilia: The Human Bond with Other Species*. Cambridge: Harvard University Press.

**World Health Organization.** 2006. *Constitution of the World Health Organization – Basic Documents*, 45th edition, Supplement. [https://www.who.int/governance/eb/who\\_constitution\\_en.pdf](https://www.who.int/governance/eb/who_constitution_en.pdf)

**Yeager RA, Smith TR, and Bhatnagar A.** 2020. Green environments and cardiovascular health. *Trends in Cardiovascular Medicine*, 30(4), 241-246.



Final event – Gilboa March, 2010  
Photo: Tsipi Eshet



Visitors at Har Adar Forest, 2008  
Photo: Tsipi Eshet

